ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
FACULTY OF COMPUTER AND MATHEMATICAL SCIENCES
DEPARTMENT OF COMPUTER SCIENCE

DESIGN AND IMPLEMENTATION OF AUTOMATIC MORPHOLOGICAL ANALYZER FOR GE'EZ VERBS

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DEDICATION

This thesis is dedicated to my father Berihu Weldegiorgis and my mother Mana G/egziabher.

I would like also to dedicate to the Ethiopian Orthodox Tewahido Church and her scholars for their dedication and faithfulness to preserve and hand down the language along with all resources written in it to this generation!

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ABBREVIATIONS AND SYMBOLS USED

SYMBOLS:

[ ] What is inside is a citation

/ / What is inside is a transliterated Geʿez word in *italics*.

' ' What is inside is a direct English translation of a Geʿez word.

( ) What is inside is a gloss or abbreviation or elaboration

ABBREVIATIONS:

1ppn = first person plural neutral

1psn = first person singular neutral

2ppf = second person plural feminine

2ppm = second person plural masculine

2psf = second person singular feminine

2psm = second person singular masculine

3ppf = third person plural feminine

3ppm = third person plural masculine

3psf = third person singular feminine

3psm = third person singular masculine

EOTC = Ethiopian Orthodox Tewahido Church

AI = Artificial Intelligence

CV = Consonant-Vowel

NL = Natural Language

NLP = Natural Language Processing

NLU = Natural Language Understanding

OMS = object marker suffix

POS = Part of Speech

SMS = subject marker suffix

TLM = Two-Level Morphology

TLMM = Two-Level Model Morphology

ABSTRACT

Morphological analysis is a crucial component of several natural language processing tasks including machine translation, spell-check, speech recognition, dictionary (lexicon) compilation, POS tagging, etc., especially for languages with a highly complex morphology, where stipulating a full lexicon of surface forms is not feasible.

Nowadays, analyzers of different kinds have been developed for languages that have relatively wider use internationally. The same cannot be said for Geʿez, the classic language of Ethiopia where majority of the Ethiopian indigenous historical, philosophical, ethical, religious, etc., literatures and ancient manuscripts are written with. This study is, thus, an attempt to design a morphological analyzer model for Geʿez verbs thereby contributing to the goal of developing a full-fledged NLP application for Geʿez. For this purpose, rule-based approaches specifically CV-based and Two-Level Morphology (TLM) are adopted to design the model and to implement the prototype of the analyzer. Besides, the analyzer uses a knowledgebase as a demon while identifying the morphosyntactic features. Finally, algorithms that take into consideration the morphological, morpho-phonological and orthographic properties of Geʿez language are developed from scratch and applied, as there are no previous such attempts.

The prototype was tested with verbs which are extracted manually by domain experts from all twenty seven New Testament books of the Ethiopic Version Bible. The accuracy of the output generated by the analyzer was compared with the manually prepared analyses of the same verb-set by the language experts at two levels: at features-of-verbs level and at verb level. Accordingly, it is observed that the analyzer has analyzed these verbs with an accuracy of 92.05% at feature level and of 73.98% at verb level. The analysis output comprises the lexeme and all valued morphosyntactic features including affixes together with their syntactical functions, indicated subjects and objects along with their person-gender-number features, tense-mood and stem type of the verb, etc. At large, this research has realized the design and implementation of automatic morphological analyzer for Geʿez verbs.

Keywords: Geʿez verbs, Geʿez verbs analyzer, Morphological Analyzer, Geʿez Morphology

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Language is one of the fundamental aspects of human behavior and it constitutes a crucial component of our lives. In its written form it serves as a means of recording information and knowledge on a long term-basis and transmitting what it records from one generation to the next [Allen, 1996].

Linguistics can be defined as the study of languages, particularly, natural languages. Natural language is a set of conventions used by human beings for communication purposes [Gazdar, 1996]. The academic discipline that studies computer processing of natural language (NL) is known as natural language processing (NLP).

NLP is a theoretically motivated range of computational techniques for analyzing and representing naturally occurring texts at one or more levels of linguistic analysis for the purpose of achieving human-like language processing for a range of tasks or applications [Liddy, 2001]. It encompasses a broad set of techniques for automated generation, manipulation and analysis of natural or human languages. Grishman [1984] states that NLP involves the development of computational models of a language, and based on this developing computer programs that can analyze NL and act appropriately on the information contained in the text or information.

Although most NLP techniques inherit largely from Linguistics and Artificial Intelligence (AI), they are also influenced by relatively newer areas such as Machine Learning, Computational Statistics and Cognitive Science [Madnani, 2009].

The goal of NLP, as stated above, is to accomplish human-like language processing. The choice of the word „processing" is very deliberate, and should not be replaced with „understanding". Although the field of NLP was originally referred to as Natural Language Understanding (NLU) in the early days of AI, it is well agreed today that while the goal of NLP is true NLU, that goal has not yet been attained. A full NLU System would be able to:

- Paraphrase an input text
- Translate the text into another language
- Answer questions about the contents of the text
- Draw inferences from the text

While NLP has made serious inroads into accomplishing the first three goals above, the fact that NLP systems cannot draw inferences from text makes NLU to remain still unaccomplished goal of NLP [Liddy, 2001].

In order to fully achieve the above mentioned goals, NLP systems are currently studied at different levels of natural language. These levels are: phonetics (deals with what sounds are used in human speech), phonology (deals with how languages use and combine sounds), morphology (deals with how languages form words), syntax (deals with how languages form sentences), semantics (deals with how languages convey meaning in sentences) and pragmatics (deals with how people use language to communicate) [Hockenmaier, 2008].

Current NLP systems tend to implement modules to accomplish mainly the lower levels of processing. This is for several reasons. First, the application may not require interpretation at the higher levels. Secondly, the lower levels have been more thoroughly researched and implemented. Thirdly, the lower levels deal with smaller units of analysis, e.g. morphemes, words, and sentences, which are rule-governed, versus the higher levels of language processing which deal with texts and world knowledge, and which are only regularity-governed [Liddy, 2001]. This study is based on the morphology level of NLP.

Nonetheless, NLP is an extremely problematical task. This difficulty emanates from the fact that natural language (NL) involves a large number of classes and relationships whose existence is not transparent from the surface structure of the natural language [Mao, 1997]. Such complication becomes even worse for highly inflected Semitic language such as Geʿez. In such languages, different word forms can be generated from a single basic unit called the root. The following example shows just a few of the many word forms that can be obtained from a single perfective root */f-q-d/* of third person singular masculine (3psm) (see section 3.4 of chapter 3 for detailed discussion).

Table 1.1: Some surface verbs of the root ፍቅድ */f-q-d/* with subject marker 'He' (3psm).

No.	Ge'ez	Transliterated	Gloss
1	ፈቀደ	fäqädä	He liked
2	ፈቀደኒ	fäqädäni	He liked me
3	ፈቀደነ	fäqädänä	He liked us
4	ፈቀደከ	fäqädäkä	He liked you(2psm)
5	ፈቀደክሙ	fäqädäkmu	He liked you(2ppm)
6	ፈቀደኪ	fäqädäki	He liked you(2psf)
7	ፈቀደክን	fäqädäkn	He liked you(2ppf)
8	ፈቀዶ	fäqädo	He liked him
9	ፈቀዶሙ	fäqädomu	He liked them(3ppm)
10	ፈቀዳ	fäqäda	He liked her
11	ፈቀዶን	fäqädon	He liked them(3ppf)
12	አስተፋቀደ	ästäfaqäd	He caused others to like each other
13	አስተፋቀዳ	astäfaqda	He caused her to be liked with
14	አፍቀደ	afqädä	He caused somebody to be liked
15	አፍቀደኒ	afqädäni	He caused me to be liked
16	አፍቀደነ	afqädnä	He caused us to be liked
17	አፍቀደከ	afqädäkä	He caused you(2psm) to be liked
18	አፍቀደክሙ	afqädäkmu	He caused you(2ppm) to be liked
19	አፍቀደኪ	afqädäki	He caused you(2psf) to be liked
20	አፍቀደክን	afqädäkn	He caused you(2ppf) to be liked
21	አፍቀዶ	afqädo	He caused him to be liked
22	አፍቀዶሙ	afqädomu	He caused them(3ppm) to be liked
23	አስተፋቀዶሙ	astäfaqädomu	He caused them(3ppm) to like each
24	ተፈቅደ	täfäqdä	He is liked by
25	ተፋቀደ	täfaqädä	He is liked with somebody
26	አፍቀዳ	afqäda	He caused her to be liked
27	አፍቀዶን	afqädon	He caused them(3ppf) to be liked
28	አስተፋቀደኒ	astäfaqädäni	He caused me to like with others
29	አስተፋቀደነ	astäfaqädänä	He caused us to like with others
30	አስተፋቀደከ	astäfaqädäkä	He caused you(2psm) to like with
31	አስተፋቀደክሙ	astäfaqädäkmu	He caused you(2ppm) to like with
32	አስተፋቀደኪ	astäfaqädäki	He caused you(2psf) to like with
33	አስተፋቀደክን	astäfaqädäkn	He caused you(2ppf) to like with
34	አስተፋቀዶ	astäfaqädo	He caused him to like with others
35	አስተፋቀዶን	astäfaqädon	He caused them(3ppf) to like with

For computers to understand NLs, they should be made to handle such variants of the same basic word form together with the unique meanings and the specific interpretations that each form has. This further complicates the task for computers to understand NL.

In this regard, works in computational linguistics or NLP systems tried to develop a system for processing NL at different levels of complexity to have a general NLU system [Allen, 1996]. There are, for instance, systems developed for processing NL at phoneme, word, sentence, and pragmatic levels. These systems are developed in such a way that the output of a lower system can serve as an input for the next higher level. For instance, the output of a morphological analyzer that works at word level could serve as an input for syntactic and semantic parsers that work at sentence level [Uibo, 2001]. The analyzer in this case will enable one to analyze the surface form (e.g. speculating) to its constituent distinct parts called morphemes (e.g. /speculate/ and /ing/). Thus, the morphological analyzer will accept the surface words as an input to analyze them into their basic lexical form together with the features tags it has.

What distinguishes language processing applications from other data processing systems is their use of knowledge of language. Sophisticated applications like machine translation systems, or robust question-answering systems, require much broader and deeper knowledge of language. Such kind of systems need to differentiate, for instance, word constructions like *I'm* and *can't*. Producing and recognizing these and other variations of individual words (e.g., recognizing that */doors/* is plural) requires knowledge about morphology, the way words break down into component parts that carry meanings like *singular* versus *plural* [Jurafsky and Martin, 2006].

Morphological analyzer has vital role in NLP systems. It is used to analyze surface word forms, which are the ones that are found in everyday communication, into their lexical components along with the grammatical function of all morphemes affixed to it. Such a system is used as a subcomponent of NLP in applications like machine translation, dictionary (lexicon) development, and spelling and grammar checking [Harris, 1985]. Thus, it is the purpose of this study to design and implement an automatic morphological analyzer useful for analyzing Ge"ez verbs.

Written Ge"ez can be traced back to the 4th century A.D. There are several witnesses confirming that Ethiopia had its own ancient educational system and writings [Heinrich, 1896]. For example, one can see various inscriptions which are written on the obelisks of Axum with Ge"ez, Saba, and Greek languages. The inscriptions narrate the activities of the then King of Ethiopia, King Ezana. This indicates that different writings were used in the country since the ancient time. This language is used

today only for religious writings and liturgical services in the Ethiopian Orthodox Tewahido Church (EOTC).

1.2 Statement of the Problem

At any time a country has to protect its own philosophy, tradition, history, knowledge and sovereignty which reflect its own identity as these all are the bases to development. Any kind of civilization agendas proposed to be implemented in a given country should take such basic contexts of the country into consideration.

Ethiopia is one of the ancient countries in the world. It has a well-defined history of more than three thousand years [Lule, 1986], an ancient and well-developed educational system, philosophy and writings [Heinrich, 1896] which are uniquely attributed to it. Furthermore, the country has its own language [Dillmann, 1899] with its alphabets and numerical system, manuscripts, arts, calendar and hymns which make it unique from all African countries [Bender, 1976]. Most of such identities of the country are found being written in Ge"ez language.

Ge"ez is the classical language of Ethiopia. It is the language of many Ethiopian literatures and manuscripts. Several ancient manuscripts[1], arts (*qəne*), scriptures, heritages, historical, ethical and religious chronicles that can be used as a primary source of knowledge are found in Ge"ez language.

The Ethiopic Bible contains 81 Books; 46 of the Old Testament and 35 of the New Testament. Of these, scriptures like Enoch are notable since its complete text has survived in no other language but in Ge"ez. Other Theological and hymn books such as the */Dɔgwa/*, */Miɔraf/*, */Mäwasɔt/*, */Zmare/*, */Şome Dɔg^{w}a/*[2], */Sä'atat/* (literally means „Book of Hours"- which contains day and night prayers), */Mäşhafä Mistr/* (the Book of Mystery)*, /Gädlä Sämaɔtat/* (Deeds of the Martyrs), */Gädlä Hawaryat/* (Deeds of the Apostles), Synaxarium (The Book of the Saints of the Ethiopian Orthodox Church) */Matshafa Berhan/* (the Book of Light) and */Matshafa Milad/* (The Book of Nativity), */Anqasa Amin/*

[1] The Ethiopian collection in the British Library comprises some 800 manuscripts written in Ge"ez dating from the 15th to the 20th centuries, notably including magical and divinatory scrolls, and illuminated manuscripts of the 16th to 17th centuries [see *http://en.academic.ru*].

[2] */Dɔgwa/*, */Miɔraf/*, */Mäwasɔt/*, */Zmare/*, */Şome Dɔg^{w}a/* are all composed by St. Yared, the father of Ethiopian church music (hymn), and are used for prayer and as commentary of the Bible.

(Gate of the Faith), */Fekkare Malakot/* (Exposition of the Godhead), */Retu'a Haimanot/* (True Orthodoxy), etc. are found being written in Geʿez.

Some of the historic books found in Geʿez are */Mäshäfä Aksum/* (Book of Axum), */Zena Ayhud/* (History of the Jews), */Kibrä Nägäst/* (Glory of the Kings; written by the Neburaʿed Yeshaq of Aksum is among the most significant works of Ethiopian literature, combining history, allegory and symbolism in a retelling of the story of Queen Sheba, King Solomon, and their son Menelik I of Ethiopia [Wallis, 1928]).

/Fitha Negest/ (Laws of the Kings) which was functioning as the supreme Law for Ethiopia until it was replaced by a modern Constitution in 1931 and is now used as a source of laws and regulations both by the church and the state is also one from among the Geʿez literatures. On the other hand, an arithmetic and calendar book, called */Mäshäfä Abushahar/*, which is used to calculate the Ethiopian calendar is also found in Geʿez language.

These resources can be used as source of philosophy, creativity, knowledge and civilization both to Ethiopia and the rest of world. Indeed, a person who is intended to survey or conduct a research on issues related to the history, tradition, custom, politics and long-lasting religion of the Ethiopians and explore the works handed down from the previous generations to the current generation has to, first, investigate these multi-functional scriptures and literatures. To use these resources, however, one must know the language itself or else these literatures have to be translated into either of the currently spoken languages manually –which may take oneʿs lifelong time.

In addition to this, as the language is the ancestor of other modern Ethio-Semitic languages like Tigrinya and Amharic [Bender, 1976], professionals of these languages should also know the linguistic nature of Geʿez language to earnestly understand and investigate the nature of these modern ones. This is because these languages use the scripts of Geʿez and share a lot of words of Geʿez. Besides, the tendency of pronouncing more than two alphabets of Geʿez in the Amharic language with the same voice and confusing with "which to use when and where" is emanated from the lack of investigating the right sound that the alphabets represent as they are in Geʿez.

At large, studying the language in a scientific approach is the critical issue for one to have a deep understanding of the identity of the nation. Nevertheless, the potential resources of evidence and

knowledge are locked in a "knowledge tomb" box which is seldom visited only by some experts (Geʿez scholars) for a specific purpose. This box is locked by a special key, the language Geʿez. Lack of efforts in making the language operational and in exploiting its usage with scientific approaches seems to be the reason for people of the current generation to be ignorant of such resources. And hence, unlocking the box by finding the key (Geʿez), studying the nature of the language computationally and finally releasing the resources out with the help of Information Technology (IT) to be used by everyone of this era is a critical assignment that deserves research. As the result, it is worth conducting research and also to develop an automatic morphological analyzer for Geʿez to contribute to the complete usage of the language by the generation.

1.3 Objective of the Research Work

1.3.1 General Objective

The main objective of this research work is to design and implement a morphological analyzer model for Geʿez verbs.

1.3.2 Specific Objective

In order to achieve the general objective stated above, the study attempts the following specific objectives:

- Studying the morphological property of Geez verbs to identify important properties to be used by the analyzer;
- Reviewing the various techniques (or approaches) and identifying one which is found appropriate for developing morphological analyzer for verbs of Geʿez language;
- Developing a lexicon which is sufficient for demonstrating the prototype of the model;
- Formulating possible morphological rules of Geʿez verbs to be used by the analyzer;
- Developing a prototype of morphological analyzer for Geʿez verbs;
- Testing the prototype of morphological analyzer for Geʿez verbs;
- Forwarding recommendations for further study.

1.4 Scope and limitation of the Study

We bound the scope of this study to verbs of Geʿez language for the following reasons:

- As many of the Geez scholars suggest in their various grammar books [Zäradawit, 1996], [Kidanä Wäld, 1948], [Bälay, 2002], etc., verbs of Geez language have highly inflectional and complex morphology in comparison with words of other POS category. The researcher has worked out the „declaration process"[3] of the verbs to find the maximum possible inflections of a given transitive verb, as an example, and affirmed that almost each of the transitive verbs of Ge"ez has around 1388 possible surface verb forms (see the Appendix II from A to F).
- In any kind of text, it is impossible for a sentence to exist without having a verb in it. Words of other POS category, however, are not necessarily found in any sentences. This indicates that the probability of the occurrence of verbs in a given text is much higher than that of words of other POS categories.
- Studying verbs of Ge"ez before words of any other category of the language is very important as many of the verbs in Ge"ez are indeed the base for many words of other category. That is, there are many nouns, adjectives and adverbs which are basically derived from verbs (see Table 1.2).

Table 1.2: Words of other POS category derived from a verb

Verb	Derived words	Gloss	POS Category
ቀተለ */qätälä/*	ቀታሊ */qätali/*	Killer (male)	Adjective
	ቀታሊት */qätalit/*	Killer (female)	Adjective
	ቀታልያን */qätalyan/*	Killers (they,3ppm)	Adjective
	ቀታልያት */qätalyat/*	Killers (they,3ppf)	Adjective
	ቀቲል */qätil/*	Act of killing	Noun
	ቀቲሎት */qätilot/*	Act of killing	Noun
	ቅቱል */qtul/*	Killed (male, singular)	Adjective
	ቅቱላን */qtulan/*	Killed (male, plural)	Adjective
	ቅትልት */qtlt/*	Killed (female, singular)	Adjective
	ቅቱላት */qtulat/*	Killed (female, plural)	Adjective
	ቅትለት */qtlät/*	Act of killing	Noun

Further, the research is limited to the Ge"ez ቀተለ */qätälä/* category verb forms because they have a dominant and representative nature among the other categories. As to the survey conducted by the researcher on the New Testament of Ethiopic Version Bible, more than 46.81% of the verbs are found to be sorted under this category. And hence, studying this category will imply studying roughly all other categories with some modifications on the algorithms developed for this category verbs

[3] The Phrase „Declaration Process" is used for what is known in Ge"ez አርባ ቅምር or ረብሐ ግስ.

The constraints we faced are the facts that the language does not have a native speaker who can give its basic linguistic facts and that there is no study, as far as we know, done on the language so far from the computational perspective.

1.5 Related Works

The fact that the design of morphological analyzer is comprised of two basic components - a lexicon and a set of rules – is used in many morphological analyzer systems [Yona, 2004], [Shlomo& Wintner, 2005], [Beesely, 2003]. A morphological analyzer for Modern Hebrew [Yona, 2004] was developed based on these two components. The set of rules comprehensively covers the morphological, morpho-phonological and orthographic phenomena. The same approach was used by [Beesely, 2003] to develop a morphological analyzer and generator based on these two components. A rule-based approach has been employed as a principal approach in both of these works. The Hebrew analyzer was developed using the finite-states as a leading technique whereas the Arabic system was developed using the two-level morphological system. In both works, the analysis display the root, pattern and all other affixes together with feature tags indicating part of speech, person, number, mood, voice, aspect, etc.

A morphological analyzer which does the analysis of simple Amharic verbal stems into their roots and feature tags has been developed by Saba & Girma [2006]. This thesis focused on devising an analyzer for Amharic verbs which have more of non-concatenative morphotactics nature and for its achievement they have used the rule-based approach. The paper affirms that non-concatenative operations of vocalic intercalation, reduplication accompanied by vowel insertion and radical reduction are the main components of word formation processes in languages with non-concatenative morphology like Amharic. Two of these operations, the vocalic intercalation and radical reduction, seem to be valid for Geʿez too.

Muluken [2007] has analyzed the declaration of Geʿez verbs according to the three traditional schools of */qəne/*. He has tried to show the nature and declaration of Geʿez verbs according to the Ethiopian scholars in different schools. He gave more emphasis to the Geʿez verb paradigms and their classification into heads and troops (details of heads and troops is given in section 3.4.3) or bases and derivations according to both the Ethiopian and foreign scholars. We found it helpful for the

understanding of way of classification of the verbs in the traditional schools of Ethiopia as the analysis was purely from the linguistics perspective.

We have also reviewed the Geʿez grammar books written by several scholars (Ethiopian and foreign scholars) among which are the books Aläqa Kidanä Wäld Kiflä [1948], Mämhr Zäradawit Adhana [1996], Liqähruyan Bälay Mäkonän [2002], Aläqa Afäwärq Zäwdä [1988], Dillmann [1899], Leslau [1987: VI], Lambdin [1978], Ludolf [1699] and Bender [1976]. These books are used to study and thoroughly understand the linquistic nature of the language based on the analyses provided by these scholars on the Geʿez verbs.

1.6 Methodology

For the successful completion of this study, the following methods have been used.

1.6.1 Literature Review and Discussion with Ge'ez Experts

The primary sources of information for this study are scholars of Geʿez in the EOTC who have studied Geʿez both traditionally and scientifically. Continous discussions with these scholars in the area of Geʿez language morphology were conducted to better understand the morphology of the language and get information which is invaluable for the study. Other sources used for a thorough understanding of the language are the Geʿez grammar */säwasɔ̂w/* books written by the foreign and traditional scholars such as Aläqa Kidanä Wäld Kiflä [1948], Mämhr Zäradawit Adhana [1996], Dillmann [1899], Leslau [1987: VI], etc. which are now found in different libraries, monasteries and churches.

Furthermore, a number of resources including research reports, journal articles, manuals, and other published and unpublished thesis have been used for the following purposes:

- To understand the overall morphological structure of verbs of Semitic languages in general and that of the Geʿez verbs in particular for no previous computational works are available for this language;
- To study techniques or approaches in morphological analysis and to adopt one that is found appropriate to the current research work;
- To know the components a morphological analyzer should have to accomplish a correct and efficient analysis.
- To know how to develop test data for morphological analysis research work.

1.6.2 Knowledgebase and Algorithm Development

As the Hebrew and the Arabic analyzers, we too propose for the analyzer to have two components: linguistically motivated rules and a knowledgebase. A knowledgebase, which basically contains the facts and rules formulated based on the morphotactic of the language, is developed to help the analyzer while identifying the features of the surface verbs in some stages of the analysis process.

Besides, algorithms are designed from scratch as there are no previously designed algorithms for this purpose based on the morphological properties of the language to analyze any surface verbs of */qätälä/* category to its constituent morphemes and to identify the role of each of the morphemes in the inflected verb.

1.6.3 Development of the prototype morphological analyzer

A combination of the two rule-based approaches, namely the CV-based (see section 2.3.2.1 of chapter two) and Two-Level Model (TLM) (see section 2.3.2.2) morphology are selected based on the morphological properties of Ge"ez and are used in this study. The CV-based approach is used to help the analyzer know the tense-mood, stem type and lexeme of the surface verb by identifying the templates of each of the tense-mood forms of a given verb. TLM is then used to handle the phonological and morphophonemic changes, which had been involved in the formation of the verb, during the analysis of the verb back into its constructing forms.

Different lexicons as a knowledgebase and algorithms required for the development of the analyzer using the above two approaches are also designed from the scratch, as there are no previously developed Ge"ez morphological analysis algorithms. While developing these algorithms, effort is waged to consider the phonological and morphological properties of Ge"ez verbs. Then, a prototype morphological analyzer for Ge"ez */qätälä/* category verbs is developed to test the accuracy of the algorithms. As a tool of development, we use Java NetBeans IDE 6.7.1 to show the prototype of the morphological analyzer for Ge"ez */qätälä/* category verbs. Java is chosen because of the following basic qualities which our system requires:

- Java-based systems can run in any platform.

- Java has vast amount of supplier and programmer support and acceptance.

For designing the lexicons, we use MS SQL Server Management Studio Express.

1.7 Testing Procedures

As a testing data, we have collected 1177 (neglecting repeatations) from all twenty seven books of the New Testament of the Ethiopic Version Bible. The analyzer is fed with such verbs. Finally, the analysis output of the system is cross checked with analysis of these verbs done manually by linguists. Upon the experiment result obtained and suggestions forwarded from the experts, incorrect analyses are made to be corrected and the performance of the system is also measured based on the number of correctly analyzed verbs and of errors reported from the final testing of the system (details of the testing procedures are given in section 5.3).

1.8 Application of the Results and Beneficiaries

Morphological analyzer is one of the most basic components of NLP [Harris, 1985]. Accordingly, morphological analyzer will also be important component of the NLP to be developed for Geʻez. Thus, the beneficiaries of this study include researchers who need to take part in achieving the goal of developing efficient NLP system for Geʻez language.

The study could also be used:

- As a base for building a full-fledged morphological system for Geʻez;
- As a component for the development of higher forms of NLP systems such as machine translation, spell-check, speech recognition, automatic dictionary (lexicon) compilation, POS tagging, morphological synthesizer, automatic sentence construction, etc.

  E.g., a very simplified version of morphological analysis is called Stemming. Stemming is a process of obtaining a stem and affixes from a surface verb, where the stem is theobjective of this operation. Its main use is as part of a term normalization process that is very important for setting up Information Retrieval systems [Yona, 2004].
- To help Geʻez learners.
- To put linguistically motivated structure of Geʻez verbs;
- To build a morphological dictionary for Geʻez verb, etc.

1.9 Organization of the Thesis

This section describes the organization of each chapters of this thesis work.

Chapter two discusses about the basic concepts of language morphology, general terminologies used in the study, types of morphologies and the basic approaches employed for this study.

Chapter three describes Geʿez verbs and their formation process, the writing system of Geʿez language, classification and issue of affixation in Geʿez verbs, the conjugation patterns and stems of Geʿez */qätälä/* category verbs, declaration process of Geʿez verbs, irregular verbs, assimilation effects and other vowel changes in Geʿez language.

In chapter four, the main contribution of this study, the architecture of the model of Geʿez verbs analyzer, particularly for */qätälä/* category verbs along with the implementation principle of the model are discussed. Besides, it describes the design of the kowledgebase used as an expert by analyzer and the application of the CV-based and TLM techniques in this study. Also described are all the algorithms developed to be inforced by the analyzer while analyzing a given verb of the domain.

Chapter five dicusses about implementation of the prototype of the algorithms designed, the data set (verb-set) prepared for testing the prototype, the experimental procedures followed to test the prototype and the results achieved after testing the model of the analyzer proposed in chapter four. Also discussed are the causes of errors encountered during the experiment.

In Chapter six, the conclusion, recommendations and future works are detailed upon the achievement of the study. Finally, the references used in this study have been following this chapter. Also to the end is the Appendices which covers the full set of Geʿez alphabets, the complete Geʿez verb declaration process to find all possible inflected surface verbs of a given lexeme form of a verb, the pseudo-codes of some of the algorithms developed, sample features incorporated to the kowledgebase and sample of the testing data.

CHAPTER TWO

MORPHOLOGICAL ANALYZER

2.1 Introduction

As it is discussed in the first chapter, the central objective of this research work is to design morphological analyzer of Ge"ez verbs. Morphology studies the structure of words. Morphological analysis is the computational process which provides information about the structure of a given surface word.

In this chapter, basic concepts of morphology and various computational approaches which can be used to design morphological analyzers are discussed. We discuss the principal concepts and terminologies of language morphology in section 2.2 and that of the approaches used in this study in section 2.3.

2.2 Concepts and Terminologies in Morphology

Morphology is the study of the way words are built up from smaller meaning-bearing units, called morphemes [Jurasfsky and Martine, 2006]. Morpheme is the building block from which a word is made up from. It cannot be broken down further into meaningful parts. Depending on the number of morphemes they contain, words can be broadly categorized as simple and complex ones [Akmajian *et.al*, 2003]. A word which contains a single morpheme is called simple word (e.g., the word /tree/ has only one morpheme and, hence, is simple word) whereas a word of more than one morpheme is called complex word (the word /trees/ is made up of two parts: the noun /tree/ and the plural ending /-s/ and, hence, is complex word).

2.2.1 The Morphemes

As described above, morpheme is the minimum meaning-bearing unit in a language. Morphemes are further categorized into two classes: „free" morphemes and „bound" morphemes [Akmajian *et.al*, 2003]. A „free" morpheme, for instance /book/, can stand alone as an independent word in a sentence. Such words are also called monomorphemic as they consist of a single morpheme. On the other hand, bound morpheme cannot stand alone but must be attached to another morpheme - as, for instance, the plural morpheme /–s/ in the word /books/. A free morpheme is referred as "stem" or „main" morpheme of the word, as it supplies the main meaning, while the bound morphemes add „additional" meaning of various

kinds [Jurasfsky and Martine, 2006]. We also use, throughout the thesis, the term „base stem" to refer to the lexicon form morpheme which constitutes the basic part of the verb (as our focus is on verbs of Ge"ez). For example, the English verbs /sang/, /sung/ and /sings/ are all surface forms[4] of the verbal stem /sing/. As most of the Semitic languages do, we refer to the third person singular masculine (3psm) form of the verb as „lexeme" of the verb. Yet is this lexeme form of a verb which serves as an origin to all surface forms of that verb. One basic task of the morphological analyzer is to parse the surface word to its lexeme form, also called stemming[5], in addition to the other features parsed together with it.

Bound morphemes can also be further categorized into two groups as affixes and contracted forms [Akmajian *et.al*, 2003].

a) *Affixes*

Affixes are further divided into prefixes, suffixes, circumfixes, and infixes. A prefix is an affix which precedes the seed[6]. In English, /re-/, /im-/, /un-/ in words like *redo*, *impossible*, and *unlike* are example of prefixes. The hyphen (-) indicates the position of the attachment. Similarly, in Ge"ez, ተ */tä-/*, ይ */y-/*, and ን */n-/* in words like ተፈቅደ */täfäkdä/* (he is liked by), ይፈቅድ */yfäqd/* (he will like), and ንቀትል */nqätl/* (we will kill) are example of prefixes.

A suffix, on the other hand, is an affix which follows the seed. For instance; /–ize/ in an English word *modernize* and ክሙ */–kmu/* in a Ge"ez word ፈቀድክሙ */fäqädkmu/* (you liked) (2ppm[7]) are examples of suffixes. A suffix which is applied to every word of the same POS is called productive suffix [Jurasfsky and Martin, 2006]. For instance, the gerunds suffix /-ing/ of verbs and the plural suffix /-s/ of nouns are productive suffixes. Productive suffixes can even be applied to newly added words of the language.

A circumfix is the combination of both prefix and suffix which together attached to the seed to bring different meaning from the former one. In Ge"ez, the combination of the prefix ይ*/y-/* and the suffix ኦ */-ä/* in the seed ፈቀድ */fäqäd/*, which becomes ይ-ፈቅድ-ኦ */y-fäqd-ä/* (he will like), is an example of circumfix.

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[4]**Surface form**of a verb is any verb form of the lexeme found in texts. That is, it is the written form of the lexeme.
[5]**Stemming** is a process of obtaining a stem and affixes from a surface word, where finding the **stem** is the objective of this operation.
[6]**Seed** is the name given to the part of a verb which doesn"t have affix (see details in sections 2.3.1.2 of this chapter)
[7]**2ppm** – stands for Second Person Plural Masculine

An infix is also another kind of affix which is inserted within the seed. Infixing in Geʿez is realized with the internal modification of the seed. Infixation of different vocalic patterns to the root of the seed results at different verb-forms with varied tense-moods, person, gender, number, etc.

A morphology that uses the first three kinds of affixes (prefix, suffix, and circumfix) is called concatenatative morphology whereas a morphology that uses infix in addition to the above three is said to be nonconcatenatative morphology [Antworth, 1991]. Accordingly, Geʿez has geberally nonconcatinative morphology.

One important point that should be noticed here is the fact that affixation and compounding are two different aspects of morphology. Their major dissimilarity lies in the nature of morphemes they combine [Trost, 2000]. Affixation attaches a bound morpheme onto a free morpheme whereas compounding combines two freely standing morphemes to form another word forms. For example, the word /shopkeeper/ is the combination of the two free morphemes: /shop/ and /keeper/. Alike to the English compound words, Geʿez compound words are separated with space but are compounded while speaking and reading. But still, one morpheme of the compound is affected by the other. For example, the Geʿez words **ወላዲት** */wäladit/* (bearer) and **አምላክ** */amlak/* (God) are two free morphemes. While compounding, however, they produce **ወላዲተ አምላክ** */wäladitä amlak/* (God-bearer) -the vowel */ä/* is added to the end of the first morpheme.

b) Contracted Forms (clitics)

A contracted form morpheme, another category of bound morphemes, is a morpheme that acts syntactically like a word, but is reduced in form and attached to another word. Such type of morpheme is also called clitic. Cliticization is the combination of a word stem with a clitic. For example, the English morpheme /„ve/ in the word *I've* is a clitic. Geʿez doesnʿt have a clitic morpheme at all. In some Semitic languages like Tigrigna, an official language of Eritrea and Tigray in Ethiopia, however, clitic morphemes are common. For example, the word **ከምኡ'ውን** */kämu'wun/* (in addition), in Tigrigna, is the cliticization of the phrase **ከምኡ እውን** */kämu ∂wun/* and hence, the morpheme **'ውን**/*'wun/* is a clitic.

2.2.2 Word Structure: Morphotactics

Every known language has systematic rules which govern pronunciation, word formation, and grammatical pronunciation. Further, the way in which meanings are associated with words or phrases of a language is characterized by regular rules [Akmajian *et.al*, 2003]. Accordingly, there have to be a kind

of rules that govern the arrangement of morphemes to create a word. Usually, it is the word grammar of one‟s language that determines these rules. A subfield of morphology that deals with such rules is called morphotactics.

Morphotactics are rules by which complex words are built up from simpler words and morphemes and, conversely, these same rules permit complex words to be analyzed into simpler ones [Akmajian *et.al*, 2003]. That is, it is a word grammar which puts several constraints on how the morphemes should be arranged to create a natural word found in any text written with that language. This implies that morphotactics is language-specific, which in turn, leads to a more general conclusion that morphology is too.

In order for the morphological analyzer to parse surface complex words robustly back to atomic constituents, it should take the morphotactic rules into account. For instance, verbs in Ge‟ez, as in most Semitic languages, cannot be spoken or written without having subject marker either being suffixed or circuffixed to their seed. For example: rules like- the subject markers of verbs precede object markers (see section 3.5); if a verb has the negative marker prefix */i-/*, it should be found before the subject marker of that verb- are examples of general morphotactic rules for Ge‟ez verbs. Missing such rules will result in errornous analysis. And hence, the analyzer ought to have a component with a role of enforcing these rules and help it in determining the constituent features[8] of complex words while parsing[9] -i.e., the morphotactics.

When morphemes concatenate to form a larger unit, the sound or shape of morphemes may be influenced and results in orthographical or phonological changes. This kind of influence is called phonological influence. Phonology is another subfield of linguistics that study the structure and systematic patterning of sounds in human language [Akmajian *et.al*, 2003]. Besides to the morphotactic rules, phonological rules are also applied during the formation of a word from morphemes which, then, results in phonological and assimilation effects. For example: when the English prefix /in-/ concatenates with a free morpheme /possible/, then it becomes influenced (changed into /im-/) and produce the complex word /impossible/ as the result of the concatenation process. A discipline called

[8]**Features** specify additional information about the word. These are aspect, tense, mood, voice, etc.
[9]**Parsing** means taking a surface word as an input and extracting some sort of linguistic features for it. For e.g., *going* can be parsed into its verbal stem *go* and the *–ing* morpheme, as VERB-go + GERUND-ing

Morphophonology, which merges both morphology and phonology, deals with these changes and their fundamental reasons. Indeed, the morphological analyzer should also have a component which takes care of these phonological changes encountered while parsing the complex words.

2.2.3 Types of Morphology

There are two productive ways to form words from morphemes: inflection and derivation [Katamba, 1993]. And hence, we have correspondingly inflectional and derivational morphology.

Inflection morphology deals with the combination of a word seed with a grammatical morpheme, usually resulting in a word of the same POS as the original seed, and usually filling some syntactic function. For instance, English has the inflectional morpheme /-s/ for marking the plural on nouns. Similarly, Geʿez has the inflectional morpheme **ክሙ**/*-kmu/* for marking the 2ppm subject[10]. An inflectional morpheme affects the grammatical function (also called morphsyntactic[11]) of the stem but not itʿs POS. It is due to inflection that the different surface forms are produced into use. For example, in English, the verb /play/has surface forms /plays/, /played/, /player/ and /playing/ as inflected word forms which are produced by adding the 3rd person singular marker /-s/, the perfective marker /-ed/, the adjective marker/-er/ and the gerund marker /-ing/ respectively. This fact remarks that the word forms produced after the inflection of the verb */play/* are all verbs, which means no change of POS category is resulted due to the affixation. In Geʿez, we have assured through the declaration process (see section 3.7) that a given transitive verb can have more than 1388 inflectional surface forms (see the Appendix II from A to F).

Derivation morphology, on the other hand, deals with the combination of the word seed with a grammatical morpheme, usually resulting in a word of a different POS, often with a meaning hard to predict exactly. For example, the verb /computerize/ can take the derivational suffix /–ation/ to produce the noun /computerization/. Likewise, Geʿez has derivational affixes which, if they are added to word, can result in a word of different POS category. For example, the verb **ፈነወ** */fänäwä/* (he sent) can take the derivational suffix */-i/* to produce the adjective **ፈናዊ** *fänawi* (sender).

[10] **Subject**, in this case, is the doer of the action.
[11] Morphosyntactic: any morphologically distinguished class of words that plays a part in syntax.

2.2.4 Prosodic (Nonconcatenative) Morphology

Traditional morpheme theory is ideal for the description of word-building processes where by morphemes are concatenated (i.e. are attached one after the other). This theory is not at all well suited to the task of describing nonconcatenative morphological processes involving, for example, infixation or the internal modification of the root. So, although it has been recognized for a long time that, in Semitic languages, the root, usually consisting of three consonants (e.g. */fqd/* „likeˮ), serves as the skeleton to which flesh is added in the process of word-formation, before the advent of prosodic morphology, there was no theoretically effective way of describing this method of word-formation [Katamba,1993:165].

Prosodic morphology was initiated by McCarthy (1979, 1981). He noted the similarity in the behavior of vowels introduced into consonantal roots by morphological processes in Arabic on the one hand, and that of phonological prosodies, such as tone spreading, on the other. He hypothesized that the verb in Arabic has elements arranged on three independent tiers at the underlying level of representation in the lexicon, the three tiers being the root tier (also called the consonantal tier), the skeletal tier and the vocalic melody tier. Below is an example in Geˮez:

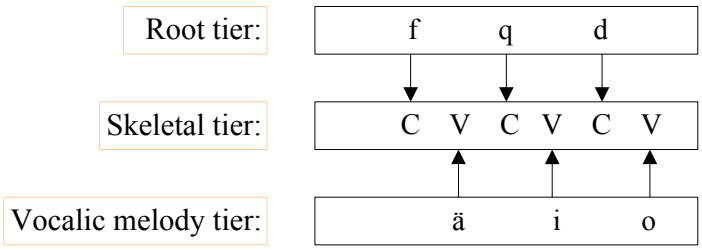

Figure 2.1: CV-based formation of the Ge'ez verb ፈቀደ */fäqido/*

The above three independent tiers give the Geˮez verb */fäqido/* (he, having liking it). These three tiers are linked together by association lines. The three universal conventions for making associations between the prosodic templates and the auto-segmentalized strings are as follows (McCarthy, 1981):

a) The meaning of a verbal lexeme is signaled at the root-tier by the consonantal segments. Usually a verb has three consonants in its underived lexical entry in the lexicon. Thus the root */f-q-d/* in Geˮez represents the lexeme *like*, which is realized by a variety of verb-forms.

b) The skeletal tier (which is also called the CV-tier or prosodic template tier) provides a canonical shape that is associated with a particular meaning or grammatical function. The template $C_1V_1C_2V_2C_3V_3$, for instance, carries the grammatical meaning gerundive. Hence */fäqido/* means 'he, having liking it'.

c) The vocalic (vowel) melody tier provides information analogous to that carried in English by inflectional affixes like tense, aspect, number or derivational affixes. For instance, in the above Ge"ez verb */fäqido/*, the vocalic pattern */ä-i-o/* indicates that the tense of the verb is gerundive. The last vowel */o/* indicates that the person is third person masculine and the number is singular.

2.2.5 Computational Morphology

Morphology deals with the internal structure of words. Computational morphology, on the other hand, is intended to handle the task, morphology, automatically with the use of computers and computational methods. Generally, the task of computational morphology is surface word analysis and synthesis.

Word analysis or recognition is the process of parsing or tokenizing a word form into its ingredient morphemes, whereas word synthesis or generation does the reverse process, which is the process of producing a word form from its constituent morphemes. The analyzer would accept as an input a surface form such as /cries/ and returns an underlying form divided into morphemes, namely, /cry/ + /s/. On the other hand, word form generator would accept as an input a lexical form (such as /cry/ + /s/) and returns the surface form /cries/. These processes demand identification of word form components (for example seeds and affixes) and taking account of the regular phonological or orthographical[12] alternations due to morphological, and morphophonological processes involved.

2.2.6 Morphological Analyzer

Morphological analysis is the computational process which provides information about the structure of a given surface word. An analysis can produce morphological and morphosyntactic features such as the root, tense, person, number, etc. A very simplified version of morphological analysis is called stemming.

[12]Orthographic rules are spelling rules used to model the changes that occur in a word, usually when two morphemes combine.

Stemming is a process of obtaining a stem and affixes from surface words, where the stem is the objective of this operation. Its main use is as part of term normalization proces that is usually done when setting up Information Retrieval systems. This is an easier and simpler problem than morphological analysis, as the morphological properties of the stripped affixes are ignored.

The component of NLP which does the word analysis process is called the morphological analyzer (parser). Such a component should separate and identify the component morphemes of the input word, labeling them with sufficient information to be useful for further processing. The design of the morphological analyzer is divided into two main components: a lexicon as a knowledgebase and a set of linguistically motivated rules [Yona, 2004].

2.2.6.1 Knowledge Required by Morphological Analyzer

One of the basic components that analyzers should have is deliberately designed lexicon to be used as a knowledgebase. This enables the analyzer to carry out the analysis process correctly and effectively. Even though some basic knowledge is common to most analyzers, the detailed knowledge is language-specific. Pullman [1988] noted that the following are the two main types of knowledge that needs to be represented for analyzers.

i. Knowledge about orthography or sound changes upon affixation; and
ii. Knowledge about the syntactic or semantic properties of affixation (that is, inflectional and derivational morphology) – i.e., Morphotactics

Moreover, the analyzer should have knowledge of the syntactic or semantic properties of the vocalic patterns of the seed particularly for Semitic words. This is because the vocalic patterns of the seed in Semitic languages can determine the inflectional and derivational category of a word. For example, the two Ge"ez words **ፈቀደ** */fäqädä/* (he liked) of vowel pattern 111 (all first order vowels[13]) and **ፈቃዲ** */fäqadi/* (one who liked) (3psm) of vowel pattern 143 (first, fourth and third order vowels, respectively) are derived from the same root **ፍቅድ** */fqd/* (like) but have different syntactical function due to the different vocalic patterns they possess.

[13] See Section 3.2 for the details of order of alphabets of Ge"ez

2.2.6.2 Sources of Rule Used by Morphological Analyzer

As pointed out in section 2.2.2, a language has its own systematic rules governing pronunciation, word formation, and grammatical pronunciation. Words are formed based on language-specific strict morphotactic rules which govern the way of concatenation of the morphemes while forming the word. For example: the surface verb **ኢ.ፈ.ቀ.ድ.ክ.ም.ዎ.ሙ** */ifäqädkmwomu/* (You-2ppm- didn"t like them-3ppm) has four morphemes: */i-/*, */fäqädä/*, */-km/* and */-womu/*, where the first and the last two are bound morphemes and the second one is free morpheme. However, if such word grammars don"t restrict their formation, we can formulate randomly the following possible word forms from these four morphemes: **ኢ.ፈ.ቀ.ድ.ክ.ም.ዎ.ሙ** */ifäqädkmwomu/*, **ዎ.ሙ.ፈ.ቀ.ድ.ክ.ም.ኢ** */womufäqädkmi/*, **ክ.ም.ኢ.ፈ.ቀ.ድ.ዎ.ሙ** */kmifäqädwomu/*, **ኢ.ክ.ም.ዎ.ሙ.ፈ.ቀ.ድ** */ikmwomufäqäd/*, etc., where all but the first are wrong formations according to grammar of Ge"ez. As a result, such ground rules of word formation should be given to the analyzer to take care of the concatenation order of the morphemes during analysis.

In addition to the aforesaid rules which governs which morpheme comes next to which, there are rules that manages phonological and orthographical changes which are likely to occur during the concatenation process of the morphemes to produce the inflected forms. Such rules too should be the basic elements of the set of rules formulated to be used by the analyzer for its robust analysis process.

In general, the basic sources of rules used by the morphological analyzer are the rules employed during the word formation process as the analysis is done depending on such strict rules.

2.2.6.3 How a Morphological Analyzer Works

The morphological analyzer starts its analysis by taking surface forms of verbs sequence as an input and returns an output of lexical forms, i.e. underlying lexeme and other morphosyntactic features. The following figure shows the input and output of a morphological analyzer.

Figure 2.2: Overview of how a morphological analyzer works.

Morphology, as described so far, is all about structure of words. And hence, sentences of a document have to be tokenized into words. Then, such verb(s) is/are fed to the analyzer and get parsed. At the end of the parsing process, the analyzer returns the lexeme and all valued morphosyntactic features as an output. For instance, if the input to the analyzer is the surface word */fäqädäkmwon/*, then the analyzer will return the following array of strings as an output.

Table 2.1: Sample of the analysis produced by the developed morphological analyzer

Verb	Lexeme	Stem	Tense-Mood	SMS	subPNG[14]	OMS	objPNG[15]
fäqädäkumwon	*fäqäde*	Base-stem	Perfective	*-kum*	*2ppm*	*-won*	*3ppf*

The output returned by the analyzer in this way will be an input to the next higher step of the NLP application.

2.3 Approaches to Morphological Analysis

Natural language processing approaches fall roughly into four categories: symbolic (rule-based), statistical (corpus-based), connectionist, and hybrid [Liddy, 2001]. Of these, the most commonly used approaches for morphological analysis are the first two: rule-based and statistical approach [Kazakov and Munandhar, 2000].

Rule-based perform deep analysis of linguistic phenomena and are based on explicit representation of facts about language through well-understood knowledge representation schemes and associated algorithms. Statistical approaches, on the other hand, employ various mathematical techniques and often use large text corpora to develop approximate generalized models of linguistic phenomena based on actual examples of these phenomena provided by the text corpora without adding significant linguistic or world knowledge. In contrast to symbolic approaches, statistical approaches use observable data as the primary source of evidence [Liddy, 2001]. The following subsections give the detail of these two approaches.

[14] subPNG stands for **sub**ject **P**erson **N**umber **G**ender of a verb.
[15] objPNG stands for **obj**ect **P**erson **N**umber **G**ender of a verb.

2.3.1 Statistical Approaches

Statistical approaches do not strictly follow explicit theory of linguistics [Kazakovand Munandhar, 2000]. The approaches are completely based on test corpora, which constitute the input data. Approaches in this category use some algorithms to learn, say about the word formation process of a language from a given corpus and perform the analysis based on this knowledge. Moreover, the employed algorithms are subject to modification and further fine-tuning during the operation [Kazakov and Munandhar, 2000].

Statistical approaches are further divided into supervised and unsupervised based on the type of test corpora they use. Unsupervised approaches use heuristics or probability information generated from the test corpora to generate the morphological analysis system [Kazakov and Munandhar, 2000]. In this approach, no sample outputs are given. Kazakov and Munandhar argued that this approach reduce the cost of browsing annotated corpora.

Supervised approach, on the other hand, requires annotated text corpora. In this case a trainer input is provided, which tells the system the outputs required for a given input.

From the facts under statistical approaches, whether supervised or unsupervised, we noticed that they do not firmly follow linguistically motivated rules, rather are completely based on test corpora. Morphological analysis, however, chiefly relies on the sophisticated linguistic rules of one‟s language. In another word, it is a process strictly done as per to the morphotactics, morphosyntactic, phonological and orthographical rules of the respected language. As a result, we didn‟t use this approach for this study.

2.3.2 Rule-based Approaches

Rule-based approaches are based on a theory of morphology laid down by experts. This group of methods enables one to incorporate sophisticated linguistic theory, such as generative phonology, into computational morphology processes. Because of their reliance on linguistic theories, systems developed using such approaches are often efficient and produce better quality outputs [Karttunen, 1983]. Moreover, Karlsson and Karttunen [2000] indicated that rule based approaches are tested quite

for a long period till now, and there are a number of systems developed using this approach both for commercial and research purposes.

As described earlier, most of the morphological analyzers are done using the rule-based approaches. The reason why morphological systems are developed using rule-based approaches is because they manage the following basic qualities over those systems developed using statistical approaches. Such advantages include the following as indicated in Karlsson & Karttunen [2000]:

Data-compaction: Morphological systems developed using rule-based approaches require less storage than morphological systems developed using statistical approaches.
High speed: Morphological systems developed using rule-based approaches are faster than those developed using the statistical approaches.
***Better Accuracy*:** Morphological systems developed using rule-based approaches are reported to have better accuracy than those developed using statistical approaches.
***Better adaptability*:** Morphological systems developed using rule-based approaches are easier and more straight forward to twist or modify for the purpose of correcting errors.

Furthermore, an analyzer developed using rule-based approaches can contribute advantage of reversibility; i.e., it is pretty straight forward to develop a morphological generator for that language from the rules used by the analyzer for both of them are strict to the exhaustively dealt rules of that language. Due to this and other aforementioned chief advantages of rule-based approaches against the statistical one, we prefer to use the rule-based approaches in this study.

There are a number of rule-based approaches for morphological analysis. Among them are two-level model (TLM) of morphology, CV-Based approach and FST-based approach. This section reviews the first two approaches that have close relevancy to this study.

2.3.2.1 CV-Based Approach or Root-and-Template Morphology

In his application of auto-segmental theory of morphology to Arabic, McCarthy [1981] proposed that a word can be regarded as having separate auto-segmental tiers for vowels (that marks information about voice and aspect) and consonant melodies (also called root, and which conveys the basic semantic

meaning) that are intercalated to a core template comprising CV- (also called Binyan) elements through universal and language-specific conventions. These association conventions are constrained by the same set of well-formedness conditions independently motivated for tone, vowel harmony and other prosodic features.

Ge"ez is a Semitic language whose morphology is quite similar to that of Arabic [Dillmann, 1899]. Thus, the points raised by McCarthy in relation to Arabic morphology seem valid for Ge"ez.

The type of morphology characterizing Semitic languages is commonly known as nonconcatenative morphology. Nonconcatenative morphology differs from its concatenative counterpart in that, apart from prefixation or suffixation, it has a morphology pervaded by a wide variety of purely morphological alternations internal to the stem. For example, infixing different vocalic patterns can produce different word forms. The following example could help to easily illustrate the aforesaid discussion.

Table 2.2: CV-based formations of seeds and words

Root	Template	Seed	Gloss	Class
f-q-d	$C_1VC_2VC_3$	*fäqäd*	he liked	Verb
	$C_1V_1C_2C_2C_3$	*fäqad*	Somebody(male) who likes	Adjective
	$C_1V_1C_2V_2C_3$	*fäqid*	To Like	Noun

As can be seen from the above table, the prime mover of a word is the root. It is a skeleton to which the flesh is intercalated to produce the possible stems of a word. As skeleton of an organism without flesh is dead, too is a root without vowels. On this point, one should notice that the intercalation process of the vocalic patterns and consonants (the root) is absolutely language dependent. And hence, different verbal stems are produced from a language-oriented template. In this study, we call the immediate product of the intercalation process „seeds"[16]. We call it seed for it has not any subject marker[17] that is affixed to a

[16] The naming is taken from the concept of root, stem vessels, leaves and fruits of plants. These are correspondingly root, templates, seeds and verbs in our case. The root for a plant is a very beginning in the life of the plant, so is the root for the existence of a verb. The stem of a plant is comprised of different vessels through which the leaves gain necessary nutrition for survival. Same is the importance of the template, which is comprised of vowels and consonants, for the existence of the seeds in our case. The end product of growing up of plants is to yield fruits which can be used by other organisms. Too is the growing up of seeds to form verbs that can be used in speech and natural language texts. We should notice from this scenario that as the stem vessels of a given plant are many in number too is the number of the templates which are created after the participation of different vowel patterns. Likewise, the seeds, which are the immediate results of the templates, are also many in number, yet is true for the verbs which are formulated as the result of the growth of the seeds via affixation.

seed to make a verb. Thus, seed is the second stage, next to the root, in the verb formation process which demands at least a subject marker to grow to be a verb. After the affixation of respective subject markers to each seed, however, each of the seeds flourishes to form a verb and begin used in the natural texts of the language (see figure 2.3). This is a third stage of verb formation in Ge"ez. Verbs, in turn, can have many inflected forms which are found as a result of the affixation process (the details of verb formation in Ge"ez language is given in the third chapter).

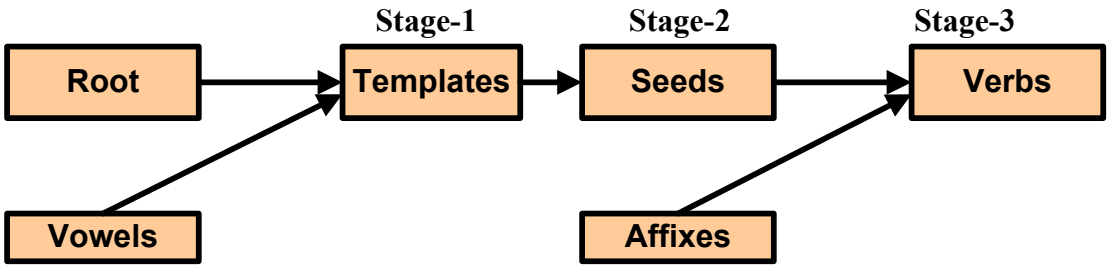

Figure 2.3: The general overview of verb formation process

Figure 2.3 depicts the general overview of Ge"ez verb formation process. As shown in the figure, seeds are created as the result of intercalation of roots and vowels in defined templates[18], which indicates the non-concatinative part of the Ge"ez language. This intercalation process forms the second stage of verb formation. The third and complex stage that brings verb formation to its natural level is the addition of affixes to the seeds. This affixation process which results in the person-number-gender and tense-mood formations (detailed discussion is given in sections 3.5 and 3.6 of chapter three) is the concatinative part of Ge"ez verb formation.

Consequently, just opposite to the verb formation process described above, the analyzing process undo the formation process starting from the final stage back to the root stage. As the primary objective of the morphological analyzer is to break down the word into its lexeme-form and other constituting components altogether, the parsing process stops once it reaches at the base-stem[19] level. There is no need of returning the verb back to its root form as all needed is to find the lexeme[20] together with the morphotactic features.

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[17] A detail of subject marker is given in section 3.5 of chapter three.
[18] Root + vocalism + template = seed
[19] Details of stems is given in section 3.6 of chapter three
[20] The lexeme is adictionary form of a verb usually 3psm verb as in all Semitic languages.

Therefore, the CV-based approach is used in this study while analyzing the surface verbs into their corresponding lexeme stems. As pointed out in table 2.2, the seeds are represented by the templates. Since each seed has got a unique template, the analyzing process is done to return the surface verbs back to this template. While mapping the verbs back to their lexeme forms based on the template already formulated, various morphological and phonological changes such as assimilations and vowel changes are also recognized. In general, the template is the highway through which the analyzing process of the surface verb to its lexeme form is carried out.

2.3.2.2 Two-Level Model of Morphology (TLM)

A major breakthrough in the field of morphology came in 1983 when KimmoKoskenniemi, a Finnish computer scientist, produced his dissertation, Two-level morphology, a general computational model for word-form recognition and generation [Koskenniemi, 1983]. Koskenniemi's model of two-level morphology was based on the traditional distinction that linguists made between morphotactics and morphophonemics, which accounts for alternate forms or spellings of morphemes according to the phonological context in which they occur.

Koskenniemi's model is two-level in the sense that a word is represented as a direct, letter-for-letter correspondence between its lexical or underlying form and its surface form. An example showing the generation of the word 'chased' is given in two-level representation as follows. In this case, + is a morpheme boundary symbol and 0 is a null character.

Table 2.3: The generation of the word chased using the two-level model

Lexical form	c	H	a	S	e	+	e	d
Surface form	c	H	a	S	0	0	e	d

Shortly after Koskenniemi's dissertation appeared, Lauri Karttunen and others produced a LISP implementation of Koskenniemi's two-level model and dubbed it as KIMMO [Karttunen, 1983]. The main components of the KIMMO parser are shown in Figure 2.4. It had two analytical components: the rules component and the lexical component, or lexicon. First, the rules component consisted of two-level rules that accounted for regular phonological or orthographic alternations, such as /chase/ versus /chas/. Second, the lexicon listed all morphemes (seeds and affixes) in their lexical form and specified morphotactic constraints. For example, the lexicon would have included lexical entries for the verb stem

/chase/ and the suffix /-ed/, and would have specified their relative order. Using these data components were two processing functions, the generator and the recognizer. The generator would accept as input a lexical form such as /spy/ + /s/ and return the surface form /spies/. The recognizer would accept as input a surface form such as /spies/ and return an underlying form divided into morphemes, namely /spy/ + /s/, plus their grammatical role such as N+PLURAL.

PC-KIMMO is a new implementation for microcomputers of a program dubbed KIMMO after its inventor Kimmo Koskenniemi [see Koskenniemi, 1983]. It is of interest to computational linguists, descriptive linguists, and those developing natural language processing systems. The program is designed to generate (produce) and/or recognize (parse) words using a two-level model of word structure in which a word is represented as a correspondence between its lexical level form and its surface levelform.

TLM of morphology is used in this study during verb affixation analysis.

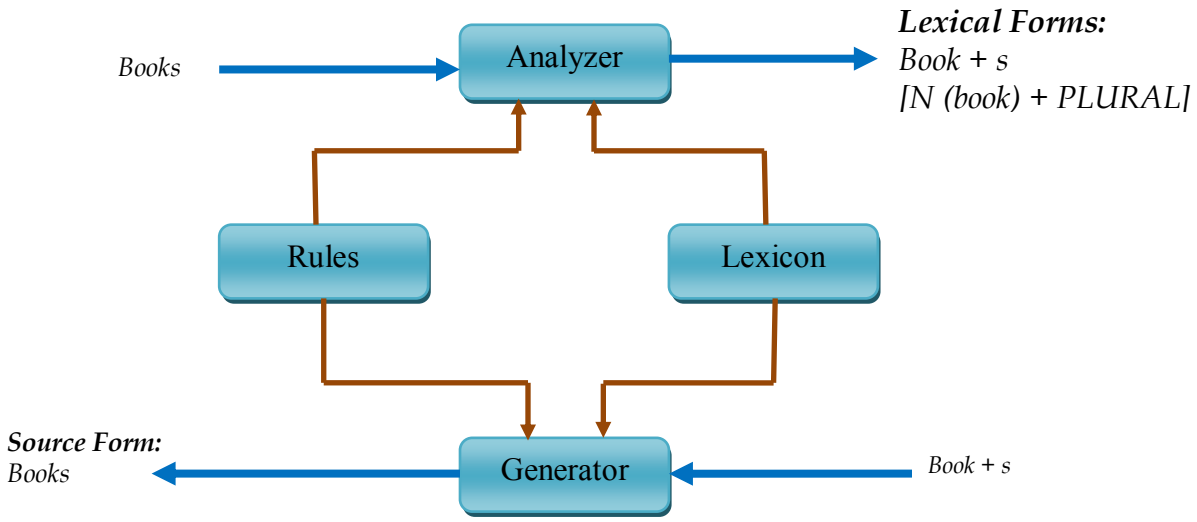


Figure 2.4: Main components of Karttunen's KIMMO Parser

2.4 Summary

Various computational morphology concepts are discussed in this chapter. The discussions included in this chapter on the approaches will be applied in chapter four to develop the model of the morphological analyzer for the Ge"ez verbs. The next chapter will discuss Ge"ez verb formation.

CHAPTER THREE

VERB FORMATION IN GE'EZ

3.1 Introduction

This chapter discusses the verb formation processes in Geʿez. As it is described in the first chapter, verb is the most important part of the language which serves as a basis for almost all other POS categories in the language. While showing the importance of verbs in Geʿez, Zäradawit [1996] says that the verb is the language.

Linguistically, Geʿez is studied by many Ethiopian and Foreign scholars. Among the Ethiopian scholars, the analysis and discussions given by Aläqa Kidanä Wäld Kiflä [1948], Mämhr Zäradawit Adhana [1996][21], Liqähruyan Bälay Mäkonän [2002], Aläqa Afäwärq Zäwdä [1988] and Mämhr Räzänä Kidanä [1998] are used for this study. In addition to this, the analysis and discussion done by the foreign scholars namely Dillmann [1899], Leslau [1987: VI], Lambdin [1978], Ludolf [1699], Bender [1976] are also used for thorough understanding of the language. As the language does not have a native speaker, our potential resources are books. Furthermore, the linguistic work of Mulukän [2007] is also used to understand the way of classification of Geʿez verbs in the traditional schools of ቅኔ /qɔ̂ne/ found under the EOTC.

3.2 Ge'ez Writing System

From among the languages of Ethiopia[22], the only language which has its own alphabets is Geʿez. Other languages like Amharic[23] and Tigrigna[24] do not have their own alphabets but have adopted these alphabets fully from Geʿez [Dillman, 1899]. Intuitively, an alphabet (*/fidäl/* in Geʿez) of a language represents its sound. Geʿez sounds can be studied by dividing them into two as simple-sounds and

[21] Zeradawit Adhana, who is now a teacher of Geʿez language and New Testament at the Holy Trinity Theological College of the EOTC, seems to be the first Ethiopian Geʿez Scholar to study the language scientifically in his book **መርዕኖ ሰዋስው ዘልሳነ ግእዝ** */Märho Säwasw Zälisanä Ge'ez/*. Other Ethiopian scholars have studied the language traditionally as it is given in the traditional schools of */qɔ̂ne/* of the EOTC.

[22] Ethiopia has more than eighty languages.

[23] Amharic adds seven more alphabets, which are yet derived from the alphabets of Geʿez by employing some modifications on them (Dellman, 1899: Appendex Table I)

[24] Tigrigna adds twelve more alphabets

complex-sounds [Zäradawit, 1996]. Simple-sounds are represented with 182 alphabets. Of these, seven of them represent vowel sounds: አ/*ä*/, ኡ/*u*/, ኢ/*i*/, ኣ/*a*/, ኤ/*e*/, እ/*ə* /and ኦ/*o*/. Whereas, the remaining represent consonant sounds.

Prior to the modification performed by the first Ethiopian Bishop, Abba Fremnatus, the total number of Geʿez alphabets were twenty six each with vowel sound አ/*ä*/. After the modification, however, every consonant was combined with other six vowel sound alphabets to produce six more derived alphabets [Zäradawit, 1996]. For example, the combination of the original alphabet ሀ/*hä*/ with the six vowel sound alphabets ኡ/*u*/, ኢ/*i*/, ኣ/*a*/, ኤ/*e*/, እ/*ə*/ and ኦ/*o*/ yields six more derived alphabets as: ሁ/*hu*/, ሂ/*hi*/, ሃ/*ha*/, ሄ/*he*/, ህ/*h*/ and ሆ/*ho*/ respectively.

In general, Geʿez has totally twenty six alphabets, each with six more derivations. And hence, it has 26×7 = 182 alphabets representing simple sounds. Doing the same derivation for every twenty six alphabets, a matrix of 26×7 size is produced. Each of the columns are labeled as ግእዝ /*ge'ez*/ (first-order), ካእብ /*kaəb*/ (second-order), ሳልስ /*sals*/ (third-order), ራብዕ /*rabə*/ (fourth-order), ሓምስ /*hams*/ (fifth-order), ሳድስ /*sads*/ (sixth-order), and ሳብዕ /*sabə*/ (seventh-order) of alphabets. The orders represent the sound of each of the vowels. For instance, if we take the verb ፈቀዶ /*fäqädto*/ (she liked him), the alphabet ፈ/*fä*/ is read as ፍአ/*fä*/, where አ/*ä*/ is a vowel with first-order sound. And hence, it is sorted under the first column /first-order/ category. Likewise, the alphabets ቀ/*qä*/ and ደ/*dä*/ both are sorted under the first-order group. The alphabet ቶ/*to*/, however, is sorted under the seventh column for it is read as ትአ /*to*/, where ኦ/*o*/ is a vowel with seventh-order sound.

The complex-sounds, on the other hand, are represented with twenty letters. The alphabets are four in number. These are: ኰ/*kʷä*/, ጐ/*gʷä*/, ቈ/*qʷä*/, and ጒ/*hʷä*/. Unlike to the simple-sound alphabets, which, as described above, have seven orders, alphabets representing complex-sounds have only four derived alphabets, which are produced after the combination of the simple-sound alphabets ከ /*kä*/, ገ/*gä*/, ቀ/*qä*/ and ጎ/*hä*/ with the vowels አ/*ä*/ and እ/*ə*/ and the semi-vowels ወ/*wä*/ and የ/*yä*/ in different patterns. For example, the alphabets ኰ/*kʷä*/, ኵ/*kʷə*/, ኩ/*kʷi*/, ኳ/*kʷa*/ and ኲ /*kʷe*/ are derived due to the combination of the vowel and the semi-vowel sounds with the consonant ከ /*kä*/ as described by Zäradawit [1996: 16].

Example: ከ /*kä*/ † አ /*ä*/ † ወ /*wä*/ = ኰ/*kʷä*/ (formation of the alphabet ኰ)

A list of the Ge"ez alphabets adopted from Zäradawit and used in this study is found in Appendix I. Further detailed discussion on Ge"ez writing system is found in his book */Märho Säwasw Zälisanä Ge'ez/*.

3.3 Formation of Ge'ez verbs

A verb in Ge"ez must pass through three stages of formation: *seed formation*, *tense-mood formation* and that of *person-gender-number formation* [Dillmann, 1899:140]. These three stages of formations of verbs are discussed phase by phase in this chapter. In this section, only seed formation will be discussed.

As described in the second chapter (section 2.3.2.1), Semitic language verbs are produced as the result of the intercalation of vowels and roots in a certain template. This fact is valid for Ge"ez verbs too. Such intercalation of vowels and consonants in a given template produces what is called seed[25]. The produced seed grows up to a more natural verb form by attaching itself to tense-mood and person-gender-number marker affixes. Each seed has its own unique template. This essentially implies the fact that verbs do have different templates. Their basic difference lies on the type of vowels participated during the formation process. More precisely, the initial, medial, final alphabets of these seeds results at one true difference among verbs of Ge"ez. The following sub-sections describe thoroughly the aforesaid difference.

3.3.1 Initial Orders of Ge'ez Verbs

As discussed in section 3.1, a consonant sound combines with each of the seven vowel sounds of the language to form what are called /*ge'ez*/, /*kaɔb*/, /*sals*/, /*rabɔ*/, /*hams*/, /*sads*/, and /*sabɔ*/. Among these orders, */kaɔb/* and */sals/* do not occur in initial position of verbs. The other five can occur in initial position as recognized by many of the Ethiopian scholars [Kidanä Wäld, 1948], [Zäradawit, 1996], [Räzänä, 1998]. The system of these scholars takes CV-template as a basic unit to determine the category of verbs. Accordingly, the orders that occur in initial position include for example, **ሀ**/*hä*/, **ሃ**/*ha*/, **ሄ**/*he*/, **ህ**/*h*/ and **ሆ**/*ho*/.

[25] We prefer to call the immediate result of the intercalation of vowels and consonants as **seed** after the reason that it does not have meaning until a subject marker (at least) is affixed to it.

The Ethiopian scholars believe that the base for any verb is what they call „relative seed"[26] or „father seed"[27]. According to them, a verb is derived either from its father seed or its relative seed. The father form is an infinitive form, like **ፈቂድ** */fäqid/* (to like).

According to Kidanä Wäld Kiflä [1948], a verb is formed only from a father seed, whereas modern scholars argue that the formation process begins from the root, which is purely consonantal. Mulukän [2007] argued that the „seed" and „root" are more or less the same. For him, the difference of these two terms is in the vowels of the seeds. Further, he argued that if we remove the vowels in a seed, we get the root.

The researcher also agreed with the argument of Mulukän and would prefer to call the prime mover of a verb as „root" and the immediate result of the intercalation of the root and the vowels as „seed".

3.3.2 Terminal Orders of Ge'ez Verbs

Some of the Ethiopian scholars believe that the terminal orders in Ge"ez verbs are only */ge'ez/* and */hams/*. According to them, the only verb that ends with */hams/* is **ይቤ** */ybe/*[28]. Nevertheless, the verb */ybe/* is arguable that many scholars said differently about it. For example, Zäradawit said that */ybe/* has the perfective form **በሀለ** */bähalä/* (he said) whereas Kidanä WäldKiflä argued that */ybe/* is the imperfective form of **ቤለ** */belä/* (he said) and its causative is **አበለ** */abälä/* (he caused someone to say).

Foreign scholars such as Dillmann, Lambdin, and Leslau consider */ybe/* as derived from the root */b-h-l/*. Lambdin said that */ybe/* has **ብሀለ** */bhlä/* (he said) as its perfective form, which seems to be the same as what Zäradawit has said. This is also what Dillmann has said.

In sum, all the Ethiopian and foreign scholars agreed that all perfective verbs end with a first-order consonant. Their only difference is on the terminal of */ybe/*.

3.4 Classification of Ge'ez Verbs

Ethiopian scholars classify verbs on the basis of criteria such as gemination, non-gemination, number and position of radicals as well as the positions of gutturals and semi-vowels in written verbs and the

[26] Relative seed is **ዘመድ ዘርእ** and it is the same as verbal noun.
[27] Father seed is **አባት ዘርእ** and it is the infinitive form of a verb which is considered as the base for other forms.
[28] It is a verb with a different morphology when compared to all other verbs of Ge"ez as it ends with a fifth-order alphabet.

conjugation[29] pattern of the verbs. Classification by foreign scholars, however, is based on the stem vowel and the root consonants, and classification of modern linguists is based on root consonants and patterns of vowels in stem formation [Mulukän, 2007].

This study uses the basic concepts of classification of verbs employed by all scholars. Accordingly, the classification criteria is summarized into three based on the context of this study as: based on object indication, based on number of radicals[30] and based on „heads" and „troops"[31]. The following sub-sections discuss the classification of verbs based on these benchmarks.

3.4.1 Based on Object Indication

According to the Ethiopian scholars, Ge"ez verbs are grouped into three types based on their tendency to indicate the object in a sentence. These are transitive, intransitive and copula verbs [Mulukän, 2007].

Transitive verbs occur with an object in a sentence. For example, the verbs **ቀተለ** */qätälä/* (he killed), **ፈነወ** */fänäwä/* (he sent), **ከፈለ** */käfälä/* (he divided), and **መተረ** */mätärä/* (he cut) are transitive verbs. These all cannot be used without mentioning the action receiver (the object) of the verb. If we take */qätälä/*, for example, we can have sentences like, **ቃየል ቀተለ አቤልሃ** (Cain killed Abel), where Abel is the object which receives the action.

Intransitive verbs, on the other hand, are other types of verbs which occur without an object in a sentence. For example, the verbs **መጽአ** */mäṣä/* (he came), **ነበረ** */näbärä/* (he sat), and **ነደደ** */nädädä/* (it was fired) are intransitive verbs. If we consider the sentence **መጽአ ቃል እምደመና** (a voice came from the cloud), for example, the verb **መጽአ** is used without an object in it.

Copula is the third type of verbs that occurs together with main verbs in a clause. The following verbs are an example of copula verbs.

[29] **Conjugation** means to give various inflectional endings of a verb, i.e. voice, mood, tense, number and person.
[30] The terms „radical" and „root" are interchangeably used in this study.
[31] See detailed discussion of „heads" and „troops" in section 3.4.2

Table 3.1: Example of Copula Verbs of Ge'ez

Copula Verbs	Description	Gloss
ውእቱ	*/wɔ̀tu/*	am, is, are, was, were
ሀሎ	*/halo/*	He existed, presented, there was
ኮነ	*/konä/*	It was done
አኀዘ	*/ähäzä/*	He held, he began, he started

For example, in the sentence ዮሐንስኒ ሀሎ ያጠምቅ በሄኖን (John too was baptizing at Aenon), ሀሎ */halo/* is copula verb.

3.4.2 Based on Number of Radicalsof a Root

Ge'ez verbs can also be classified into three depending on the number of alphabets their roots have as tri-literal, quadri-literal, and multi-literal [Dillmann, 1899]. Tri-literal roots are composed of three consonants and are those which best answer to the Semitic root-forming tendency [Dillmann, 1899:125]. One can have a look at the Table 3.2 to see the formation of verbs from tri-radical roots.

Table 3.2: Formation of verbs from tri-radical root

Root	Template	Verb	Gloss
f-q-d	$C_1äC_2äC_3ä$	*/fäqädä/*	He liked
	$C_1äC_2äC_3u$	*/fäqädu/*	They (2ppm) liked
	$C_1äC_2aC_3i$	*/fäqadi/*	Somebody (male) who likes
h-m-m	$C_1äC_2äC_3ä$	*/hämämä/*	He becomes ill
	$C_1äC_2äC_3a$	*/hämäma/*	They (2ppf) become ill
	$C_1C_2uC_3$	*/hmum/*	Somebody (male) who is ill

As indicated in Table 3.2 for example, a root usually consists of three radicals. There seems to exist, however, roots possessing only two consonants like መነ */mänä/* (he excommunicated himself from the world), ሐመ */hämä/* (he ill), ሐገ */hägä/* (he formulated a law), and ነደ */nädä/* (he/it was fired). Nevertheless, these roots are products of the later time influences on the language. The original nature of these roots was tri-radical as መነነ, ሐመመ, ሐገገ, and ነደደ respectively [Dillmann, 1899]. Dillmann continue to argue that every original root of Ge'ez comprises of three firm letters. The researcher also believes that bi-radical[32] roots are only found in the latest literatures and are results of the influence of the later writers who are not native to the language. For example, the original shapes of the verbs ቦአ

[32] Roots with two radicals are called bi-radicals.

/boa/, **ሖረ** */horä/*, **ቆመ** */qomä/*, and **ኤለ** */elä/* were **በወአ**[33] */bäwää/*, **ሐወረ** */häwärä/*, **ቀወመ** */qäwämä/*, and **አየለ** */äyälä/* respectively. Furthermore, the verbal noun **ሐዋርያ** */häwarya/* (apostle) could only be a derivation of a verb only if the verb is */häwärä/*, not */horä/*. As the result, bi-radical roots are not at all common and natural to Ge"ez language.

Quadri-literal roots, on the other hand, are roots with four radicals. For example, the verbs **ማህረከ** */mahräkä/* (he took captive) and **ደንገፀ** */dängäṣä/* (he become terrified) are verbs of Quadri-literal roots. The occurrence of such verbs in Ge"ez is too small compared to the tri-radical verbs. Multi-literals are also roots of more than four letters. For example, the root of the verb **ደለቅለቀ** */däläqläqä/* (he made something to shake) is a quni-literal (five-radical) root. Nevertheless, roots with more than four letters are not at all common in Ge"ez [Dillmann, 1899:122-123].

The main focus of this study is on verbs formulated from tri-radical roots. Researcher"s survey on the Ge"ez-Amharic dictionary by Liqähruyan Bälay Mäkonän [2000], which contains more than ten thousand Ge"ez verbs, shows that tri-radical verbs are the dominant.

Table 3.3: Result of Researcher's survey on the Ge'ez-Amharic dictionary

Type of Verbs	Number of verbs found in the dictionary	Total (%)
Bi-literal	356	3.56
Tri-literal	8068	80.68
Quadri-literal	1212	12.12
Quni-literal	273	2.73
Six-literal	91	0.91
Total	**10,000**	**100**

As can be seen from Table 3.3, the tri-radical verbs occupy the largest room in the language. And hence, the focus of our study inclines to such verbs. The quari-literal and multi-literal verbs are beyond the scope of this study after the reason which will be given in the next section.

[33] When a vowel appears independently in a verb, it is counted as a radical.

3.4.3 Based on Heads and Troops

Both the Ethiopian and foreign scholars agreed on the grouping of Ge"ez verbs as „heads" and „troops" taking their CV-template as a basic unit. Heads are those verbs which can represent other verbs of their type. Troops are any other verbs which can be sorted under either of the identified heads because of their pattern (template) similarity with the head. Nevertheless, these scholars do not agree on the number of heads.

The Ethiopian scholars differ one from the other in the number of heads. According to Kidanä Wäld Kiflä [1948:61], there are only seven heads. These are **ቀተለ** */qätälä/* (he killed), **ቀደሰ** */qäddäsä/* (he consecrated), **ባረከ** */baräkä/* (he blessed), **ዴገነ** */degänä/* (he followed), **ኖለወ** */noläwä/* (he kept), **ደንገፀ** */dängäṣä/* (he terrified), and **ማህረከ** */mahräkä/* (he took captive). According to Zäradawit Adhana [1996:181], however, the heads are eight in number. These are **ቀተለ** */qätälä/* (he killed), **ቀደሰ** */qäddäsä/* (he consecrated), **ገብረ** */gäbrä/* (He did), **ተንበለ** */tänbälä/* (he begged), **ባረከ** */baräkä/* (he blessed), **ኤለ** */elä/* (he rounded), **ክህለ** */khlä/* (he abled), and **ያዶ** */odä/* (he wake circular). Afäwärq Zäwudä [1988:159], on the other hand, argued that the heads are six: **ቀተለ** */qätälä/*, **ቀደሰ** */qäddäsä/*, **ባረከ** */baräkä/*, **ደንገፀ** */dängäṣä/*, **ፄወወ** */ṣewäwä/* (he took a captive), and **ጦመረ** */tomärä/* (he wrote). In the classification process, the main issue which seems highly arguable is on the number of the heads but not on the sameness of the verbs considered as heads.

The foreign scholars have also classified the verbs differently from each other and from the Ethiopian scholars. Ludolf [1699] has recognized three verbs as heads. These are **ገብረ** */gäbrä/* (he did), **ገበረ** */gäbärä/* (he did) and **ጋብረ** */gabrä/* (he did). Whereas, Dillmann [1899] believe that the heads are four. These are **ነገረ** */nägärä/* (he told), **ገብረ** */gäbrä/* (he did), **ፈጸመ** */fäṣämä/* (he completed), and **ባረከ** */baräkä/* (he blessed). Lambdine [1978], however, has said that the heads are two. These are **ቀተለ** */qätälä/* and **ቀደሰ** */qäddäsä/*.

The classification given by Zäradawit is adopted for this study. Table 3.4 depicts the „head"verbs and their CV-template.

Table 3.4: 'heads' of Ge'ez verbs together with their templates

No.	Head	Template	Number of Radicals and Vocalic Patterns	Gloss
1	**ቀተለ** */qätälä/*	$C_1äC_2äC_3ä$	Tri-radical, first-first-first (111) order of vocalic pattern	he killed
2	**ቀደሰ** */qäddäsä/*	$C_1äC_2C_2äC_3ä$	Tri-radical, first-first-first (111) order of vocalic pattern and geminated at its middle alphabet.	he consecrated
3	**ገብረ** */gäbrä/*	$C_1äC_2C_3ä$	Tri-radical, first-sixth-first (161) order of vocalic pattern	He did
4	**ተንበለ** */tänbälä/*	$C_1äC_2C_3äC_4ä$	Quadri-radical, first-sixth-first-first (1611) order od vocalic pattern	he begged
5	**ባረከ** */baräkä/*	$C_1aC_2ä\ C_3ä$	Tri-radical, fourth-first-first (411) order of vocalic pattern	he blessed
6	**ዴገነ** */dägänä/*	$C_1eC_2ä\ C_3ä$	Tri-radical, fifth-first-first (511) order vocalic pattern	he followed
7	**ክህለ** */khlä/*	$C_1C_2\ C_3ä$	Tri-radical, sixth-sixth-first (661) order of vocalic pattern	he abled
8	**ኖለወ** */noläwä/*	$C_1oC_2ä\ C_3ä$	Tri-radical, seventh-first-first (711) order of vocalic pattern	he kept

Classification of Ge"ez verbs into eight heads is also supported by the scholars of the famous traditional school of **ቅኔ** */qǝne/* called *washära*[34] [Mulukän, 2007]. Depending on this classification, a head verb which encompasses the dominant number of troops under it is the head **ቀተለ** */qätälä/*. The survey conducted by the researcher on the New Testament of the Ethiopic (Ge"ez) Version Bible also shows that more than 46% of the verbs are troops of **ቀተለ** */qätälä/*. The other part is occupied with troops of the other seven heads. As the result, the focus of this study lies on verbs of **ቀተለ** */qätälä/* category.

Verbs of **ቀተለ** */qätälä/* category have more or less tri-radical roots. Verbs of quadri-literal roots are allocated under **ተንበለ** */tänbälä/* and, hence, are not considered in this study. All together, the focus of this study bounds to both transitive and intransitive tri-radical verbs of */qätälä/* category.

3.5 Affixation in Ge'ez Verbs

In section 3.1, we have discussed the first stage of verb formation: *seed formation*. In this section, we present the next higher stage of formation of verbs namely the *person-gender-number formation*. The seed, which is produced as a result of the intercalation of vocalic patterns and a given root, grows up to a more natural verb form by attaching itself to affixes. Affixation realizes the two next stage of verb formation: person-gender-numberand tense-mood formation. Therefore, verbs attain their maximum growth level through affixation and are verbs of this stage which are the most common and natural verbs of Ge"ez. Basically, Ge"ez has all types of the affixes namely infixes, prefixes, suffixes and circumfixes. Infixation is realized while forming the seeds from a given root via interdigitaizing (intercalating) of the vocalic

[34] Washera is one of the famouse traditional schools of Qene under the EOTC.

patterns with the consonants (i.e., the internal modification of the seed). The following sections discuss the details of the last three affixes.

3.5.1 Prefixation

Geʿez prefixes can be roughly categorized into two categories as negation marker and affirmative marker prefixes. The affirmative marker prefixes can further be divided into two as verbal-stem-marker and person-marker prefixes. A given affirmative verb can have a prefix merely from among the affirmative marker prefixes. Only negative verbs can have the possibility of having two prefixes: the negation marker being followed by one of the positive prefixes. That is, negation marker of a verb (if exists) should always be at the very beginning of the verb. Following is the detail of the three types of prefixes in Geʿez verbs.

a) ***Verbal-Stem-Marker Prefixes***: This type of prefixes are attached to the front of the base-stem form of a verb to form four more derived stems namely causative, causative-reciprocal, reflexive and reciprocal stems (detailed discussion about stems is given in section 3.6). For example: the base-stem verb **ፈቀደ** */fäqädä/* (he liked) has **አፍቀደ** */äfqädä/* (he caused somebody to like), **አስተፋቀደ** */ästäfaqädä/* (he caused others to be liked each other), **ተፈቅደ** */täfäqädä/* (he is liked by), **ተፋቀደ** */täfaqädä/* (he get liked with somebody) and as its causative, causative-reciprocal, reflexive and reciprocal stem forms respectively.

b) ***Person Marker Prefixes***: these are **አ-** */ä-/,* **ነ-** */nä-/*, **ተ-** */tä-/* and **የ-** */yä-/*[35] which are prefixes attached in front of the indicative, subjunctive and jussive mood verbs (detailed discussion on tenses and moods are given in section 3.6) to indicate the subject (doer) of the action of the verb. They can also be used in their second, fourth and sixth orders depending on the formation of the verb. With some exceptional cases like in verbs with gutturals, the usual occurrences of these prefixes are in their sixth order forms. For example, the verb **ፈቀደ** */fäqädä/* (he liked) has its indicative, subjunctive and jussive forms as **ይፈቅድ** */yfäqd/* (he will like), **ይፍቅድ** */yfq/* (he must like) and **ይፍቅድ** */yfqd/* (for him to like). These all are person indicators. Table 3.5 shows which of the above discussed prefixes indicate which person.

[35] According to the Ethiopian scholars, these prefixes are called as **አስራው ግሳት**.

Table 3.5: Prefixes of Indicative, Subjunctive, and Jussive verbs

Indicative	Subjunctive	Jussive	Person Referred
አ- */ä-/*	አ- */ä-/*	አ- */ä-/*	አነ */änä/* (I, 1psn)
ነ- */nä-/*	ነ- */nä-/*	ነ- */nä-/*	ንሕነ */nhnä/* (We, 1ppn)
ተ- */tä-/*	-	ተ- */tä-/*	አንተ */äntä/* (You, 2psm)
ተ- */tä-/*	-	ተ- */tä-/*	አንትሙ */äntmu/* (You, 2ppm)
ተ- */tä-/*	-	ተ- */tä-/*	አንቲ */änti/* (You, 2psf)
ተ- */tä-/*	-	ተ- */tä-/*	አንትን */äntn/* (You, 2ppf)
ተ- */tä-/*	ተ- */tä-/*	ተ- */tä-/*	ይእቲ */yɔ̈ti/* (She, 3psf)
የ- */yä-/*	የ- */yä-/*	የ- */yä-/*	ውእቱ */wɔ̈tu/* (He, 3psm)
የ- */yä-/*	የ- */yä-/*	የ- */yä-/*	ውእቶሙ */wɔ̈tomu/* (They, 3ppm)
የ- */yä-/*	የ- */yä-/*	የ- */yä-/*	ውእቶን */wɔ̈ton/* (They, 3ppf)

As can be seen from Table 3.5, the prefixes */ä-/* and */nä-/* are unique to the 1psn and 1ppn respectively. Whereas, the prefix */tä-/* is common to all second persons and to the 3psf. On the other hand, the prefix */yä-/* is employed only to the 3psm, 3ppm and 3ppf. The hyphen (-) with each of prefixes above indicates the place of attachment. One can also be noticed from this table that Geʿez, as many of the other Semitic languages, has ten pronouns.

c) ***Negation marker prefix:*** **-** In Geʿez, affirmative verb is converted into its negative form by attaching the prefix አ- /*i*-/ in front of it. For example, the intransitive verbs ተፈቅደ */täfäqdä/* (he is liked by) and ተቀትለ */täqätlä/* (he is killed by) and their transitive forms ፈቀደ */fäqädä/* (he liked) and ቀተለ */qätälä/* (he killed) can be prefixed with /*i*-/ to produce their corresponding negative verbs አተፈቅደ */itäfäqädä/* (he is not liked by), አተቀትለ */itäqätlä/* (he is not killed by), አፈቀደ */ifäqädä/* (he didnʿt like), and አቀተለ */iqätälä/* (he didnʿt kill) respectively.

In general, all the possible prefixes of Geʿez verbs along with their grammatical function can be summarized as in the Table 3.6.

Table 3.6: List of Ge'ez verbs prefixes along with their syntactical functions

Prefixes	Syntactical Function
አ- */ä-/*	Causative Stem Marker
እ- */ə-/*	Indicative, Subjunctive and Jussive Moods Marker
አስተ- */ästä-/*	Causative-Reciprocal Stem Marker
ኢ- */i-/*	Negation Marker
ና- */na-/*	Causative Stem Marker
ናስተ- */nastä-/*	Causative-Reciprocal Stem Marker
ን- */n-/*	Indicative, Subjunctive and Jussive Moods Marker
ንተ- */nt-/*	Reciprocal and Reflexive Stems Marker
ታ- */ta-/*	Causative Stem Marker
ታስተ- */tastä-/*	Causative-Reciprocal Stem Marker
ተ- */tä-/*	Reflexive and Reciprocal Stems Marker
ት- */t-/*	Indicative, Subjunctive and Jussive Moods Marker
ተት- */tt-/*	Reciprocal and Reflexive Stems Marker
ያ- */ya-/*	Causative Stem Marker
ያስተ- */yastä-/*	Causative-Reciprocal Stem Marker
ይ- */y-/*	Indicative, Subjunctive and Jussive Moods Marker
ይተ- */yt-/*	Reciprocal and Reflexive Stems Marker

3.5.2 Suffixation

Ge'ez verbs, as in other Semitic languages, cannot be told without having affixes which indicate at least the doer of the action (the subject) done by the verb, otherwise both the subject and the object of the verb. This is done through affixation particularly through suffixation and circumfixation. The subjects of the perfective, imperative and gerundive verbs are indicated through suffixation. Nevertheless, the subjects of the indicative, subjunctive and jussive verbs are indicated through circumfixation (details of Ge'ez verbs circumfixes is given in the next section). In Ge'ez, verbal suffixes are of two types: „subject marker"[36] and „object marker"[37] suffixes.

The subject marker suffix (SMS) indicates subject (doer) of the action. For example, if we take the seed ፈቀድ */fäqäd/*, certain suffixes can be attached to it to produce various inflected surface verbs as shown in the Table 3.7.

[36]Subject marker is a morpheme that indicates a subject of a verb.
[37] Object marker is a morpheme that indicates an object of a verb.

Table 3.7: List of Ge'ez Verbal subject marker suffixes along with indicated persons

Seed		Subject Marker Suffix	Inflected verb	Subject Indicated
ፈቀድ */fäqäd/*	†	-ኩ */-ku/*	ፈቀድኩ */fäqädku/*	I
		-ነ */-nä/*	ፈቀድነ */fäqädnä/*	We
		-ከ */-kä/*	ፈቀድከ */fäqädkä/*	You (2psm)
		-ክሙ */-kmu/*	ፈቀድክሙ */fäqädkmu/*	You (2ppm)
		-ኪ */-ki/*	ፈቀድኪ */fäqädki/*	You (2psf)
		-ክን */-kn/*	ፈቀድክን */fäqädkn/*	You (2ppf)
		-አ */-ä/*	ፈቀደ */fäqädä/*	He
		-ኡ */-u/*	ፈቀዱ */fäqädu/*	They (3ppm)
		-አት */-ät/*	ፈቀደት */fäqädät/*	She
		-ኣ */-a/*	ፈቀዳ */fäqäda/*	They (3ppf)
		-የ */-yä/*	ፈቂድየ */fäqidyä/*	I
		-ኦ */-o/*	ፈቂዶ */fäqido/*	He
		-ሙ */-mu/*	ፈቂዶሙ */fäqidomu/*	They/3ppm
		-ን */-n/*	ፈቂዶን */fäqädon/*	They/3ppf
		-እ/-ዕ */-ə/*	ፍቅድ */fqd/*	You/2psm
		-ኡ/-u */-u/*	ፍቅዱ */fqdu/*	You/2ppm
		-ኢ/-i */-i/*	ፍቅዲ */fqdi/*	You/2psf

As a general remark, perfective, imperative and gerundive[38] verbs cannot be told without having one of these suffixes as subject marker. The first ten subject markers in Table 3.7 are suffixes mainly for perfective verbs. The next four suffixes, next to the first ten, in this table are used for gerundive verbs. The last most three suffixes, however, are used for imperativeverbs. Either of these suffixes is attached to a seed to produce a verb of the aforementioned tense-mood types. The plus (†) sign in the table symbolizes the „process of concatenation" of the morphemes to produce the surface verbs indicated in the fourth column.

The object marker suffix (OMS), on the other hand, indicates the object (action receiver) of the action of the verb. OMS cannot be directly attached to a seed. We show the concatenation process of object markers to a verb to produce many more inflected verbs by taking the previous verb */fänäwä/* in the table below. Table 3.8 shows the concatenation process of object markers to a verb to produce many more inflected verbs by taking the verb **ፈነወ** */fänäwä/*.

[38] Details of the Tense-mood types will be given in section 3.6.

Table 3.8: List of Ge'ez Verbal object marker suffixes along with indicated persons

Verb	Object Marker Suffix	Objects indicated
ፈነወ */fänäwä/*	*-ኒ /-ki/*	Me
	-ነ /-nä/	Us
	-ከ /-kä/	You (2psm)
	-ክሙ /-kmu/	You (2ppm)
	-ኪ /-ki/	You (2psf)
	-ክን /-kn/	You (2ppf)
	-ክዎ /-kwo/, -ሁ /-hu/, -ኦ /-o/, -ዎ /-wo/, -ዮ /-yo/	Him
	-ዎሙ /womu/, -ክሙ /kmu/, -ሙ /-mu/, -ሆሙ /-homu/, -ዮሙ /-yomu/	Them (3ppm)
	-ዋ /-wa/, -ሃ /-ha/, -ኣ /-a/, -ያ /-ya/	Her
	-ዎን /-won/, -ሆን /-hon/, -ን /-n/, -ዮን /-yon/	Them (3ppf)

Table 3.8 conveys that the first persons and second persons each have only one object marker suffix whereas third persons do have more than one. In this case, which object marker suffix belongs to which person depends on the subject of the verb. This results in a strict rule of suffixation that object marker suffixes can only be attached to a verb right after the subject marker. Subject marker is mandatory for any verb whereas object marker is optional. As the result, verbs choose an object marker suffix based on the subject marker already attached to them.

Two central rules of suffixation that govern the concatenation process of morphemes to produce surface verbs are:

1. **Seed † subject-marker = surface verb** (only with SMS)
2. **Seed † subject-marker † object-indicator = surface verb** (with both SMS and OMS)

Therefore, we can have two forms of surface verb forms, where the one is with subject marker only and the other is with both subject and object markers. This is because object markers are optional to be attached to a verb.

Example:

Rule-1: seed † subject-marker = surface verb (only with SMS)

ፈነው· */fänäw/* † ኩ· */ku/* = ፈነውኩ· */fänäwku/* (I sent)

Rule-2: seed † subject-marker † object-marker = surface verb (with both SMS and OMS)

ፈነው· */fänäw/* † ኩ/*-ku/* † ዎሙ·/*-womu/* = ፈነውክዎሙ· */fänäwkwomu/* (I sent them)

In this case, the subject marker */ku/* points that the subject is „I" whereas the object marker */womu/* indicates the object „Them". Hence, the verb */fänäwkwomu/* would able to indicate both the sender (subject) and the one who is sent (object). But, its corresponding English word „sent" wouldn't do that. This is essentially the general characteristics of the verbs of Semitic languages.

3.5.3 Circumfixes

Circumfix, as discussed in the second chapter, are affixes attached to both sides of the seed of the verb. In Ge"ez, circumfixes are the subject markers of indicative, subjunctive and jussive seeds. For such type of verbs too, the object markers are attached immediately after the circumfix of the seed. Hence, subject markers can be suffixes or circumfixes based on the type of the tense-mood of the verb. The object markers, if they appeared, however, are always suffixes to all verbs. Table 3.9 depicts the circumfixes of troops of */qätälä/* category.

Table 3.9: List of Ge'ez Verbal subject marker circumfixes along with their moods

Circumfix	Subject Indicated	Used In Moods
እ-እ */ə-ə/*	I	Indicative, subjunctive and jussive
ን-እ */n-ə/*	We	Indicative, subjunctive and jussive
ት-እ */t-ə/*	You/2psm and She	Indicative, subjunctive and jussive
ት-ኡ */t-u/*	You/2ppm	Indicative and jussive
ት-ኢ */t-i/*	You/2psf	Indicative and jussive
ት-ኣ */t-a/*	You/2ppf	Indicative and jussive
ይ-እ */y-ə/*	He	Indicative, subjunctive and jussive
ይ-ኡ */y-u/*	They/3ppm	Indicative, subjunctive and jussive
ይ-ኣ */y-a/*	They/3ppf	Indicative, subjunctive and jussive

The verb analysis process is done based on the way morphemes concatenate to produce surface verbs. In general, the type of morphems and the way they concatenate to produce surface verbs can be summarized as in Table 3.10.

Table 3.10: possible type of morphemes concatenated to form a verb in Ge'ez

No.	Possible Morphemes of a verb	*Example*
1	Verb = [NegPref][PosPre][39][Seed][SMS][OMS]	[ኢ][አስተ][ፋቀድ][ክም][ዎሙ]
2	Verb = [NegPref][PosPre][Seed][SMS]	[ኢ][አስተ][ፋቀድ][ክሙ]
3	Verb = [PosPre][Seed][SMS][OMS]	[አስተ][ፋቀድ][ክም][ዎሙ]
4	Verb = [NegPref][Seed][SMS][OMS]	[ኢ][ፈቀድ][ክም][ዎሙ]
5	Verb = [PosPre][Seed][SMS]	[አስተ][ፋቀድ][ክሙ]
6	Verb = [NegPref][Seed][SMS]	[ኢ][ፈቀድ][ክሙ]
7	Verb = [NegPref][PreCirc][40][Seed][SufCirc][41][OMS]	[ኢ][ት]ፍቅድ][ዎሙ][42]
8	Verb = [PreCirc][Seed][SufCirc][OMS]	[ት]ፍቅድ][ዎሙ]
9	Verb = [NegPref][PreCirc][Seed][SufCirc]	[ኢ][ት]ፍቅዱ][43]

3.6 The Conjugation Patterns and Stems of */qätälä/* Category Verbs

In this section, the final stage of verb formation process namely the *tense-mood formation* is discussed. This is the third and final stage next to the person-gender-number stage of formation discussed in section 3.5. The reason behind this is the fact that tense-mood formation cannot be done without personal-formation [Dillman, 1899:174].

Regarding to the tense-mood formation, Dillmann said that Ge"ez, like the other Semitic languages, proceeds from the twofold, and not from the threefold division of time. These are the finished state (perfect) and unfinished state (imperfect) tenses [Dillmann, 1899: 166]. According to him, the following three conditions belongs to the imperfect tense: action happening in the present, something which is only to be realized in the future and something which is only thought of and willed, which may or must be realized. And therefore, the imperfect is the source of the formation of the so-called moods[44] of the verb, through which the conditions of will and necessity are expressed. In connection to this, Dillmann suggested that the name „imperfect" is a general name for the indicative, subjunctive[45] and imperative[46]

[39] NegPref = **Neg**ation **Pre**fix, PosPre = **Pos**itive **Pre**fix
[40] PreCirc = **Pre**fix **Circ**umfix (i.e., the prefix part of the circumfix)
[41] SufCirc = **Suf**fix **Circ**umfix (i.e., the suffix part of the circumfix)
[42] The suffix part of the circumfix in this verb is the „እ" vowel of the third alphabet of the seed.
[43] The suffix part of the circumfix in this verb is the „ኡ" vowel of the third alphabet of the seed
[44] **Mood** is the form of the verb that shows the mode or manner in which a thought is expressed.
[45] Subjunctive is a special form of imperfect which express an action coming into being or has to be set forth as one that is willed [Deillman, 1899:173].
[46] Imperative is a special ramification of the subjunctive, and has been developed out of it.

moods [Dillmann, 1899: 173]. This suggestion is used in this study while naming of the tense-mood[47] types.

The types of verbs described as perfective, indicative, subjunctive and imperative verbs are those, according to the Ethiopian scholars, which are called **ዓበይት አናቅፅ** */abäyt anaqṣ/* to mean verbs which can close the idea of a sentence independently without seeking a help of other verbs. In addition to these verbs, the scholars identify extra verbs called **ንኡሳን አናቅጽ** */nusan anaqṣ/* which cannot close a sentence unless other verbs are added to them. The later types of verbs are similar to the English auxiliary verbs. Table 3.11 is dedicated to clear up the above discussion.

Table 3.11: List of Ge'ez tenses and moods according to both Ethiopian and Foreign Scholars

Tense-mood Identified by Ethiopian Scholars				**Tense-mood Identified by Foreign Scholars**	
No	***Tense-mood***	***Category***		***Tense-mood***	***Category***
1	**ቀዳማይ /ኃላፊ አንቀጽ** (Perfective)	**ዓበይት አናቅጽ** */abäyt anaqṣ/*		Perfective	Perfective
2	**ካልኣይ /ትንቢት አንቀጽ** (Indicative)			Indicative	Imperfective
3	**ሣልሣይ /ትእዛዝ አንቀጽ** (Subjunctive)			Subjunctive	
4	**የቅርብ ትእዛዝ አንቀጽ** (Imperative)			Imperative	
5	**ምክንያታዊ**[48] **አንቀጽ** (Jussive)	**ንኡሳን አናቅጽ** */nusan anaqṣ/*		–	–
6	**ቦዝ አንቀጽ** (Gerundive)				
7	**አርእስት አንቀጽ** (Infinitive)				
8	**ሳቢ-ዘር አንቀጽ** */sabizär anqäṣ/*				
9	**ቅጽል አንቀጽ** */qṣl anqäṣ/*				

As can be seen from Table 3.11, the tense-mood identified by the Ethiopian scholars are the same as that of those identified by the foreign scholars except that the Ethiopians identified extra moods which are categorized as */nusan anaqṣ/*. This study adopts the identification of tense-mood types according to the Ethiopian scholars. Nevertheless, the last two moods in this table have a derivational morphology (see

[47] The term „tense-mood" is used to refere to all conjugation patterns (see Table 3.11) as the imperfect tense type encompasses all the identified moods in it.
[48] Some scholars prefer to call this as **ዘንድ አንቀጽ** */zänd anqäṣ/*.

section 2.2.3) as they are verbal noun and verbal adjective respectively and, hence, are left undone in this study.

The imperative verbs are command verbs as that of the subjunctive verbs except that imperatives have only second person subject markers. Likewise, the difference between subjunctive and jussive verbs lies on the fact that the jussive verbs with second person subject markers have the prefix */tä/* whereas the subjunctive verbs with second person subject markers do not have prefixes and, hence, have got a special name: imperative verbs.

The perfective, imperative, gerundive and infinitive verbs do have SMS as a subject marker whereas indicative, subjunctive and jussive have subject markers being circumfixed to their seeds. Regarding to the object marker, however, all tense-mood types except gerundive and infinitive verbs do have OMS being suffixed after their subject markers (suffixed or circumfixed to them). Infinitive verbs can have SMS but not OMS.

Infinitive verbs can be spoken with and without having SMS. Those which don‟t have SMS are common to all pronouns. For example: **አፍቅዶት** */äfqdot/* is an infinitive verb which doesn‟t have SMS. As a result this verb doesn‟t indicate any subject. The infinitive verb **አፍቅዶትየ** */äfqdotyä/*, however, has an SMS **የ***/yä/* which indicates that the subject is „I‟. In general, it is only infinitive verbs in Ge‟ez which may not indicate the doer of the action of the verb.

The following sub-sections discuss the conjugation patterns and number of stems of */qätälä/* category verbs based on the aforesaid tense-mood types.

3.6.1 The Conjugation Patterns of */qätälä/* Category Verbs

According to the Ethiopian scholars, both transitive and intransitive troops of */qätälä/* have seven conjugation patterns[49] (excluding the other two which are not verbs) based on the seven tense-mood identifications presented above. Conjugation patterns are the basic templates through which the surface verbs of */qätälä/* category are formulated. The templates are effectively used during the declaration process carried out to find the inflected surface forms of the verb. Table 3.12 depicts the basic

[49] These are what the Ethiopian Scholars called them as **አናቅፅ**.

conjugation patterns and their corresponding templates by taking the verb **ፈቀደ** */fäqädä/*, one of the troops of */qätälä/*, as an example.

Table 3.12: Basic conjugation patterns of a root along with their templates and vocalic patterns

No.	Root	Vocalic Pattern(VP)	CV-Template	Conjugation Patterns	Tense-mood
1	**ፍቅድ** */f-q-d/*	111	$C_1äC_2äC_3ä$	**ፈቀደ** */fäqädä/*	Perfective
2		166	$yC_1äC_2C_3$	**ይፈቅድ** */yfäqd/*	Indicative
3		666	$yC_1C_2C_3$	**ይፍቅድ** */yfqd/*	Subjunctive
4		666	$C_1C_2C_3$	**ፍቅድ** */fqd/*	Imperative
5		666	$yC_1C_2C_3$	**ይፍቅድ** */yfqd/*	Jussive
6		137	$C_1äC_2iC_3o$	**ፈቂዶ** */fäqido/*	Gerundive
7		136	$C_1äC_2iC_3$	**ፈቂድ** */fäqid/*	Infinitive
		137	$C_1äC_2iC_3ot$	**ፈቂዶት** */fäqidot/*	

As can be seen from table 3.12, the conjugation patterns (column-IV) are produced after the intercalation of the root with vowels of varies patterns (column-V) in the templates given in column-III of the table. All tri-literal */qätälä/* category verbs share the template, conjugation pattern and vocalic patterns depicted in this table.

3.6.2 The Stems of /qätälä/ Category Verbs

According to Ethiopian scholars, stems are the pillars or bases of verbs. They are called **አዕማድ** */aʔmad/* „pillars", or shaft that support the roof of building. In this sense, they are pillars that support the conjugations of verbs. These scholars believe that Ge'ez has five stem patterns which all are independent of each other. They are perfective, causative, causative-reciprocal, reflexive and reciprocal stems [Zäradawit, 1996].

The foreign scholars, however, have recognized different number of stems. The stems of Ludolf are only four in number. These are perfective, causative, reflexive passive and causative-reflexive stems. Stems of Dillmann are four. As to him, there are no stems for reciprocity like Ludolf and unlike the local scholars. Lambdin, on the other hand, recognized six stems by adding one more stem which, according to him, is called causative of reflexive passive.

This study assumed the types of stems as recognized by the Ethiopian scholars. These are perfective, causative, causative-reciprocal, reflexive and reciprocal stems. Table 3.13 is dedicated to show the stems of the aforesaid seven tense-moods of */qätälä/*.

Table 3.13: The five stem types for each of the seven tense-mood types of Ge'ez verbs

No.	Tense-mood	The Five Stems				
		ገቢር */gäbir/* **(Perfective)**	**አግብሮ** */agbro/* **(Causative)**	**ተገብሮ** */tägäbro/* **(Reflexive)**	**ተጋብሮ** */tägabro/* **(Reciprocal)**	**አስተጋብሮ** */astägabro/* **(Causative-Reciprocal)**
፩	Perfective	ፈቀደ */fäqädä/*	አፍቀደ */äfqädä/*	ተፈቅደ */täfäqdä/*	ተፋቀደ */täfaqädä/*	አስተፋቀደ */ästäfaqädä/*
፪	Indicative	ይፈቅድ/*yfäqd/*	ያፈቅድ */yafäqd/*	ይትፈቀድ */ytfäqäd/*	ይትፋቀድ */ytfaqäd/*	ያስተፋቅድ */yastäfaqd/*
፫	Subjunctive	ይፍቅድ */yfqd/*	ያፍቅድ */yafqd/*	ይትፈቀድ */ytfäqäd/*	ይትፋቀድ */ytfaqäd/*	ያስተፋቅድ */yastäfaqd/*
፬	Imperative	ፍቅድ */fqd/*	አፍቅድ */äfqd/*	ተፈቀድ */täfäqäd/*	ተፋቀድ */täfaqäd/*	አስተፋቅድ */ästäfaqd/*
፭	Jussive	ይፍቅድ */yfqd/*	ያፍቅድ */yafqd/*	ይትፈቀድ */ytfäqäd/*	ይትፋቀድ */ytfaqäd/*	ያስተፋቅድ */yastäfaqd/*
፮	Gerundive	ፈቂዶ */fäqido/*	አፍቂዶ */äfqido/*	ተፈቂዶ */täfäqido/*	ተፋቂዶ */täfaqido/*	አስተፋቂዶ */ästäfaqido/*
፯	Infinitive (a)	ፈቂድ */fäqid/*	አፍቅዶ */äfqdo/*	አስተፋቅዶ */äStefaqdo/*	ተፈቅዶ */täfäqdo/*	ተፋቅዶ */täfaqdo/*
	(b)	ፈቂዶት */fäqidot/*	አፍቅዶት */äfqdot/*	አስተፋቅዶት */äStefaqdot/*	ተፈቅዶት */täfäqdot/*	ተፋቅዶት */täfaqdot/*

As can be seen from Table 3.13, each of the tense-moods has five stems. Nevertheless, as most Ethiopian scholars suggest, only transitive verbs can have complete stem forms (five stems) whereas intransitive verbs have less than five [Kidanä Wäld, 1948], [Zäradawit, 1996], [Räzänä, 1998]. In connection to this, the name of the first tense-mood (perfective) seems to be confusing with the name of the first stem (perfective). To avoid this confusion, we use the name „base stem"[50] for the first column (**ገቢር** */gäbir/*) stem. Verbs which belong to the base, causative and causative-reciprocal stems are transitive verbs. On the other hand, verbs which belong to the reflexive passive and reciprocal stems are intransitive verbs. Furthermore, we call each of the seven rows (numbered as 1 to 7) stems respectively as perfective stems category, indicative stems category, subjunctive stems category, imperative stems category, jussive stems category, gerundive stems category and infinitive stems category.

3.7 Declaration of Ge'ez verbs

„Declaration" is the process of finding all the inflected (surface) forms of a given verb in Ge"ez. The process starts from the 3psm form of the verb. The declaration process passes through three independent phases:

[50]We named the first stem type as **base stem** for it is the base of all the rest stems. The other four types of stems are derived from this stem and hence, the name **base stem.** This name also works for verbs of all tense-moods.

- ***Declaration using the tense-mood and stems:*** this declaration process is done as a „declaration-template" only for the 3psm form of the verb by making the identified tense-mood types as rows and the stems as columns and form a matrix of size 7×5. A total of forty surface verbs are obtained from this phase (see Table 3.13).
- ***Declaration using the ten subject pronouns[51]:*** each of the surface forms obtained in phase-I (each of the verb forms in Table 3.13) are declared further using the ten pronouns by appending the subject marker (see Table 3.7 and 3.8) of each of the ten pronouns. For each of the verb forms depicted in Table 3.13, nine additional surface forms are obtained through this phase.
- ***Declaration using object marker suffixes (using the ten object pronouns):*** each of the ten surface forms (in addition to the surface form with 3psm) are derived by adding the object markers to indicate the object pronouns. By this phase only, additional eighty eight surface verbs are obtained (see figure 3.1).

[51] Ge"ez language has ten pronouns: **አነ** /I/, **ንሕነ** /We/, **አንተ** /You-2psm/, **አንትሙ** /You-2ppm/, **አንቲ** /You-2psf/, **አንትን** /You-2ppf/, **ውእቱ** /He-3psm/, **ይእቲ** /She-3psf/, **ውእቶሙ** /They-3ppm/, and **ውእቶን** /They-3ppf/.

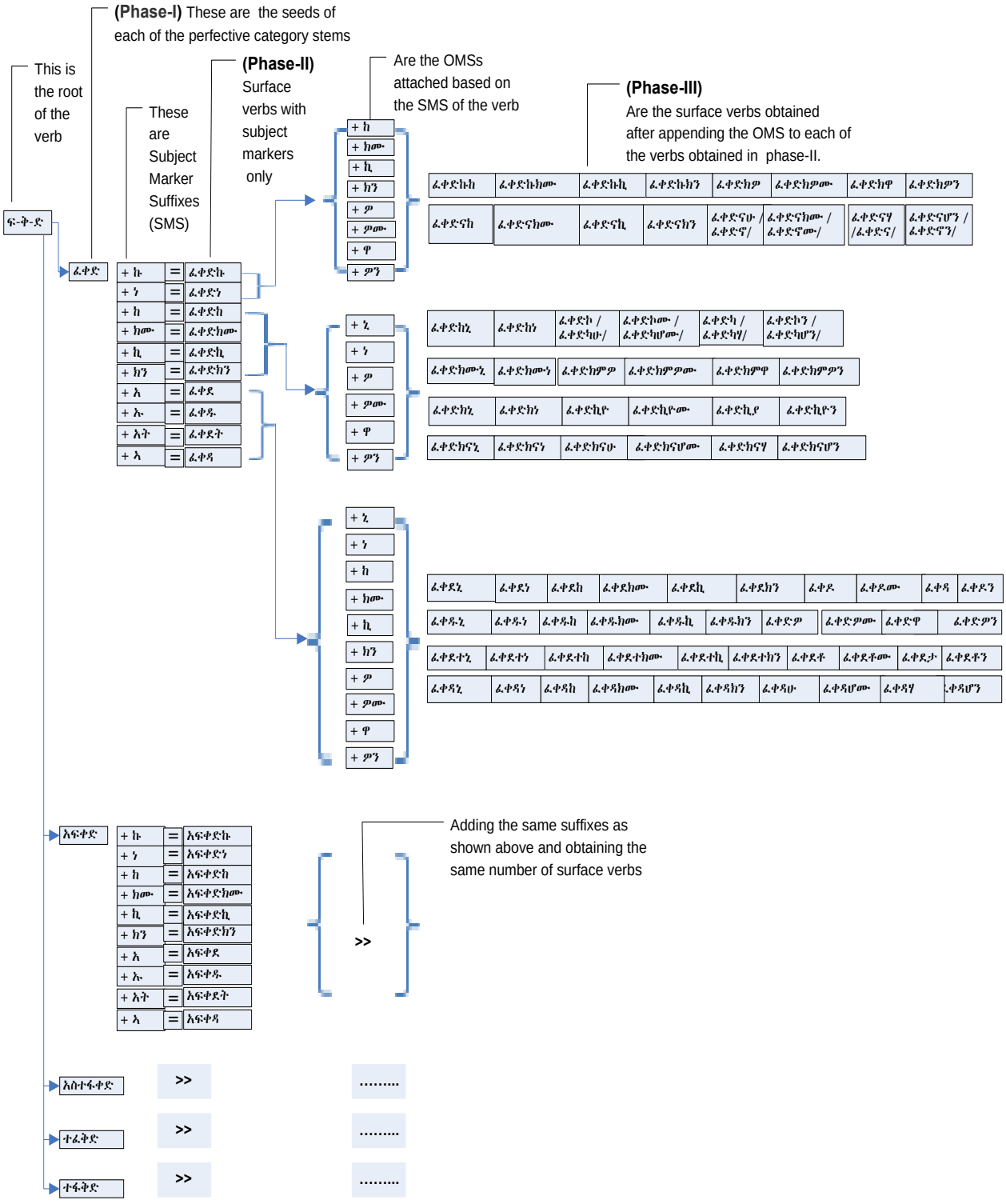


Figure 3.1: Declaration of the perfective verb *ፈቀደ /fäqädä/:* firstly, by its stems; secondly, by appending the SMS to all forms obtained in the first phase; thirdly and finally, by the object pronouns: i.e., by appending their OMS to each of the surface forms obtained in the second phase.

By undergoing similar declaration process as in figure 3.1 for all verb-forms of each of the tense-mood and stem types depicted in Table 3.13, it is possible to obtain all the surface verbs of a given verb lexeme[52]. Accordingly, each of the transitive verbs of the perfective stem category (row-I in Table 3.13) verbs can be declared further using the ten pronouns by adding only the subject makers or both subject and object makers. By adding ten of the subject makers to each of the verbs of this category, we can have their corresponding ten inflections. Declaring each of the verbs further by adding the object makers to the already formed ten inflected verb forms will result in another eighty eight new inflections (surface verbs) of each of the verbs. In this case, we can have total ninety eight surface forms for each of these verbs found as the result of the declaration process. In sum, all verbs of this category do have ninety eight inflected forms **(**see Appendix-II A: i, ii, iii). Each of the intransitive verbs of this category, however, do have ten inflected forms after the reason that they can be declared only by adding the subject marker suffixes and not by the object suffixes **(**see Appendix-II A: iv, v).

Each of the transitive verbs of the indicative, subjunctive and jussive stem categories (row-2 to row-4 in Table 3.13), on the other hand, do have only ninety eight inflected forms (see Appendix-II B, C, and D: i, ii, iii). Besides, each of the intransitive verbs of these categories, like the perfective stem category intransitive verbs, do have also ten inflections obtained after attaching the ten subject marker suffixes to them (see Appendix-II B, C, and D: iv, v). On the one hand, both transitive and intransitive verbs of gerundive stem category each do have ten inflected forms and, hence, a total of hundred surface verb forms (see Appendix-II E). The category (a) infinitive verbs in Table 3.13 can not be declared further. Whereas, category (b) infinitve verbs in Table 3.13 can be declared using all the ten pronouns and therefore can have a total of fifty five surface verbs (see Appendix-II F). Accordingly, we can have sixty infinitive surface verbs.

In sum, 1388 inflected verb forms (surface verbs) were obtained from a given verb lexeme through the declaration process.

[52]Lexeme form of a verb for Semitic languages is the dictionary (lexicon) form of the verb usually in 3psm form.

3.8 Ge'ez Irregular */qätälä/* CategoryVerbs

Irregular verbs are those troops of */qätälä/* that have slightly changed morphological structure when compared with the CV-template of their head-verb, **ቀተለ** */qätälä/*, due to the existence of one of the guttural alphabets namely **ሀ**, **ሐ**, **ኀ**, **አ** and **ዐ** either at their beginning or middle positions. The effects of these two possible occurances of the guttural alphabets in a verb are discussed as follows:

- *Occurance of the guttural alphabets at the beginning of a verb*: when the guttural alphabets are existed at the beginning of a verb, the person-marker of the indicative base-stem is changed from the usual six-order form into first-order form. That is, **ይ** is changed into **የ** because of the occurrence of these alphabets at the beginning of the verb.

- *Occurance of the guttural alphabets at the middle of a verb*: when the guttural alphabets are existed at the middle position of the verb, some changes are obsereved in the inflected forms of the verb (see Table 3.14).

Table 3.14: Morphological irregularities observed on verbs with a guttural alphabet at their middle

Tense-mood and Stem	Underlying Vocalic Pattern	Altered Vocalic Pattern	*Example*		
			Underlying form	*changed to*	*Surface form*
Perfective reflexive-stem	161	661	ተሰአለ */täSäʔlä/*	=>	ተስእለ*/täSʔlä/*
Indicative base-stem	166	666	ይሰእል*/ySäʔl/*	=>	ይስእል*/ySʔl/*
Subjunctive base-stem	666	616	ይስእል*/ySʔl/*	=>	ይስአል*/ySäl/*
Jussive base-stem	666	616	ይስእል */ySʔl/*	=>	ይስአል */ySäl/*
Gerundive base-stem	137	637	ሰኢሎ*/Säilo/*	=>	ስኢሎ*/Silo/*
Infinitive base-stem	136	636	ሰኢል/ሰኢሎት */Säil/|/Säilot/*	=>	ስኢል/ስኢሎት */Sil/ |/Silot/*
Indicative causative stem	166	666	ያሰእል*/yaSäʔl/*	=>	ያስእል*/yaSʔl/*
Gerundive reflexive stem	137	637	ተሰኢሎ */täSäilo/*	=>	ተስኢሎ */täSilo/*
Infinitive reflexive stem	167	667	ተሰእሎ/ተሰእሎት */täSäʔlo/|/täSäʔlot/*	=>	ተስእሎ/ተስእሎት */täSʔlo/|/täSʔlot/*

- The prefixes of the indicative reflexive stem, subjunctive reflexive stem and jussive reflexive stem are changed from **ይት** */yt/* to **ይ** */y/*. That is, the alphabet **ት** */t/* in their prefix is omitted because of the

occurrence of these vowels at the middle of the verb. For example: the indicative reflexive-stem verb **ይሰአል** */ySääl/* is altered from its regular form **ይትሰአል** */ytSääl/* by omitting **ት**/*t*/ from the prefix. Similarly, the prefixes of the indicative reciprocal stem, subjunctive reciprocal-stem and jussive reciprocal-stem are aslo changed from **ይት** */yt/* to **ይ**/*y*/.

3.9 Assimilation and Vowel Changes

As discussed in the second chapter, seeds are formed through non-concatenative process. Once seeds are formulated in this way, the second growth of verbs to their more common existence is through affixation, which is essentially a concatenative process. During the later process, various phonological changes such as assimilation and vowel changes that may alter the original existence can occur, usually at the morpheme boundaries. As the result, for the analyzer to parse a verb formulated in this way accurately, phonological changes that have taken place during the verb formation should also be carefully considered during the verb analysis.

3.9.1 Assimilation effects

Assimilation effects are observed in verbs which end with either glottal or semivowel alphabets. Whenever an SMS markers specifically **ከ** */kä/*, **ኩ** */ku/*, **ኪ** */ki/*, **ክን** */qn/* or **ክሙ** */qmu/* are appended to the end of a verb which ends with either of the glottal alphabets namely **ቀ** */qä/*, **ከ** */kä/*, or **ገ** */gä/*, assimilation effects are observed on the boundary of the morphemes. Furthermore, when the SMS **ነ** */nä/* is added to the end of a verb which ends with **ን** */n/*, similar effect is detected at the boundary of the morphemes. On the one hand, the presence of either of the semivowels **ወ** */wä/* or **የ** */yä/* at the beginning, middle or end of a verb also brought a change in the inflected forms of the verb in its indicative, subjunctive, imperative and jussive stem categories. As the objective of this study is analyzing verbs found in a given text, only processes that changes in a grapheme[53] are considered.

3.9.2 Vowel Changes

As discussed earlier in this chapter, Ge"ez verbs have at least subject marker suffixes. Object marker suffixes are optional to be attached to verbs. Vowel changes are usually detected when object marker suffixes are added after subject marker suffixes or circumfixes. Below is the detail of the possible changes.

[53] Grapheme is the minimal distinct unit in the writing system of a language.

a) Vowel changes occurred when OMS are attached after SMS: Table 3.15 summarizes the possible changes of vowel sounds that can occur during concatenating of the aforesaid suffixes.

Table 3.15: Vowel changes occurred when OMS are attached right after SMS

Subject Marker		Object Marker		Changed form		Subject Marker		Object Marker		Changed form	
ኩ/ku/	+	ዎ /wo/	=	ክዎ /kwo/		ከ /kä/	+	ኦ /o/	=	ኮ /ko/	
ኩ/ku/	+	ዎሙ /womu/	=	ክዎሙ /kwomu/		ከ /kä/	+	ሁ /hu/	=	ካሁ /kahu/	
ኩ/ku/	+	ዋ /wa/	=	ክዋ /kwa/		ከ /kä/	+	ሙ /mu/	=	ኮሙ /komu/	
ኩ/ku/	+	ዎን /won/	=	ክዎን /kwon/		ከ /kä/	+	ሆሙ /homu/	=	ካሆሙ /kahomu/	
						ከ /ke/		ኣ /o/	=	ካ /ka/	
ነ /nä/	+	ከ /kä/	=	ናከ /nake/		ከ /kä/	+	ሃ /ha/	=	ካሃ /kaha/	
ነ /nä/	+	ክሙ /kmu/	=	ናክሙ /nakmu/		ከ /kä/	+	ን /nE/	=	ኮን /kon/	
ነ /nä/	+	ኪ /ki/	=	ናኪ /naki/		ከ /kä/	+	ሆን /hon/	=	ካሆን /kahon/	
ነ /nä/	+	ክን /kn/	=	ናክን /nakn/							
ነ /nä/	+	ሁ /hu/	=	ናሁ /nahu/		ክሙ /kmu/	+	ዎ /wo/	=	ክምዎ /kmwo/	
ነ /nä/	+	ኦ /o/	=	ኖ /no/		ክሙ /kmu/	+	ዎሙ /womu/	=	ክምዎሙ /kmwomu/	
ነ /nä/	+	ሆሙ /homu/	=	ናሆሙ /nahomu/		ክሙ /kmu/	+	ዋ /wa/	=	ክምዋ /kmwa/	
ነ /nä/	+	ሙ /mu/	=	ኖሙ /nomu/		ክሙ /kmu/	+	ዎን /won/	=	ክምዎን /kmwon/	
ነ /nä/	+	ሃ /ha/	=	ናሃ /naha/							
ነ /nä/	+	ኣ /a/	=	ና /na/		ኪ /ki/	+	ኒ /ni/	=	ክኒ /kni/	
ነ /nä/	+	ሆን /hon/	=	ናሆን /nahon/		ኪ /ki/	+	ነ /nä/	=	ክነ /knä/	
ነ /nä/	+	ን /n/	=	ኖን /non/							
						ክን /kn/	+	ኒ /ni/	=	ክናኒ /knani/	
ኣት /ät/	+	ኒ /ni/	=	ኣተኒ /ätäni/		ክን /kn/	+	ነ /nä/	=	ክናነ /knanä/	

አት /ät/	+	ነ /nä/	=	አተነ /ätänä/		ክን /kn/	+	ሁ /hu/	=	ክናሁ /knahu/
አት /ät/	+	ከ /kä/	=	አተከ /ätäkä/		ክን /kn/	+	ሆሙ /homu/	=	ክናሆሙ /knahomu/
አት /ät/	+	ክሙ /kmu/	=	አተክሙ /ätäkmu/		ክን /kn/	+	ሃ /ha/	=	ክናሃ /knaha/
አት /ät/	+	ኪ /ki/	=	አተኪ /ätäki/		ክን /kn/	+	ሆን /hon/	=	ክናሆን /knahon/
አት /ät/	+	ክን /kn/	=	አተክን /ätäkn/						
አት /ät/	+	ኦ /o/	=	አቶ /äto/		አ /ä/	+	ኦ /o/	=	ኦ /o/
አት /ät/	+	ሙ /mu/	=	አቶሙ /ätomu/		አ /ä/	+	ሙ /mu/	=	ኦሙ /omu/
አት /ät/	+	ኣ /a/	=	አታ /äta/		አ /ä/	+	ኣ /a/	=	ኣ /a/
አት /ät/	+	ን /n/	=	አቶን /äton/		አ /ä/	+	ን /n/	=	ኦን /on/
ኡ /u/	+	ዎ /wo/	=	እዎ /ɔwo/						
ኡ /u/	+	ዎሙ /womu/	=	እዎሙ /ɔwomu/						
ኡ /u/	+	ዋ /wa/	=	እዋ /ɔwa/						
ኡ /u/	+	ዎን /won/	=	እዎን /ɔwon/						

***b) Vowel changes occurred when OMS are attached after circumfix*:** Table 3.16 summarizes the possible changes of vowel sounds that can occur during concatenating of the OMS to the circumfix of one‟s verb.

Table 3.16: Vowel changes occurred when OMS are attached after circumfixes

End of Circumfix		*Object Marker*		*Changed form*		*End of Circumfix*		*Object Marker*		*Changed form*	
እ /ə/	†	ከ /kä/	=	አከ /äkä/		ኡ /u/	†	ዎ /wo/	=	እዎ /əwo/	
እ /ə/	†	ክሙ /kmu/	=	አክሙ /äkmu/		ኡ /u/	†	ዎሙ /womu/	=	እዎሙ /əwomu/	
እ /ə/	†	ኪ /ki/	=	አኪ /äki/		ኡ /u/	†	ዋ /wa/	=	እዋ /əwa/	
እ /ə/	†	ክን /kn/	=	አክን /äkn/		ኡ /u/	†	ዎን /won/	=	እዎን /əwon/	
እ /ə/	†	ኦ /o/	=	ኦ /o/							
እ /ə/	†	ሙ /mu/	=	አሙ /omu/		ኢ /i/	†	ኒ /ni/	=	እኒ /əni/	
እ /ə/	†	ኣ /a/	=	ኣ /a/		ኢ /i/	†	ነ /nä/	=	እነ /ənə/	
እ /ə/	†	ን /n/	=	ኦን /an/		ኢ /i/	†	ዮ /yo/	=	እዮ /əyo/	
እ /ə/	†	ኒ /ni/	=	አኒ /äni/		ኢ /i/	†	ዮሙ /yomu/	=	እዮሙ /əyomu/	
እ /ə/	†	ነ /nä/	=	አነ /änä/		ኢ /i/	†	ያ /ya/	=	እያ /əya/	
እ /ə/	†	ሁ /hu/	=	ኣሁ /ahu/		ኢ /i/	†	ዮን /yon/	=	እዮን /əyon/	
እ /ə/	†	ሆሙ /homu/	=	ኣሆሙ /ahomu/							
እ /ə/	†	ሃ /ha/	=	ኣሃ /aha/							
እ /ə/	†	ሆን /hon/	=	ኣሆን /ahon/							

3.10 Summary

This chapter has discussed about the verb formation process in Ge"ez, specifically about */qätälä/* category verbs, by dividing the formation process into three stages as *seed formation*, *person-gender-number formation* and *tense-mood formation*. The next chapter will discuss about the design of the model of Ge"ez verbs analyzer along with the implementation principle employed. The design process is accomplished based on what have been discussed in this chapter.

CHAPTER FOUR

DESIGN AND IMPLEMENTATION OF THE MODEL OF GEEZ VERBS ANALYZER

4.1 Introduction

This chapter discusses the design of the model of Ge"ez verbs analyzer along with the implementation principle of the model. The design process is based on the morphological properties of the language presented in chapter three and the assumptions and approaches discussed in chapter two.

Section 4.2 discusses the assumptions and conventions taken into consideration during the design and implementation issues. Section 4.3 describes the architecture of the Ge"ez verbs analyzer and the implementation procedures according to the designed model of the analyzer.

4.2 Assumptions Considered During the Design and Implementation

The following assumptions are taken into consideration while designing the model and implementing the prototype of the analyzer:

i) Every Ge"ez verb should be first transliterated into Roman letters before any kind of analysis process began. Regarding to the transliteration, one should notice that the transliteration used for the documentation and the implementation are different. This is done purposely for the sake of readability of the documentation and simplicity of the implementation[54]. The transliteration convenience used for the documentation and implementation are both given in Appendix IV: A and B respectivelly.

ii) During the implementation, every Ge"ez alphabet is represented with two Roman letters (a consonant accompanied by its vowel) for simplified processing of the strings. For example: the Ge"ez verb ሐተመ is transliterated as */heteme/*, where every alphabet of Ge"ez is represented with two convenient Roman letters. For this reason, phrases like „first character", „second character", „third character", etc., in the following algorithms refers to the character order of the transliterated form of the verb and not for the original Ge"ez verb.

[54]The reason why we used the Romanic transliteration of the Ge"ez verbs during the implementation phase is to have a Unicode format of the verb which is suitable for our implementation as we used Java to develop the prototype of the analyzer.

iii) Vowels during the implementation are *e*, *u*, i, *a*, *A*, *Y*, and *o* representing the seven convenient Geʿez vowels namely አ ፣ ኡ ፣ ኢ ፣ ኣ ፣ ኤ ፣ እ and ኦ respectively. If vowels are found explicitly in the verb, then they are transliterated only using either of the above listed verbs. For example: each of the alphabets in the verb **አፍቀደተክሙ** are transliterated as **አ**=e, **ፍ**=fY, **ቀ**=qe, **ደ**=de, **ተ**=te, **ክ**=kY and **ሙ**=mu. Since the first alphabet (**አ**) is a vowel, it is transliterated with one Roman alphabet.

iv) Throughout all the algorithms, the operation *remove()* should be understood only as an operation which detaches a feature from a verb and store that feature for later use in identifying another features that the verb has. It does not mean discard the feature rather detach and store it to be one of the valued features even in the later output of the analysis process.

4.3 Architecture of the Analyzer

As pointed out in section 2.2.6.3 of chapter two, the analyzer accepts sequence of surface verbs (verb-set) extracted manually from the contemporary Geʿez texts by domain experts. Accepting such an input, the analyzer passes through definite steps to analyze the verb into its constituting lexeme and morphosyntactic features. Figure 4.1 depicts the general tasks that the analyzer does while analyzing any verb of */qätälä/* category.

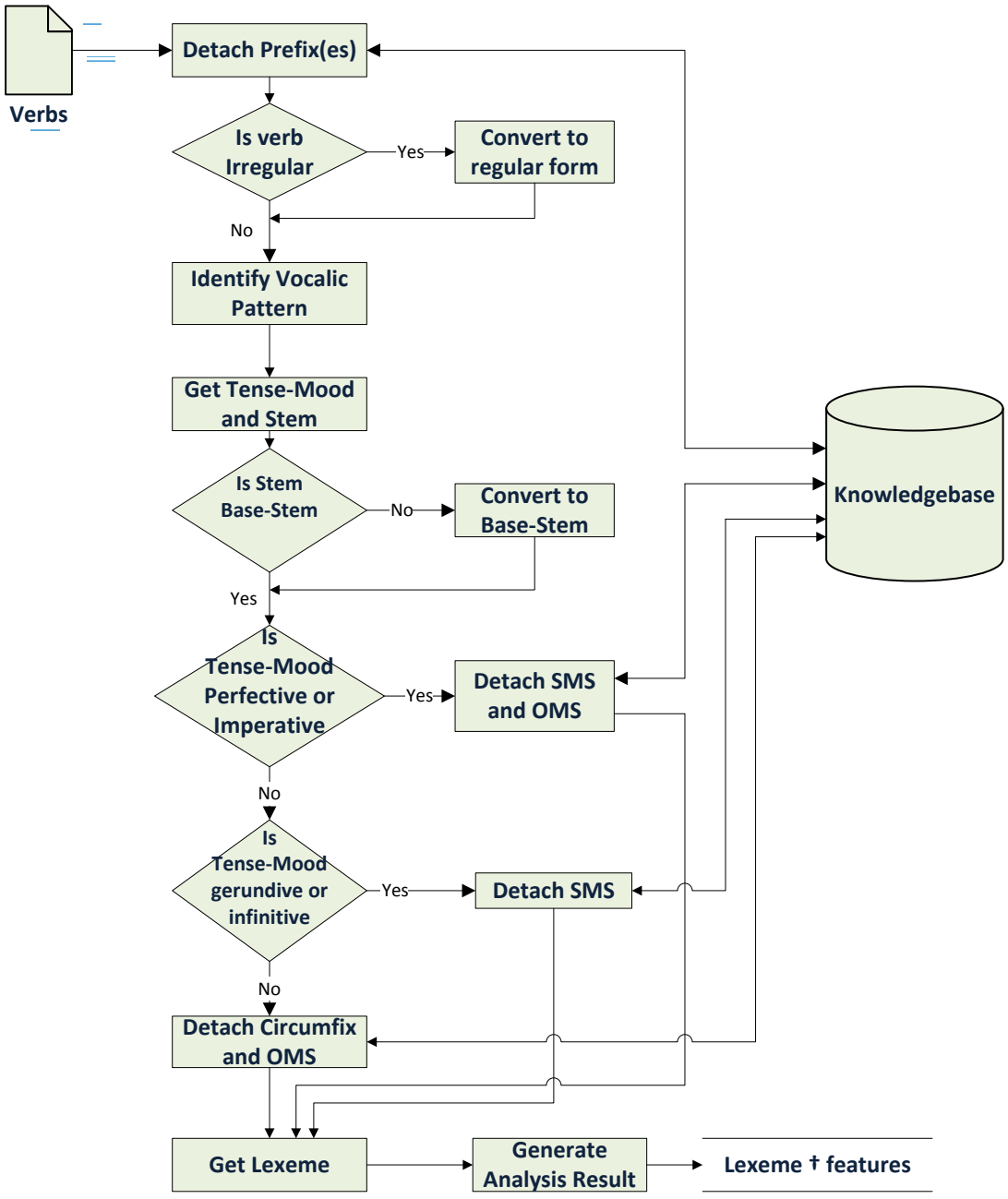


Figure 4.1: Architecture of Ge'ez Verbs Analyzer

As can be seen from figure 4.1, the input of the analyzer is a verb, which is a troop of */qätälä/*. Accepting this input, the analyzer goes through the main activities to analyze the verb. It uses the knowledgebase as a demon component while identifying and detaching the affixes from the verb.

The general description on how the analyzer works is presented below.

4.3.1 Detaching Prefix of a Verb

As discussed in section 3.5.1, prefixes of Ge‟ez verbs can indicate stem and tense-mood types of the respected verb. For this reason, detaching the prefix right after accepting the verb should be the first task of the analyzer to identify the rest features of the verb. A verb might have two prefixes being concatenated one after the other as described in section 3.5.1. This possibility of existence of double prefixes is occurred only in negative verbs which are prefixed by the negation marker */i-/*. To handle such cases, the analyzer first checks the existence of the negation marker */i-/* and then the existence of the other prefix (if any) next to it. If the verb is going to have a prefix, the possible order of the radical next to it should be either first or fourth or sixth order which, in turn, leads to a conclusion that there is no possibility for a prefix of a verb to be followed by second, third, fifth or seventh order radicals.

To identify the prefix of the verb, the analyzer uses the rules and facts incorporated to the knowledgebase. The knowledgebase contains the possible prefixes occurred in any troops of */qätälä/* along with their syntactical functions. Accordingly, if the verb is found to have a prefix attached to it, then the analyzer splits it from the verb and stores it as a feature. Otherwise, it continues to the next step. For example, if the verb entered to the analyzer is **ኢ.ያስተፋቀድክምዎሙ** */iyaSYtefaqedYkYmYwomu/*, then the analyzer detaches the prefix /i-/ as a negation marker and then the prefix /yaSYte-/ as a causative-reciprocal stem marker and, finally, passing the remaining part of the verb */faqedYkYmYwomu/* for further analysis to the next steps.

4.3.2 Checking Verb Irregularity

Irregular verbs are those troops of */qätälä/* that have slightly altered morphological structure when compared with the CV-template of their head-verb, **ቀተለ** */qätälä/*, due to the existence of one of the guttural alphabets namely **ሀ**, **ሐ**, **ኀ**, **አ** and **ዐ** either at their beginning or middle positions. Once the prefix of a verb is removed, the analyzer checks if the verb-part (part of the verb with prefix (es) detached, for instance, */faqedYkYmYwomu/* in the above example) has any of the aforementioned alphabets in it. To do so, the analyzer takes the first and the third character of the verb-part to identify if the verb is „beginning guttural‟ and „middle guttural‟ respectively. Mismatching of these characters with any of the aforesaid guttural alphabets means that the verb is regular.

The analyzer uses the knowledgebase as a demon while analyzing the irregular verbs too. Sample of the facts and features rules of irregular verbs incorporated to the knowledgebase is shown in Table 4.1.

Table 4.1: Sample of facts and features of irregular verbs incorporated to the knowledgebase

Prefixes	Vocalic Patten (VP)	Tense-mood	Stem
yY	61	Subjunctive/ Jussive	Base
tY	61	Subjunctive/ Jussive	Base
e	66	Indicative	Causative

As depicted in the sample given in Table 4.1, the possible prefixes together with the vocalic patterns (to be discussed in section 4.3.4 of this chapter) of the verbs of */qätälä/* are incorporated to the knowledgebase as features of irregular verbs. Furthermore, the fact that the prefix and vocalic pattern of a verb can together specify the tense-mood-stem of the verb is also incorporated to the knowledgebase as one and solid fact. For example, from Table 4.1, the tense-mood and stem of a verb with a prefix */yY/* and a vocalic pattern 61 are subjunctive (or jussive) and base-stem respectively.

4.3.3 Converting Irregular Verbs to Their Corresponding Regular Forms

The analyzer does its analysis process after making sure that a verb is regular. Regular verbs are those which have the same CV-template with their head-verb, **ቀ·ተ·ለ** */qätälä/*, in all their inflected forms. Some troops of */qätälä/*, however, tend to have irregular CV-template due to the existence of the guttural and semivowel[55] alphabets in them. Such irregular verbs ought to be converted into regular forms by undergoing certain modifications at their beginning or middle positions in order for them to be consumed (analyzed) by the analyzer.

As described above, we have identified two forms of irregular verbs namely „beginning guttural" and „middle guttural" irregular verbs depending on the position of the guttural alphabets existed in them. The conversion process conducted for both types of irregular verbs is given as follows. In this regard, one should be noticed that every conversion process is done without changing the tense-mood and stem of the verb.

[55] Ge"ez has two semivowels namely **ወ***/wä/* and **የ***/yä/*.

I) Converting 'beginning-guttural' irregular verbs into their corresponding regular forms

The difference between „beginning guttural" irregular verbs and their corresponding regular forms lies only on the alphabetical order of the person-marker prefixes of their indicative base-stem forms. The person-marker prefixes of the regular forms are **እ***/ə/*, **ነ***/n/*, **ት***/t/* and **ይ***/y/*. The prefixes of the irregular indicative base-stem forms, however, are **አ***/ä/*, **ነ***/nä/*, **ተ***/tä/* and **የ***/yä/*. And hence, the conversion process is done by returning the order of these prefixes from first order to their equivalent six order forms.

II) Converting 'middle-guttural' irregular verbs into their corresponding regular forms

The change happened due to the occurrence of guttural alphabets at the middle position of a verb depends on the tense-mood and stem of the verb. Unlike to the case of beginning guttural verbs, the difference between middle guttural verbs and their corresponding regular forms lies on all their tense-mood forms except on the imperative one.

Perfective middle-guttural verbs do have irregular morphological structure only in their reflexive stem forms. The irregularity of such verbs can be changed back to their regular forms simply by replacing the first two sixth-order vowel characters (in the transliterated form) with the first-order character. For example: if the middle-guttural verb to be analyzed is **ተ·ምሕለ** */tämHle/*, it will be first transliterated as */temYHYle/* and then the conversion process is done by replacing both the first two */Y/* with */e/* and, which then become its equivalent regular form, */temeHele/*. Be noticed in this example that the prefix */te/* is already detached from the verb in the first step.

Indicative middle-guttural verbs, however, have irregular morphology in all of their stems except in their causative-reciprocal stem form. Table 4.2 is dedicated to show these stems and actions to be taken during their conversion back to their equivalent regular forms.

Table 4.2: Rules applied while converting indicative middle-guttural irregular verbs to regular form

Stem Type	*Rules applied while converting to regular form*
Base	Replace the first vowel */Y/*of the seed of the verb with */e/*
Causative	Replace the first vowel */Y/*of the seed of the verb with */e/*
Reflexive	Appending the string ት */tY/* to the end of each of the prefixes of this stem verbs namely አ */e/*, ት */tY/*, ይ */yY/* and ን */nY/*[56].
Reciprocal	Appending the string ት*/tY/* to the end of each of the prefixes of this stem verbs namely አ */e/*, ት */tY/*, ይ */yY/* and ን */nY/*

On the other hand, subjunctive middle-guttural verbs have different morphological structure from their corresponding regular forms in their three stem types namely base, reflexive and reciprocal stems. The rules applied during the conversion process of such type of irregular verbs are given in the Table 4.3.

Table 4.3: Rules applied while converting subjunctive middle-guttural irregular verbs to regular form

Stem Type	*Rules applied while converting to regular form*
Base	Replace the first vowel */e/* of the seed of the verb with */Y/*
Reflexive	Appending the string ት */tY/* to the end of the prefix of the verb only if its prefix is found to be either of the prefixes አ */e/*, ት */tY/*, ይ */yY/* and ን */nY/*.
Reciprocal	Appending the string ት */tY/* to the end of the prefix of the verb only if its prefix is found to be either of the prefixes አ */e/*, ት */tY/*, ይ */yY/* and ን */nY/*.

Jussive middle-guttural verbs also have irregular morphological structure in their three stem types namely base, reflexive and reciprocal stems. The rules applied during the conversion process of such type of irregular verbs are given in the Table 4.4.

[56]*For example*: the indicative reflexive middle-guttural verb ንሰአል */nYSeel/* is converted into its regular form ን-ት-ሰአል */nY-tY-Seel = nYtYSeel/* by appending the string ት*/tY/* to the end of its original prefix ን*/nY/*.

Table 4.4: Rules applied while converting jussive middle-guttural irregular verbs to regular form

Stem Type	*Rules applied while converting to regular form*
Base	Replace the first vowel */e/* of the seed of the verb with */Y/*
Reflexive	Appending the string **ት** */tY/* to the end of the prefix of the verb only if its prefix is found to be either of the prefixes **አ***/e/*, **ት** */tY/*, **ይ** */yY/* and **ን** */nY/*.
Reciprocal	Appending the string **ት** */tY/* to the end of the prefix of the verb only if its prefix is found to be either of the prefixes **አ** */e/*, **ት** */tY/*, **ይ** */yY/* and **ን** */nY/*.

Similarly, gerundive middle-guttural verbs have different morphological structure in their two stem types namely base and reflexive. The rules applied during the conversion process of such type of irregular verbs are given in the Table 4.5.

Table 4.5: Rules applied while converting gerundive middle-guttural irregular verbs to regular form

Stem Type	*Rules applied while converting to regular form*
Base	Replace the first vowel */Y/* of the seed of the verb with */e/*
Reflexive	Replace the first vowel */Y/* of the seed of the verb with */e/*

Likewise, infinitive middle-guttural verbs have different morphological structure in their three stem types namely base, Causative-reciprocal and reflexive. The rules applied during the conversion process of such type of irregular verbs are given in the Table 4.6.

Table 4.6: Rules applied while converting infinitive middle-guttural irregular verbs to regular form

Stem Type	*Rules applied while converting to regular form*
Base	Replace the first vowel */Y/* of the seed of the verb with */e/*
Causative-reciprocal	Replace the first vowel */Y/* of the seed of the verb with */a/*
Reflexive	Replace the first vowel */Y/* of the seed of the verb with */e/*

For example: let us take the infinitive reflexive middle-guttural verb **አስተስእሎት** */eSYteSYYlotY/*. Now, the conversion process that the analyzer undergoes can be pictured as in the figure 4.2.

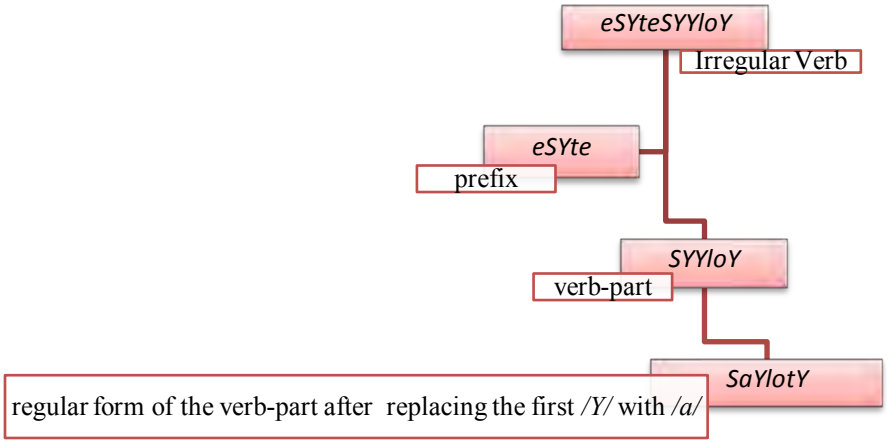


Figure 4.2: procedure of converting the irregular verb አስተስእሎት */eSYteSYYlotY/* **to its equivalent regular form አስተሳእሎት** */eSYteSaYlotY/*

In this way, irregular verbs of all tense-mood types are converted into their equivalent regular forms without changing their tense-mood and stem types thereby can be further analyzed by the analyzer.

4.3.4 Identifying Verb's Vocalic Pattern

The next step is detecting the vocalic pattern of the seed. The seed of a verb has its own CV-template by which is possible to identify the order pattern of the vowels that participate in the seed formation. Hence, vocalic pattern of a seed is the order pattern of the vowels of that seed extracted from its CV-template and is used later during the tense-mood identification process. For instance, the vocalic pattern of the verb **ቀተለ** */qätälä/* is 111, which is respectively the order of the vowels ($ä_s$) in the seed or in the entire verb (see Section 3.2 for more detail about alphabet orders). Taking the vocalic pattern of the first two vowels of a seed is found to be adequate for the required purpose and hence the orders 61, 66, 41, etc., in Table 4.1. This is the point where CV-based approach is effectively used.

4.3.5 Identifying Tense-Mood and Stem of a Verb

Identifying the tense-mood and stem type of a verb is the most crucial task for the analyzer to decide how to analyze the verb. To realize this, the analyzer uses the prefix detached and that of the vocalic pattern identified in the previous steps together to uniquely identify the tense-mood and the stem of the verb. Since the CV-templates of some of the tense-moods of the verbs are similar, distinguishing the tense-mood of verbs through their CV-template was found difficult. For this reason, composite key (prefix together with the vocalic pattern of the verb) is used to identify these two essential features of

verbs. But still, the CV-Template is very important agent to know the tense-mood and stem of a verb for it is the only means of knowing the vocalic pattern of a verb as described above.

4.3.6 Converting Verbs of different Stems to Base-Stem Form

The analyzer does its core analysis process at base-stem level for all tense-mood types. Consequently, if the stem of a verb is found to be different from base-stem, it is made to be converted into base-stem before any kind of analysis process begins. This conversion is done without changing the tense-mood of the stem, i.e., among stems of the same tense-mood type. Accordingly, a verb with a perfective causative stem type is converted into a perfective base stem type, an indicative causative stem type is converted into an indicative base stem type, an indicative reflexive stem type is converted into an indicative base stem type, and so on. Nevertheless, if the stem type of the verb is found to be base-stem, it doesn‟t need any kind of conversion.

As described in the second chapter, the analyzer uses the two-level model approach as a principal approach in mapping (converting) verbs of different stems into their base-stem form. While making such type of mapping process, the analyzer manages various phonological and orthographical changes with the help of the knowledgebase. Following are the discussions on how to convert verbs with a stem different from base-stem back to their equivalent base-stem forms.

I) Converting Verbs of Perfective Stems Category to their base-stem form

Perfective */qätälä/* category verbs which have stems different from base-stem are converted into their corresponding base-stem category forms mainly by removing their prefixes. Causative, causative-reciprocal and reciprocal verbs require further modification on the internal body of their seeds. The rules in Table 4.7 are applied in modifying the seed of these stems.

Table 4.7: Rules applied while converting perfective stems category verbs to their equivalent base-stem

Stem Type	*Rules applied while converting to base-stem*
Causative	Replace the first vowel */Y/* of the seed of the verb with */e/*
Causative-reciprocal	Replace the first vowel */a/* of the seed of the verb with */e/*
Reciprocal	Replace both the first vowel */a/* of the seed of the verb with */e/*

For example: the perfective causative-stem verb **አፍቀድከ** */efYqeYke/* is converted into its base-stem form by removing the prefix **አ** */e/* and replacing the first vowel */Y/* of the remaining verb-part /*fYqedYke*/ with */e/* to produce the base form **ፈቀድከ** /*feqedYke*/.

II) Converting Verbs of Indicative Stems Category to their base stem form

Any indicative */qätälä/* category verb with a stem type different from base-stem is converted into its corresponding base-stem form simply by replacing its prefix with its equivalent base-stem prefix. For example, the indicative verb **ታፈቅዲ** */tafäqdi/* has a causative-stem type and can be converted into its base-stem by replacing the prefix **ታ** */ta/* with its corresponding base-stem prefix **ት** */t/* and, finally, produce the base verb **ትፈቅዲ** */tfäqdi/*.

In the case of causative-reciprocal, reflexive and reciprocal stem types, however, further modifications are required internally in the body of their seed. Accordingly, the rules given in Table 4.8 are applied during the conversion process of these stem types.

Table 4.8: Rules applied while converting indicative stems category verbs to their equivalent base-stem

Stem Type	*Rules applied while converting to base-stem*
Causative-reciprocal	Replace the first vowel */a/* of the seed of the verb with */e/*
Reflexive	Replace the first vowel */e/* of the seed of the verb with */Y/*
Reciprocal	Replace the first vowel */a/* and the second vowel /e/ of the seed of the verb with */e/* and */Y/* respectively

III) Converting Verbs of Subjunctive Stems Category to Their Base-Stem Form

Any subjunctive */qätälä/* category verb with a stem type different from base-stem is converted into its corresponding base-stem simply by replacing its prefix with its equivalent base-stem prefix. For example, the subjunctive verb **ያፍቅድ** */yafqd/* has a causative-stem type and can be converted into its base-stem form by replacing the prefix **ያ***/ya/* with its corresponding base-stem prefix **ይ***/y/* and, finally, produce the base verb **ይፍቅድ** */yfqd/*.

In the case of causative-reciprocal, reflexive and reciprocal stem types, besides to the prefix change, extra changes are done internally in the body of their seed. For this reason, the rules given in Table 4.9 are applied during the conversion process.

Table 4.9: Rules applied while converting subjunctive stems category verbs to their equivalent base-stem

Stem Type	*Rules applied while converting to base-stem*
Causative-reciprocal	Replace the first vowel */a/* of the seed of the verb with */Y/*
Reflexive	Replace the first and the second vowels (both */e/*) of the seed of the verb with */Y/*
Reciprocal	Replace both the first vowel */a/* and the second vowel /e/ of the seed of the verb with */Y/*

IV) Converting Verbs of Imperative Stems Category to Their Base-Stem Form

Removing the stem prefix of any imperative */qätälä/* category verb converts it into its corresponding base-stem form. For example, the imperative verb **አፍቅዱ** */äfqdu/* has a causative-stem type and can be converted into its base-stem form by removing the prefix **አ** */ä/* to produce the base-stem verb **ፍቅዱ** */fqdu/*. An exception to this general rule is the need of seed modification in the case of the three stem types specifically causative-reciprocal, reflexive and reciprocal. This exception is tackled by applying the rules given in Table 4.10 while converting these stems.

Table 4.10: Rules applied while converting imperative stems category verbs to their equivalent base-stem

Stem Type	*Rules applied while converting to base-stem*
Causative-reciprocal	Replace the first vowel */a/* of the seed of the verb with */Y/*
Reflexive	Replace the first and the second vowels (both */e/*) of the seed of the verb with */Y/*
Reciprocal	Replace both the first vowel */a/* and the second vowel /e/ of the seed of the verb with */Y/*

V) Converting Verbs of Jussive Stems Category to Their Base Stem Form

Any jussive */qätälä/* category verb with a stem type different from base-stem is converted into its corresponding base-stem simply by replacing its prefix with its equivalent base-stem prefix. For example, the jussive verb **ናፍቅድ** */nafqd/* has a causative-stem type and can be converted into its base-stem form by replacing the prefix **ና** */na/* with its corresponding base-stem prefix **ን** */n/* and, finally, produce the base verb **ንፍቅድ** */nfqd/*.

In the case of causative-reciprocal, reflexive and reciprocal stem types, besides to the prefix change, they demand extra modifications internally in the body of their seed. To do such a modification, the rules given in Table 4.11 are applied on verbs of these stem types.

Table 4.11: Rules applied while converting jussive stems category verbs to their equivalent base-stem

Stem Type	*Rules applied while converting to base-stem*
Causative-reciprocal	Replace the first vowel */a/* of the seed of the verb with */Y/*
Reflexive	Replace the first and the second vowels (both */e/*) of the seed of the verb with */Y/*
Reciprocal	Replace both the first vowel */a/* and the second vowel /e/ of the seed of the verb with */Y/*

VI) Converting Verbs of Gerundive Stems Category to their base stem form

Gerundive */qätälä/* category verbs with a stem different from base-stem are converted into their corresponding base-stem by removing their prefix. In the case of causative, causative-reciprocal and reciprocal stems, however, further modification of the body of the seeds is done by applying certain rules while the conversion process. The rules applied for this purpose are depicted Table 4.12.

Table 4.12: Rules applied while converting gerundive stems category verbs to their equivalent base-stem

Stem Type	*Rules applied while converting to base-stem*
Causative	Replace the first vowel */Y/* of the seed of the verb with */e/*
Causative-reciprocal	Replace the first vowel */a/* of the seed of the verb with */e/*
Reciprocal	Replace both the first vowel */a/* of the seed of the verb with */e/*

For example, the gerundive causative-reciprocal verb **አስተፋቂዶ** */eStefaqido/* is converted into its base-stem form by removing its prefix **አስተ** */eSte/* and then modifying the seed **ፋቂዶ** */faqido/* by replacing its first vowel */a/* with */e/* to produce the base-stem form **ፈቂዶ** */feqido/*.

VII) Converting Verbs of Infinitive Stems Category to their Base-Stem Form

Alike to gerundive verbs, infinitive */qätälä/* category verbs which have a stem different from base-stem are converted back to their base-stem form by removing their prefixes. Further modifications are also done on some of their seeds. Basically, infinitive verbs are of two types: those which end with **ት** */t/* and

those which are not. Those which end with the suffix ት /t/ are made to remove this suffix during the conversion process. And then, the rules are applied for the internal modifications in both cases.

Table 4.13: Rules applied while converting infinitive stems category verbs to their equivalent base-stem

Stem Type	*Rules applied while converting to base-stem*
Causative	Replace the first two vowels (both */Y/)* and the third vowel */o/* of the seed of the verb with */e/*, */i/* and */Y/* respectively
Causative-reciprocal	Replace the vowels */a/*, */Y/* and */o/* respectively with */e/*, */i/* and */Y/*
Reflexive	Replace the second vowel */Y/* and the third vowel */o/* with */i/* and */Y/*
Reciprocal	Replace the vowels */a/*, */Y/* and */o/* respectively with */e/*, */i/* and */Y/*

The Table 4.14 is dedicated to clear up how the two-level morphology approach is used while mapping other stem types to their base-stem forms by taking the infinitive verb **አፍቅዶት** */efYqYdotY/* which has a causative stem type.

Table 4.14: The operations performed while applying TLM in converting other stem verbs to base-stem

Infinitive causative verb	**አፍቅዶት**								
Transliterated form[57]	e	f	Y	q	Y	d	O	t	Y
	↓		↓		↓				
Base-stem form	-	f	e	q	i	d	O	t	Y

The arrows (↓) in the Table 4.14 depicts the two-level mappings carried out during the stem conversion process. Accordingly, the first arrow shows that the prefix of the causative-stem verb is removed whereas the next subsequent arrows indicate the replacement operation during the mapping process.

4.3.7 Detaching the SMS and OMS of Perfective and Imperative Verbs

After converting the stem of the verb back to its base stem, the analyzer begins its principal analyzing process. Yet should be the analysis carried out to identify the SMS and OMS at the base-stem level of each of the tense-mood types. As discussed in section 3.6, verbs of */qätälä/* category particularly

[57] This transliteration is used only during implementation

perfective, imperative, gerundive and infinitive verbs have SMS markers. But, since gerundive and infinitive do not have OMS, we developed a separated algorithm that can detach onlythe SMS of these two tense-mood types.

As described in section 3.5 of the third chapter, OMS of a perfective or imperative verb is attached immediately after its SMS. Further, OMS and SMS of the same morphology cannot be affixed at the same time to a given verb. Nevertheless, there are times where the SMS of these verbs have the same morphology with some of the OMS suffixes of the same verbs. For example, the OMS **ክ** */kä/* of the perfective verb **ፈቀድናክ** */fäqädYnakä/* and the SMS **ክ***/kä/* of another perfective verb **ፈቀድክ** */fäqädYkä/* are the same.

As a result, the algorithm developed to analyze these type verbs tries to tackle such a problem by first checking if the verb has SMS before detaching a feature from the verb as OMS feature. If the verb is found to have an SMS which is different from the formerly detached feature (expected OMS), then the former feature detached from the verb is regarded as OMS and the later as an SMS. Otherwise, the former feature could only be an SMS feature.

The fact that the maximum possible length of SMS and OMS is four is another important point used during the development of the algorithm. The complete pseudocode of the algorithm developed to detach an SMS and OMS of a verb is given in Appendix III-A.

For the purpose of identifying the SMS and OMS of the verb, the analyzer uses the knowledgebase as a demon. The facts and rules incorporated to the knowledgebase include the subject marker along with the subject and the subjPNG[58] indicated by the marker. Sample SMS features incorporated to the knowledgebase are given in Appendix-VB. Similar representation facts and rules are used while incorporated features related to the OMS of the verbs (see Appendix-V C).

4.3.8 Detaching the SMS of Gerundive and Infinitive verbs

If the tense-mood of a verb is found to be gerundive and infinitive, all the analyzer does is detaching their SMS only. Hence, a separate algorithm is developed for this purpose. As it is discussed above, the maximum possible length of an SMS of a verb is four. For this reason, the algorithm begins detaching this length feature from a verb and then checking the existence of such a feature in the knowledgebase.

[58] subjPNG stands for subject"s person, number and gender

If the feature is found as valid SMS feature, it is made to be detached and stored as valued feature in the output.

4.3.9 Detaching the Circumfix and OMS of Indicative, Subjunctive and Jussive Verbs

Circumfix, as it is described in the second chapter, has two parts, one before the seed and the other after the seed. As discussed in section 3.5.3, verbs with any of the indicative, subjunctive or jussive tense-moods have circumfixes attached to their seed. Such verbs may also have OMS suffix attached to the verb immediately after the circumfix. Accordingly, if a verb is identified to have either of these tense-moods, then the analyzer detaches both the circumfix and the OMS suffix of the verb with the help of the rules incorporated in the knowledgebase. Sample of the circumfix and OMS features of such verbs incorporated to the knowledgebase is shown in Appendix-V D.

While detaching the circumfix and the OMS of such verbs, the analyzer passes through four defined steps. Firstly, it detaches the prefix of the verb. Since the analysis process is done at a base-stem level of the verb, the maximum length of the prefix is two. For this reason, the analyzer begins identifying the prefix of a given verb by detaching the first two characters and checks their existence in the knowledgebase. If not found, it continue detaching a feature of length one less than the former until it finds a valid prefix feature. Secondly, it detaches the OMS of the verb. The maximum possible length of an OMS of any verb is four. So, the analyzer begins by detaching the last four characters and checks their existence in the knowledgebase. Otherwise, it continue detaching a feature by decreasing its length by one until it finds a valid feature while compared to what is incorporated to the knowledgebase. Thirdly, itdetaches the suffix part of the circumfix feature of the verb. The suffix part of the circumfix is found being attached directly to the seed before the OMS (if any). This feature is identified by detaching from among the last four characters of the verb found before the OMS (if any) of the verb. The combination of the prefix obtained in the first step and the suffix detached here in the third step yields the circumfix of the verb. Fourthly, it identifies the SMS, subject and subjPNG of the verb based on the features found in the above three steps. The complete pseudocode of the algorithm developed to detach circumfix and OMS of verbs of the above mentioned tense-mood types is given in Appendix-III C.

4.3.10 Identifying the Lexeme of a Verb

As described so far, the main task of the analyzer is to analyze surface form verbs back to their lexeme forms and other morphosyntactic features. Lexeme form of a verb for Semitic languages is the dictionary (lexicon) form of the verb usually in 3psm form. Since the main focus of this study is on verbs of */qätälä/* category, the general CV-template of the lexeme of this category verb is 111, where the vowels of the verb are all first order vowels. For example: lexeme of the indicative verb **ይገዝምዎ** */ygäzmwo/* (they will cut it off) is **ገዘመ** */gäzämä/* (he cut something off), where all of the vowels are first order vowels, hence 111. As a result, some replacements and removals of characters should be done by the analyzer to return the seed of the verb to this generic template of the entire */qätälä/* paradigm. The complete pseudo code of the algorithm developed to identify the lexeme of a verb is given in Appendix III B.

4.3.11 Generating Analysis Result

Finally, an output of the analysis process which is comprised of the lexeme and all other valued morphosyntactic features identified all over the whole analysis process (from step one to ten) discussed above is generated.

4.4 Summary

In this chapter, the chief contribution of this study, the architecture of the model of Ge"ez verbs analyzer particularly for */qätälä/* category verbs along with the implementation issues is discussed. The design and implementation issues discussed in this chapter are based on language-oriented analyses described in the third chapter. Furthermore, the approaches proposed in the second chapter are also effectively used during the designing and implementation issues of this chapter. The next chapter discusses the performance testing procedures and the results of the experiment based on the design and implementation analyses presented in this chapter. The chapter also discusses the causes of errors encountered during the experiment.

CHAPTER FIVE
EXPERIMENTAL ANALYSIS

5.1 Introduction

In the previous chapter, an attempt was made to discuss the design of the model of the Ge"ez verbs analyzer. In this chapter, we describe the prototype implementation of the algorithms designed, the data set (verb-set), the experimental procedures and the results achieved after testing the model of the analyzer proposed in chapter four with a thoughtfully prearranged verb-set. Also discussed are the causes of errors encountered during the experiment.

5.2 The Prototype

The algorithms presented in chapter four are coded using Java NetBeans IDE 6.7.1. Figure 5.1 shows the main screen of the developed system.

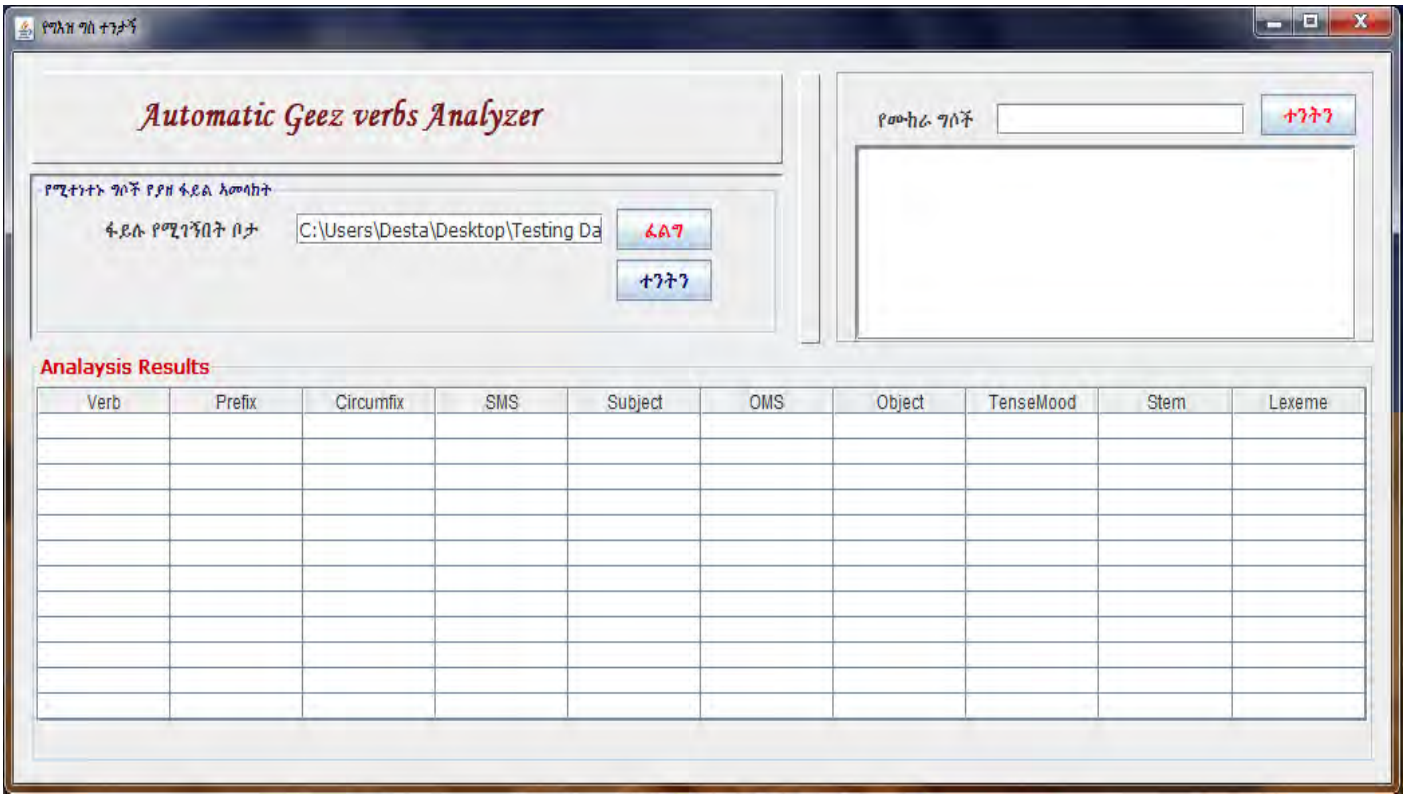
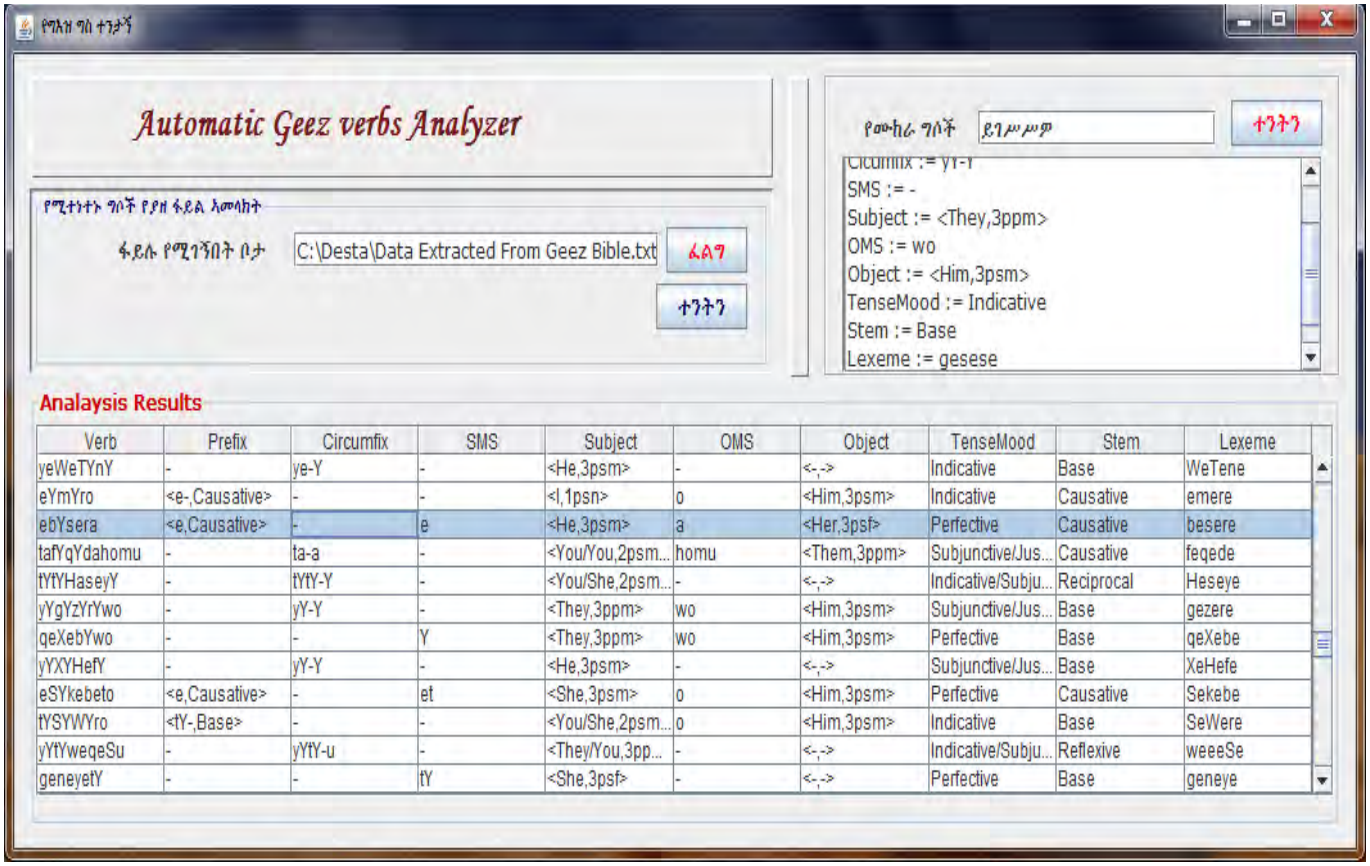


Figure 5.1: Main screen of the prototype of the analyzer

The developed prototype begins analyzing the verbs by taking the path of the file where the collected verb-set are stored. The button (**ፈልግ**), an equivalent to the English word **'Browse'**, is used to browse the path of the file where the verb-set is found. Next, when the button '**ተንትን**' (to mean analyze) is pressed, every verb in the file indicated through the path given in the text field are taken one by one and the algorithms discussed in the fourth chapter are all applied based on the context of the verb and finally the lexeme and other morphosyntactic features of the verb are all listed in the table. In need of analyzing a single verb, it is possible by entering in the **የመከራ ግሶች** text field and then pressing the button '**ተንትን**' found next to this text field will list all the features of the verb on the text area given under it. Figure 5.2 is dedicated to show the output of the prototype obtained after pressing the '**ተንትን**' button.



Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
yeWeTYnY	-	ye-Y	-	<He,3psm>	-	<-,->	Indicative	Base	WeTene
eYmYro	<e-,Causative>	-	-	<I,1psn>	o	<Him,3psm>	Indicative	Causative	emere
ebYsera	<e,Causative>	-	e	<He,3psm>	a	<Her,3psf>	Perfective	Causative	besere
tafYqYdahomu	-	ta-a	-	<You/You,2psm...	homu	<Them,3ppm>	Subjunctive/Jus...	Causative	feqede
tYtYHaseyY	-	tYtY-Y	-	<You/She,2psm...	-	<-,->	Indicative/Subju...	Reciprocal	Heseye
yYgYzYrYwo	-	yY-Y	-	<They,3ppm>	wo	<Him,3psm>	Subjunctive/Jus...	Base	gezere
qeXebYwo	-	-	Y	<They,3ppm>	wo	<Him,3psm>	Perfective	Base	qeXebe
yYXYHefY	-	yY-Y	-	<He,3psm>	-	<-,->	Subjunctive/Jus...	Base	XeHefe
eSYkebeto	<e,Causative>	-	et	<She,3psm>	o	<Him,3psm>	Perfective	Causative	Sekebe
tYSYWYro	<tY-,Base>	-	-	<You/She,2psm...	o	<Him,3psm>	Indicative	Base	SeWere
yYtYweqeSu	-	yYtY-u	-	<They/You,3pp...	-	<-,->	Indicative/Subju...	Reflexive	weeeSe
geneyetY	-	-	tY	<She,3psf>	-	<-,->	Perfective	Base	geneye

Figure 5.2: Output of the prototype of the Ge'ez Verbs Analyzer system

As can be seen from figure 5.2, the possible features of the verb expected to be returned as the end of the analysis process are labeled as column names. The columns labeled as „prefix", „subject" and „object" each contains two features of the verb namely the prefix along with its syntactical function, the subject

together with its subPNG and the object along with its objPNG[59]. If the expected feature is not found in the verb, then the value of the feature is indicated by (-) in the table.

5.3 Performance Evaluation Procedures

The following procedures were employed to evaluate the performance of the analyzer.

i. Data collection

Three independent Geʿez language experts were employed to extract the verbs found in all twenty seven New Testament books of the Ethiopic (Geʿez) Version Bible to be used for testing of the model of the analyzer. Extracting verbs, classifying them into their appropriate heads and identifying the tense-mood of each of the extracted verbs were some of the duties of these experts while preparing this verb-set. The total number of verbs collected from this version Bible, neglecting repetitions, were 1177 of whom 551 (46.81%) were found to be troops of */qätälä/* category (see Table 5.1).

Table 5.1: Total Number of verbs extracted from the New Testament of the Ethiopic Version Bible and their classification into their respective heads (representatives) according to the domain experts

No.	Verb Heads	Number of verbs extracted	Total (%)
1	ቀተለ	551	46.81
2	ቀደሰ	164	13.93
3	ገብረ	212	18.01
4	ተንበለ	126	10.70
5	ባረከ	24	2.04
6	ዴገነ	30	2.55
7	ክህለ	28	2.39
8	ኖለወ	42	3.57
	Total	***1177***	***100***

Further, 136 of these */qätälä/* category verbs were verbs with derivational morphology[60] by which are left out of the scope of the study. And hence, only 415 verbs of the total */qätälä/* category verbs were used for testing of the developed prototype of the analyzer.

[59] objPNG refers to the person, number and gender of the object

The reason why the testing verb-set was collected from the Ethiopic Version Bible and not from the other sources is because this Bible is the most authentic scripture in the EOTC, the only source of this study, and is written with the genuine[61] nature of the language. Besides, it containes all types of the verbs. Hence, extracting the testing verb-set from such resource is believed to make a better confidence on the reality of the performance of the proposed model of the analyzer.

ii. Preparing Verbs Analysis Manually

The verb-set collected in the aforesaid way was analyzed manually yet by other domain experts and was encoded based on the transliteration principle followed during the implementation of the prototype of the analyzer (See Appendix VI).

iii. Designing database for the manually analyzed verb-set

For the manually analyzed verb-set to be easily consumed during the evaluation, it was made to be stored in an MS-SQL server database.

iv. Evaluating the Analysis Output of the System by Domain Experts

Those experts who prepared the manual analysis of the verb-set have also evaluated the analysis output generated by the analyzer. With the aim of improving the accuracy of the analyzer, causes of errors were identified and finally were corrected. This process of correcting errors was done until the result obtained was found to be satisfactory.

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[60] As it is already described in the second chapter, derivational morphology refers to a type of morphology of words which have changed their POS as the result of their concatenation with grammatical morphemes. Hence, the mentioned numbers of */qätälä/* category verbs which are of this type of morphology are left out of the scope of this study because they have changed their verb nature to other POS category particularly to verbal nouns and verbal adjectives.

[61] By ‚**genuine nature'** we mean the real grammar with an appropriate usage of the alphabets of the language especially the usage of alphabets ሀ፣ ሃ፣ ሐ፣ ሓ፣ ኀ፣ ኃ፣ አ፣ ኣ፣ ዐ፣ ዓ፣ ፀ፣ ጸ፣ ፃ፣ ጻ፣ ሰ፣ ሠ፣ ሳ and ሣ. The tendency of pronouncing the first six alphabets as „ሃ", the next four as „ኣ", the next two as „ጸ", etc. in Amharic language has influenced some recently written Ge"ez literatures. Actually, these alphabets represent distinct sounds from the very beginning till now. A lot of scrtiptures have been written with the appropriate sound respresentation of these alphabets. Trying to merge or use them in a different way will result at loosing the whole content of the ancient and medival time literatures which are written with the right sound representation of the alphabets. Doing so in the language can in no way be considered as a developmental asset of the language rather demolishing and loosing what it had! And hence, the preference of the Bible for preparing the testing verb-set is to avoid such confusion.

v. Comparing the actual analysis output with the desired analysis results

At last, evaluation of the performance of the analyzer is performed in two levels: *at features of verbs level* and *at verbs level*.

v.a) at features of verbs level:

One way of measuring the performance of the analyzer is by comparing the features of each of the verbs generated as an output by the analyzer (actual output) with their corresponding features of each of the verbs (desired output) stored in the database. Thus, the accuracy of the system is calculated as the number of correctly analyzed features of verbs divided by the total number of features of verbs generated by the system multiplied by 100.

Mathematically,

$$Accuracy = \frac{Total\ Number\ of\ Correctely\ Analyzed\ Featurs\ of\ verbs}{Total\ number\ of\ Analyzed\ Featurs\ of\ verbs} * 100\%$$

v.b) at verb level

The second way of measuring the performance of the analyzer is based on the number of qurectly analyzed verbs and, hence, is calculated as the number of correctly analyzed verbs divided by the total number of testing verbs multiplied by 100.

Mathematically,

$$Accuracy = \frac{Total\ Number\ of\ Correctely\ Analyzed\ verbs}{Total\ number\ of\ Testing\ verbs} * 100\%$$

5.4 Results of the Experiment

In this section, the result of the experiment conducted to evaluate the performance of the analyzer based on the two level of evaluation discussed above is presented.

a) Result of the experiment conducted at features of the verbs level

Table 5.2 presents the results of the experiment conducted by inputting the verb-set by applying the above procedures at the features of the verbs level.

Table 5.2: the result of the experiment conducted at features of the verbs level

No.	*Verb features*	*Correctly analyzed features*	*Incorrectly analyzed features*	*Performance (%)*	*Total*
1	Prefixes with its syntactic function	369	46	88.92	415
2	Circumfixes	398	17	95.90	415
3	SMS	345	70	83.13	415
4	Subject	366	49	88.19	415
5	OMS	386	29	93.01	415
6	Object	402	13	96.87	415
7	Tense-Mood	411	4	99.04	415
8	Stem	410	5	98.80	415
9	Lexeme	351	64	84.58	415
	Total	***3438***	***297***	***828.44***	***3735***
	In percent	***92.048%***	***7.952%***	***92.048%***	***100%***

As can be seen from Table 5.2, the system has completed analyzing the features of the inputed verbs with an accuracy of 92.05%. About 8% of the features are wrongly analyzed due to different reasons which will be discussed in section 5.5.

b) Result of the experiment conducted at verb level

As it is described above, the total number of verbs used to test the system is 415. Of these, 307 (73.98%) verbs are correctly analyzed; i.e., every feature of the verbs is analyzed perfectly. The remainng 108 (26.02%) verbs, however, are analyzed with some errors in some of their features.

5.5 Discussion of the Results

As indicated in Table 5.2 above, the evaluation of the performance of the developed model of the analyzer is carried out by comparing each of the features of the verbs produced by the analyzer with each of their correspondent features in the manually analyzed testing verb-set stored in the database. Accordingly, a given feature, during the comparison, is either going to be the same as its correspondent features of other side verb-set or else different from the desired one. Consequently, two parameters are used to count „number of matches" and „number of mismatches" for each of the nine expected features from a given verb. Hence, for each of the features, these two variables articulate how many were correctly analyzed and how many were not. This issue is boldly answered in the Table 5.2. As is pointed

out in this Table, larger amount of errors are occurred while analyzing the SMS of the verbs, next greater occurrence of errors are seen while identifying the lexeme and yet next greater were encountered during identifying the subject and so on.

The error analysis presented in this section is based on the assumed approach namely the rule-based approach discussed in section 2.3.2. The analysis carried out by the analyzer is based on linguistically motivated rules laid down by the researcher, i.e., the errors are created truly as the result of the nature of the rules formulated for the analyzer. Following is the discussion on the causes of the errors shown in Table 5.2 as in the case of each of the expected features.

5.5.1 Causes of errors while analyzing the prefixes of the verbs

In section 3.5.1, we discussed about the type and list of possible prefixes of Ge"ez */qätälä/* category verbs. For example, we have seen that the prefixes **አ** */ä/*, **ነ** */nä/*, **ተ** */tä/*, and **የ** */yä/* (in both their first order and six order forms) are person-marker prefixes particularly for indicative, subjunctive and jussive verbs and the cusative-stem-marker prefix **አ** */ä/*[62] for perfective, gerundive and infinitive causative-stem verbs. We formulated a general rule which helps the analyzer to detach these prefixes if any in a given verb of such categories. Nevertheless, this rule has encountered confusing cases while analyzing some verbs of these types. These cases are common in verbs which begin with **አ** */ä/*, **ነ** */nä/*, **ተ** */tä/*, and **የ** */yä/* (in both of their possible occurrences) but do not have any prefix. For example: the subjunctive verb **ንስግድ** */nsgd/* (we shall bow down!) has a person-marker prefix **ን** */n/* and the same category verb **ንበር** */nbär/* (You-2psm- must sit down!) seems to have the same prefix as the former but is not in the reality. For the later verb, **ን** */n/* is not a prefix rather one radical of the root of the verb- but leads to a confusion with the former verb case.

Similarly, the person-marker prefix, **ተ** */tä/*, of indicative verbs (though occurred only in irregular verbs) is confusing with the reflexive-stem-marker prefix **ተ** */tä/* of perfective, gerundive and infinitive verbs. For example: the indicative verb **ተሐሠይ** */täHäsäy/* has a person-marker prefix **ተ** */tä/* and the perfective reflexive-stem verb **ተሐሠየ** */täHäsäyä/* has the prefix **ተ** */tä/* which has in no way a morphological

[62] The causative-stem-prefix is, nowadays, written as **አ** */ä/* after the mis-pronounsation of **አ** */ä/* as **ኣ** */a/* in Amharic language and its influence in contemporary the Ge"ez scriptures and literaturs.

difference except that they are of different syntactical function which causes an error during the analysis in both the prefix feature and stem feature of the verb.

5.5.2 Causes of errors while analyzing the circumfixes of the verbs

If a verb is going to have a circumfix, then it should have a prefix part of the circumfix attached to its front. And if there are cases where the analyzer confuses with some of the prefixes, intuitively, same errors will also be happened while analyzing the circumfix of verbs with the similar cases. For this reason, the errors occurred while analyzing these feature are implication of errors encountered while analyzing either the prefix or the suffix or both part(s) of the circumfix (causes of errors of suffix of such verbs is given below).

5.5.3 Causes of errors while analyzing the SMS of the verbs

SMS, as described earlier, is a bound morpheme suffixed particularly to perfective, gerundive and infinitive verbs to indicate who the subject of the verb is. While identifying SMS of such verbs, the analyzer has generated error analyses basically for certain verbs of two qualities:

i) Verbs which ends with glottal alphabets

ii) Verbs which ends with semivowel alphabets

Following is the discussion on both the above mentioned cases.

i) Verbs which ends with glottal alphabets

Whenever an SMS markers specifically **ከ** */kä/*, **ኩ** */ku/*, **ኪ** */ki/*, **ክን** */qn/* or **ክሙ** */qmu/* are appended to the end of a verb which ends with either of the glottal alphabets namely **ቀ** */qä/*, **ከ** */kä/*, or **ገ** */gä/*, assimilation effects are observed on the boundary of the morphemes. Furthermore, when the SMS **ነ** */nä/* is added to the end of a verb which ends with **ን** /n/, similar effect is detected at the boundary of the morphemes. In sum, the possible assimilation effects observed during the experiment are presented as in Table 5.3.

Table 5.3: Assimilation effects observed when SMS morphemes are attached to a verb which ends with ቀ /qä/, ከ /kä/ or ገ /gä/

Underlying Form		Surface Form	*Example*		
ቅ */q/* † ከ */kä/*	=	ቀ */qä/*	አጥመቅ † ከ	=	አጥመቀ
ቅ */q/* † ኩ */ku/*	=	ቁ */qu/*	አጥመቅ † ኩ	=	አጥመቁ
ቅ */q/* † ኪ */ki/*	=	ቂ */qi/*	አጥመቅ † ኪ	=	አጥመቂ
ቅ */q/* † ክን */kn/*	=	ቅን */qn/*	አጥመቅ † ክን	=	አጥመቅን
ቅ */q/* † ክሙ */kmu/*	=	ቅሙ */qmu/*	አጥመቅ † ክሙ	=	አጥመቅሙ
ክ */k/* † ከ */kä/*	=	ከ */qe/*	ሰበክ † ከ	=	ሰበከ
ክ */k/* † ኩ */ku/*	=	ኩ */qu/*	ሰበክ † ኩ	=	ሰበኩ
ክ */k/* † ኪ */ki/*	=	ኪ */qi/*	ሰበክ † ኪ	=	ሰበኪ
ክ */k/* † ክን */kn/*	=	ክን */qn/*	ሰበክ † ክን	=	ሰበክን
ክ */k/* † ክሙ */kmu/*	=	ክሙ */qmu/*	ሰበክ † ክሙ	=	ሰበክሙ
ግ */g/* † ከ */kä/*	=	ገ */gä/*	ሐደግ † ከ	=	ሐደገ
ግ */g/* † ኩ */ku/*	=	ጉ */gu/*	ሐደግ † ኩ	=	ሐደጉ
ግ */g/* † ኪ */ki/*	=	ጊ */gi/*	ሐደግ † ኪ	=	ሐደጊ
ግ */g/* † ክን */kn/*	=	ግ */gn/*	ሐደግ† ክን	=	ሐደግን
ግ */g/* † ክሙ*/kmu/*	=	ግሙ */gmu/*	ሐደግ† ክሙ	=	ሐደግሙ
ን */n/* † ነ */nä/*	=	ነ */nä/*	አመን † ነ	=	አመነ

Due to the assimilation effects happened at the boundaries of the morphemes, the morphology of such surface verbs has altered from the regular form after which is the analyzer produced error analyses for these types of verbs.

ii) Verbs which ends with semivowel (ወ /wä/ and የ /yä/) alphabets

The presence of either of the semivowels **ወ** */wä/* or **የ** */yä/* at the end of a verb brought a change in the inflected forms of the verb in its indicative, subjunctive, imperative and jussive stem categories. Table 5.4 depicts the possible changes observed in each of the aforementioned stems by putting the underlying and surface forms of the verb **ፈተወ** */fätäwä/* (he wanted), which is one of the troops of */qätälä/* with the semivowel **ወ** */wä/* at its end, as an example.

Table 5.4: Assimilation of a verb with ወ /wä/ at its end

Base Stem		Causative Stem		Causative-Reciprocal		Reflexive		Reciprocal	
Underlying form	Surface form	Underlying form	Surface form	Underlying form	Surface form	Underlying form	Surface form	Underlying form	Surface form
ይፈትው /yfetw/	ይፈቱ /yfetu/	ያፈትው /yafetw/	ያፈቱ /yafetu/	ያስተፋትው /yastefatw/	ያስተፋቱ /yastefatu/	ይትፈተው /ytfetew/	ይትፈቶ /ytfeto/	ይትፋተው /ytfatew/	ይትፋቶ /ytfato/
ይፍትው /yftw/	ይፍቱ /yftu/	ያፈትው /yafetw/	ያፈቱ /yafetu/	ያስተፋትው /yastefatw/	ያስተፋቱ /yastefatu/	ይትፈተው /ytfetew/	ይትፈቶ /ytfeto/	ይትፋተው /ytfatew/	ይትፋቶ /ytfato/
ይፍትው /yftw/	ይፍቱ /yftu/	ያፈትው /yafetw/	ያፈቱ /yafetu/	ያስተፋትው /yastefatw/	ያስተፋቱ /yastefatu/	ይትፈተው /ytfetew/	ይትፈቶ /ytfeto/	ይትፋተው /ytfatew/	ይትፋቶ /ytfato/

As pointed out in Table 5.4, the presence of */wä/* at the end of the verbal stems caused a change on the vowel of its preceding radical and finally disappeared itself from the verb. If the radical preceding */wä/* has a six order vowel, then the presence of */wä/* converts this vowel into second order. If the vowel of the preceding radical is first order, then the occurrence of */wä/* converts it into seventh order.

Similar changes are observed in verbs which end with the semivowel የ */yä/*. Table 5.5 depicts the possible changes occurred in each of the aforementioned stems by putting the underlying and surface forms of the verb ቀነየ */qänäyä/* (he bought), which is one of the troops of */qätälä/* with the semivowel የ */yä/* at its end.

Table 5.5: Assimilation of a verb with የ */yä/* at its end

Base Stem		***Causative Stem***		***Causative-Reciprocal***	
Underlying Form	***Surface Form***	***Underlying Form***	***Surface Form***	***Underlying Form***	***Surface Form***
ይቀንይ /yqäny/	ይቀኒ /yqäni/	ያቀንይ /yaqäny/	ያቀኒ /yaqäni/	ያስተቃንይ /yastäqany/	ያስተቃኒ /yastäqani/
ይቅንይ /yqny/	ይቅኒ /yqni/	ያቀንይ /yaqäny/	ያቀኒ /yaqäni/	ያስተቃንይ /yastäqany/	ያስተቃኒ /yastäqani/
ይቅንይ /yqny/	ይቅኒ /yqni/	ያቀንይ /yaqäny/	ያቀኒ /yaqäni/	ያስተቃንይ /yastäqany/	ያስተቃኒ /yastäqani/

As pointed out in the Table 5.5, the presence of የ */yä/* at the end of a verb brought a change in its indicative, subjunctive, imperative and jussive stem categories. In all of these forms, the semi-vowel /*yä*/ disappeared from the verb after changing the vowel of its preceding consonant into third order. The vowel of the middle consonant of both the gerundive and the infinitive verb forms are also changed from third order into six order vowel.

For this reason, the presence of the semivowels alphabets brought an irregularity effect on the verbs. And leaving this irregular morphology uncaught leads the analyzer to mistakenly analyze the SMS features of such verbs.

5.5.4 Causes of errors while analyzing the Subject of the verbs

The errors occurred while identifying the subject of the verb are direct implications of the errors issued while analyzing the SMS of the verb. This is because it is merely by its SMS that the subject of a verb could be recognized.

5.5.5 Causes of errors while analyzing the OMS of the verbs

There are verbs which do not have OMS markers but seem to end with alphabets matching with either of the possible OMS marker features. As it is discussed in section 4.3.7, a feature is detached from a verb as OMS marker if and only if there is another feature in the verb preceding that feature which could be taken as a subject marker. Accordingly, for the aforesaid verb types, if the analyzer finds the character */Y/*[63] just before the ending alphabet(s) which matches with either of the OMS markers, then it mistakenly consider */Y/* as a subject marker and the OMS matching feature of the verb as OMS. For example: the verb **ተሐፅነ** */teHexYne/*[64] ends with the feature **ነ***/ne/* which matches with the OMS marker **ነ***/ne/*. Now, the analyzer proceeds to see the feature before **ነ***/ne/* in the verb. Then, in this case, it finds the feature */Y/* which matches with the subject marker */Y/*. Finally, the analyzer ends up with a wrong analysis by considering **ነ***/ne/* as OMS of the verb and */Y/* as its subject marker.

5.5.6 Causes of errors while analyzing the object of the verbs

The errors occurred while identifying the object of the verb are direct implications of the errors issued while analyzing the OMS of the verb. This is because it is merely by its OMS that the object of a verb could be recognized.

5.5.7 Causes of errors while analyzing the tense-mood of the verbs

The occurrence of errors while identifying the tense-mood of a verb is because of the presence of the semivowels either at the beginning or middle or end of a verb which could change the morphology of

[63] The character */Y/* is added to the six order alphabets as a vowel during the implementation. For example: **ፈቂድ** is transliterated during the implementation as */feqidY/*, where */Y/* is the vowel of the six order alphabet in the equivalent Ge"ez form.

[64] The English transliteration of the verb during implementation

the verb in some of its tense-mood types by reducing the number of radicals and changing the order of some of its vowels as it is shown in Table 5.4 and Table 5.5. Since the analyzer uses the prefix and vowel pattern of the verb as a compound key to identify the tense-mood of a verb, errors encountered during detaching the prefix of the verb have also some contributions to the errors detected while analyzing the tense-mood of the verb.

5.5.8 Causes of errors while analyzing the stem of the verbs

The chief causes of errors while recognizing the stem of the verb are the errors occurred while identifying the prefixes of the verb. This is because the analyzer could identify the right stem type of the verb only if it has correctly detached the prefix of the verb.

5.5.9 Causes of errors while analyzing the lexeme of the verbs

The main cause of errors in the course of identifying the lexeme of a verb is actually the commulative implication of the errors encountered while analyzing the SMS and OMS and circumfix of the verb. The main reason behind is the fact that the seed is the nucleus of the verb obtained after the affixes around it are removed. Failing to remove the affixes will directly result at incorrect lexeme identification.

The other possible cause of errors while identifying the lexeme of a verb is the existence of the semivowels in the verb as they shrink the verb‟s body and convert the order of some of the vowels in it. For example, the verb **ወረደ** */wärädä/* (he descended), one of the troops of */qätälä/* which starts with the semivowel **ወ***/wä/*, has **ይረድ** */yräd/* (he must descend) and **ይረድ**[65] */yräd/* (for him to descend) as its subjunctive and jussive base stems respectively. According to the regular structure of */qätälä/* category verbs, however, the verb forms of these stems should be **ይወርድ** */ywrd/* and **ይወርድ** */ywrd/* respectively. In the reality, however, these forms are found being diminished to a smaller form, **ይረድ** */yräd/*. Then, when the analyzer removed the affixes in */yräd/*, the remaining body of the verb to be a lexeme is **ረድ** */räd/*. As the result, the analyzer fails to identify the actual lexeme of the verb **ወረደ** */wärädä/* as it is difficult for it to predict the third missed radical (**ወ**) of the verb.

[65] The subjunctive and jussive inflections of a verb with a subject different from second persons are all the same in morphology. Their difference lies, however, in the usage which is determined based on the context of the sentences they are used in.

CHAPTER SIX
CONCLUSION, RECOMMENDATIONS AND FUTURE WORKS

6.1 Conclusion

The purpose of this study was to design ananalyzer for Geʿez ቀተለ */qätälä/* category verb forms. The Morphological properties of Geʿez in general and that of */qätälä/* category verb forms in particular which are useful for computer representation are identified. Then the various techniques to morphological analysis are reviewed. Accordingly, a rule-based approach, by combining both CV-based approach and TLM are employed for this study. These techniques are selected because they take the properties of the language into account. The rules of templates, roots, suffixes and phonological variations (guttural properties, vowel changes) which helps the analyzer to analyze different features from an input verb are designed.

Algorithms are designed from scratch as there are no previously designed algorithms for this purpose based on the morphological properties of the language to analyze */qätälä/* category surface verbs. Finally, a prototype verb analyzer is developed to evaluate the performance of the designed algorithms. It has been found throughout the research that Geʿez is a morphologically complex language. Most of the words in the language are verbs or derived from verbs. It is indicated that verbs are the most productive classes of words in the language. The root is a basic lexical unit of the language. The root form of a base-stem verb can be tri-literal, quadri-literal, and multi-literal.

Formation of verbs in Geʿez is realized through three stages of formation: seed formation, person-gender-number formation and that of tense-mood formation. The intercalation of vowels with consonants in a given template produces what we call seed. The produced seed grows up to a more natural verb forms by attaching itself to tense-mood and person-gender-number marker morphemes. Each seed has its own unique template. This essentially implies the fact that verbs do have different templates. Their basic difference lies on the type of vowels participated during the formation process. More precisely, the initial, medial and final alphabets of these seeds (in other words, their CV-template) results at one true difference among verbs of Geʿez. It is also shown that verb formation follows regular patterns: infixing, prefixing, suffixing and circumfixing. Thus, it is possible to conclude that even

though Ge‟ez is morphologically complex language its regular patterns make it manageable for algorithmic processing.

In order to evaluate the accuracy of the designed model, verbs found in all twenty seven New Testament books of the Ethiopic Version Bible was extracted by domain experts. Accordingly, */qätälä/* category verbs of these total extracted verbs were given to the prototype of the model. The accuracy of the output generated by the analyzer was compared with the manually prepared analyses of the same verb-set by the language experts at two levels: *at features of verbs level* and *at verb level*. Accordingly, it is observed that the analyzer has analyzed these verbs with an accuracy of 92.05% at feature level and of 73.98% at verb level. At large, this research has realized the design and implementation of automatic morphological analyzer for Ge‟ez verbs.

6.2 Reccomendations

It is believed that the remaining seven verb categories which are left out of the scope of this study do have the same morphological structure particularly on the last two formation stages. The only difference among these verb categories, however, lies on their seed formation, which means only their CV-template brings the difference among them. As the result, the researcher believes that the model can also work for such type of verbs by carrying out simple modifications particularly in the stem conversion algorithms. Especially, the person-number-gender markers and tense-mood formations analyzed in this study can be used without any kind of modificationswhile working with the remaining other categories.

Moreover, the approach and analysis procedures followed in this thesis can also be easily adopted while in need of designing analyzer(s) for each of the other POS category words of Ge‟ez. For example, the inflected surface forms of verbal nouns (nouns derived from verbs) obtained through undergoing declaration have similar morphological structures and, hence, can be analyzed using the algorithms developed in this thesis by incorporating simple modifications(only for some exceptional cases).

Furthermore, researchers who are interested to design and develop the analyzer‟s counterpart component of NLP, the morphological synthesizer, for Ge‟ez language can adopt the facts, rules and feature analysis concepts carried out in this study without or with little modifications.

Generally speaking, this research will serve as a starting point for other researchers by indicating the possibility of developing an automatic morphological analyzer for Geez verbs in general and for */qätälä/* category verbs in particular. Muchinterestingly, it is realized that it is possible to study and analyze Geʿez language and disclose the ancient Ethiopic resources yet locked with it into use with the help of Information Technology.As a result, it is believed that it will encourage Ethiopian students and researchers to take part in similar researches which ultimatelyled to a higher level and more demanding research endeavors such as parsing andmachine translations thereby attaining the goal of developing the full-fledged NLP application for Geʿez.

6.3 Future Works

1. Designing a morphological analyzer for the other verb categories of Geʿez by adopting the rules, facts and procedures analyzed in this study and moving to the final goal of attaining a full-fledged verb morphological analyzer for Geʿez language is an interest in future works.
2. Designing the morphological synthesizer, one of the components of NLP, for Geʿez language using the rules and facts formulated in this study is the other one to be realized in the future.
3. Developing a morphological analyzer for Geʿez and other local languages, using other approaches (e.g. purely statistical or both a hybrid of statistical and rule-based), and compare the results obtained with that of the approach followed in this thesis.
4. Designing and developing an optical character recognizer which can convert scanned Geʿez scripts to editable formats and then applying the full-fledged morphological analyzer on such broad-coverage and natural Geʿez texts.
5. Launching big project to develop an efficient full-fledged automatic morphological analyzer for Geʿez language which works for all POS categories.
6. Designing POS tagger, sentence grammar checker and other components of NLP and finally implementing a full-fledged NLP system for Geʿez language by forming a team of experts from different domain (mainly linguists and computer scientists) for its achievement.

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አፈወርቅ ዘውዴ (አለቃ)፣ 1988፣ ሀገረ መጻሕፍት፣ ሰዋስው ግእዝ ወአማርኛ፣ አዲስ አበባ፣ ትንሣኤ ማሳተሚያ ድርጅት።

ኪዳነ ወልድ ክፍሌ (አለቃ)፣ 1948፣ መጽሐፈ ሰዋስው ወግስ ወመዝገበ ቃላት ሐዲስ፣ አዲስአበባ፣ አርቲስቲክ ማተምያ ቤት።

ዘርአዳዊት አድሐና (መምህር)፣ 1996፣ መርኖ ሰዋስው ዘልሣነ ግእዝ፣ አዲስአበባ፣ ብርሃንና ሰላም ማተምያ ድርጅት።

Appendix I

The Ge'ez Alphabet */fidäl/* Set [Zäradawit, 1996]

No.	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	7th Order
1.	ሀ	ሁ	ሂ	ሃ	ሄ	ህ	ሆ
2.	ለ	ሉ	ሊ	ላ	ሌ	ል	ሎ
3.	ሐ	ሑ	ሒ	ሓ	ሔ	ሕ	ሖ
4.	መ	ሙ	ሚ	ማ	ሜ	ም	ሞ
5.	ሠ	ሡ	ሢ	ሣ	ሤ	ሥ	ሦ
6.	ረ	ሩ	ሪ	ራ	ሬ	ር	ሮ
7.	ሰ	ሱ	ሲ	ሳ	ሴ	ስ	ሶ
8.	ቀ	ቁ	ቂ	ቃ	ቄ	ቅ	ቆ
9.	በ	ቡ	ቢ	ባ	ቤ	ብ	ቦ
10.	ተ	ቱ	ቲ	ታ	ቴ	ት	ቶ
11.	ነ	ኑ	ኒ	ና	ኔ	ን	ኖ
12.	ኘ	ኙ	ኚ	ኛ	ኜ	ኝ	ኞ
13.	አ	ኡ	ኢ	ኣ	ኤ	እ	ኦ
14.	ከ	ኩ	ኪ	ካ	ኬ	ክ	ኮ
15.	ወ	ዉ	ዊ	ዋ	ዌ	ው	ዎ
16.	ዐ	ዑ	ዒ	ዓ	ዔ	ዕ	ዖ
17.	ዘ	ዙ	ዚ	ዛ	ዜ	ዝ	ዞ
18.	የ	ዩ	ዪ	ያ	ዬ	ይ	ዮ
19.	ደ	ዱ	ዲ	ዳ	ዴ	ድ	ዶ
20.	ገ	ጉ	ጊ	ጋ	ጌ	ግ	ጎ
21.	ጠ	ጡ	ጢ	ጣ	ጤ	ጥ	ጦ
22.	ጸ	ጹ	ጺ	ጻ	ጼ	ጽ	ጾ
23.	ፀ	ፁ	ፂ	ፃ	ፄ	ፅ	ፆ
24.	ፈ	ፉ	ፊ	ፋ	ፌ	ፍ	ፎ
25.	ፐ	ፑ	ፒ	ፓ	ፔ	ፕ	ፖ
26.	ቨ	ቩ	ቪ	ቫ	ቬ	ቭ	
27.	ኰ	ኵ	ኲ	ኳ	ኴ		
28.	ቈ	ቍ	ቊ	ቋ	ቌ		
29.	ጐ	ጕ	ጒ	ጓ	ጔ		
30.	ኀ	ኁ	ኂ	ኃ	ኄ		

APPENDIX II

The possible Number of Inflected forms obtained from the troop verb ፈቀደ/*fäqädä*/

A. Perfective Verbs [ቀዳማይ አንቀጽ]

i Perfective Base-Stem Verb Forms - ፈቀደ

- A total of 98 inflected verb forms are obtained

Subject	*Main verb*	*Object*									
		To Me	To Us	To You */2psm/*	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	ፈቀድኩ	-	-	ፈቀድኩክ	ፈቀድኩክሙ	ፈቀድኩኪ	ፈቀድኩክን	ፈቀድክዎ	ፈቀድክዎሙ	ፈቀድክዋ	ፈቀድክዎን
We	ፈቀድነ	-	-	ፈቀድናክ	ፈቀድናክሙ	ፈቀድናኪ	ፈቀድናክን	ፈቀድናሁ /ፈቀድኖ/	ፈቀድናክሙ /ፈቀድኖሙ/	ፈቀድናሃ /ፈቀድና/	ፈቀድናሆን /ፈቀድኖን/
you	ፈቀድክ	ፈቀድክኒ	ፈቀድክነ	-	-	-	-	ፈቀድኩ /ፈቀድካሁ/	ፈቀድኩሙ /ፈቀድካሆሙ/	ፈቀድካ /ፈቀድካሃ/	ፈቀድኩን /ፈቀድካሆን/
you	ፈቀድክሙ	ፈቀድክሙኒ	ፈቀድክሙነ	-	-	-	-	ፈቀድክምዎ	ፈቀድክምዎሙ	ፈቀድክምዋ	ፈቀድክምዎን
you	ፈቀድኪ	ፈቀድክኒ	ፈቀድክነ	-	-	-	-	ፈቀድኪዮ	ፈቀድኪዮሙ	ፈቀድኪያ	ፈቀድኪዮን
you	ፈቀድክን	ፈቀድክናኒ	ፈቀድክናነ	-	-	-	-	ፈቀድክናሁ	ፈቀድክናሆሙ	ፈቀድክናሃ	ፈቀድክናሆን
He	ፈቀደ	ፈቀደኒ	ፈቀደነ	ፈቀደክ	ፈቀደክሙ	ፈቀደኪ	ፈቀደክን	ፈቀዶ	ፈቀዶሙ	ፈቀዳ	ፈቀዶን
They	ፈቀዱ	ፈቀዱኒ	ፈቀዱነ	ፈቀዱክ	ፈቀዱክሙ	ፈቀዱኪ	ፈቀዱክን	ፈቀድዎ	ፈቀድዎሙ	ፈቀድዋ	ፈቀድዎን
She	ፈቀደት	ፈቀደተኒ	ፈቀደተነ	ፈቀደተክ	ፈቀደተክሙ	ፈቀደተኪ	ፈቀደተክን	ፈቀደቶ	ፈቀደቶሙ	ፈቀደታ	ፈቀደቶን
They	ፈቀዳ	ፈቀዳኒ	ፈቀዳነ	ፈቀዳክ	ፈቀዳክሙ	ፈቀዳኪ	ፈቀዳክን	ፈቀዳሁ	ፈቀዳሆሙ	ፈቀዳሃ	ፈቀዳሆን

ii Perfective Causative-stem Verb Forms -አፍቀደ

- A total of 98 inflected verb forms are obtained

Subject	Main verb	Object									
		To Me	To Us	To You /2psm/	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	አፍቀድኩ	-		አፍቀድኩከ	አፍቀድኩክሙ	አፍቀድኩኪ	አፍቀድኩክን	አፍቀድክዎ	አፍቀድክዎሙ	አፍቀድክዋ	አፍቀድክዎን
We	አፍቀድነ	-	-	አፍቀድናከ	አፍቀድናክሙ	አፍቀድናኪ	አፍቀድናክን	አፍቀድኖ/ አፍቀድናሁ	አፍቀድኖሙ /አፍቀድናሆሙ	አፍቀድና /አፍቀድናሃ	አፍቀድኖን /አፍቀድናሆን
you	አፍቀድከ	አፍቀድከኒ	አፍቀድከነ	-	-	-	-	አፍቀድከ /አፍቀድካሁ/	አፍቀድክሙ /አፍቀድካሆሙ/	አፍቀድካ /አፍቀድካሃ/	አፍቀድክን አፍቀድካሆን
you	አፍቀድክሙ	አፍቀድክሙኒ	አፍቀድክሙነ	-	-	-	-	አፍቀድክሙነ	አፍቀድክምዎ	አፍቀድክምዋ	አፍቀድክምዎን
you	አፍቀድኪ	አፍቀድክኒ	አፍቀድክነ	-	-	-	-	አፍቀድኪዮ	አፍቀድኪዮሙ	አፍቀድክያ	አፍቀድኪዮን
you	አፍቀድክን	አፍቀድክናኒ	አፍቀድክናነ	-	-	-	-	አፍቀድክናሁ	አፍቀድክናሆሙ	አፍቀድክናሃ	አፍቀድክናሆን
He	አፍቀደ	አፍቀደኒ	አፍቀደነ	አፍቀደከ	አፍቀደክሙ	አፍቀደኪ	አፍቀደክን	አፍቀዶ	አፍቀዶሙ	አፍቀዳ	አፍቀዶን
They	አፍቀዱ	አፍቀዱኒ	አፍቀዱነ	አፍቀዱከ	አፍቀዱክሙ	አፍቀዱኪ	አፍቀዱክን	አፍቀድዎ	አፍቀድዎሙ	አፍቀድዋ	አፍቀድዎን
She	አፍቀደት	አፍቀደተኒ	አፍቀደተነ	አፍቀደተከ	አፍቀደተክሙ	አፍቀደተኪ	አፍቀደተክን	አፍቀደቶ	አፍቀደቶሙ	አፍቀደታ	አፍቀደቶን
They	አፍቀዳ	አፍቀዳኒ	አፍቀዳነ	አፍቀዳከ	አፍቀዳክሙ	አፍቀዳኪ	አፍቀዳክን	አፍቀዳሁ	አፍቀዳሆሙ	አፍቀዳሃ	አፍቀዳሆን

iii Perfective Causative-reciprocal stem Verb Forms -አስተፋቀደ

- A total of 98 inflected verb forms are obtained

Subject	Main Verb	Object									
		To Me	To Us	To You /2psm/	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	አስተፋቀድኩ	-	-	አስተፋቀድኩክ	አስተፋቀድኩክሙ፡	አስተፋቀድኩኪ	አስተፋቀድኩክን	አስተፋቀድክዎ	አስተፋቀድክዎሙ፡	አስተፋቀድክዋ	አስተፋቀድክዎን
We	አስተፋቀድነ	-	-	አስተፋቀድናክ	አስተፋቀድናክሙ፡	አስተፋቀድናኪ	አስተፋቀድናክን	አስተፋቀድናዉ /አስተፋቀድኖ	አስተፋቀድናሆሙ፡ /አስተፋቀድኖሙ፡	አስተፋቀድናሃ /አስተፋቀድና	አስተፋቀድናሆን /አስተፋቀድኖን
you	አስተፋቀድክ	አስተፋቀድክኒ	አስተፋቀድክነ	-	-	-	-	አስተፋቀድኩ /አስተፋቀድካዉ/	አስተፋቀድኩሙ፡ /አስተፋቀድካሆሙ፡/	አስተፋቀድካ /አስተፋቀድካሃ/	አስተፋቀድኩን /አስተፋቀድካሆን/
you	አስተፋቀድክሙ፡	አስተፋቀድክሙኒ	አስተፋቀድክሙነ	-	-	-	-	አስተፋቀድክምዎ	አስተፋቀድክምዎሙ፡	አስተፋቀድክምዋ	አስተፋቀድክምዎን
you	አስተፋቀድኪ	አስተፋቀድክኒ	አስተፋቀድክነ	-	-	-	-	አስተፋቀድኪዮ	አስተፋቀድኪዮሙ፡	አስተፋቀድኪያ	አስተፋቀድኪዮን
you	አስተፋቀድክን	አስተፋቀድክናኒ	አስተፋቀድክናነ	-	-	-	-	አስተፋቀድክናዉ	አስተፋቀድክናሆሙ፡	አስተፋቀድክናሃ	አስተፋቀድክናሆን
He	አስተፋቀደ	አስተፋቀደኒ	አስተፋቀደነ	አስተፋቀደክ	አስተፋቀደክሙ፡	አስተፋቀደኪ	አስተፋቀደክን	አስተፋቀዶ	አስተፋቀዶሙ፡	አስተፋቀዳ	አስተፋቀዶን
They	አስተፋቀዱ	አስተፋቀዱኒ	አስተፋቀዱነ	አስተፋቀዱክ	አስተፋቀዱክሙ፡	አስተፋቀዱኪ	አስተፋቀዱክን	አስተፋቀድዎ	አስተፋቀድዎሙ፡	አስተፋቀድዋ	አስተፋቀድዎን
She	አስተፋቀደት	አስተፋቀደተኒ	አስተፋቀደተነ	አስተፋቀደተክ	አስተፋቀደተክሙ፡	አስተፋቀደተኪ	አስተፋቀደተክን	አስተፋቀደቶ	አስተፋቀደቶሙ፡	አስተፋቀደታ	አስተፋቀደቶን
They	አስተፋቀዳ	አስተፋቀዳኒ	አስተፋቀዳነ	አስተፋቀዳክ	አስተፋቀዳክሙ፡	አስተፋቀዳኪ	አስተፋቀዳክን	አስተፋቀዳዉ	አስተፋቀዳሆሙ፡	አስተፋቀዳሃ	አስተፋቀዳሆን

iv Perfective Reflexive-stem Verb Forms -ተፈቅደ

This can have only intransitive surface forms obtained while declaring them using the ten pronouns. A total of ten pronouns are obtained from such type of declaration.

Pronoun	*Reflexive verb*
I	ተፈቀድኩ
We	ተፈቀድነ
You */2psm/*	ተፈቀድከ
You */2ppm/*	ተፈቀድክሙ
You */2psf/*	ተፈቀድኪ
You */2ppf/*	ተፈቀድክን
He	ተፈቅደ
They */3ppm/*	ተፈቀዱ
She	ተፈቀደት
They */3ppf/*	ተፈቀዳ

v Perfective Reciprocal-stem Verb Forms -ተፋቀደ

- A total of ten pronouns are obtained

Pronoun	*Reciprocal verb*
I	ተፋቀድኩ
We	ተፋቀድነ
You */2psm/*	ተፋቀድከ
You */2ppm/*	ተፋቀድክሙ
You */2psf/*	ተፋቀድኪ
You */2ppf/*	ተፋቀድክን
He	ተፋቀደ
They */3ppm/*	ተፋቀዱ
She	ተፋቀደት
They */3ppf/*	ተፋቀዳ

B. Indicative Verbs[ካልአይ ኣንቀጽ]

i) Indicative Base-Stem Verb Forms -ይፈቅድ

- A total of 98 inflected verb forms are obtained

Subject	Main Verb	Object									
		To Me	To Us	To You /2psm/	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	እፈቅድ	-	-	እፈቅደከ	እፈቅደክሙ፡	እፈቅደኪ	እፈቅደክን	እፈቅዶ	እፈቅዶሙ፡	እፈቅዳ	እፈቅዶን
We	ንፈቅድ	-	-	ንፈቅደከ	ንፈቅደክሙ፡	ንፈቅደኪ	ንፈቅደክን	ንፈቅዶ	ንፈቅዶሙ፡	ንፈቅዳ	ንፈቅዶን
you	ትፈቅድ	ትፈቅደኒ	ትፈቅደነ	-	-	-	-	ትፈቅዶ/ትፈቅዳሁ/	ትፈቅዶሙ/ ትፈቅዳሆሙ፡/	ትፈቅዳ/ትፈቅዳሃ/	ትፈቅዶን /ትፈቅዳሆን/
you	ትፈቅዱ	ትፈቅዱኒ	ትፈቅዱነ	-	-	-	-	ትፈቅድዎ	ትፈቅድዎሙ፡	ትፈቅድዋ	ትፈቅድዎን
you	ትፈቅዲ	ትፈቅድኒ	ትፈቅድነ	-	-	-	-	ትፈቅድዮ	ትፈቅድዮሙ፡	ትፈቅድያ	ትፈቅድዮን
you	ትፈቅዳ	ትፈቅዳኒ	ትፈቅዳነ	-	-	-	-	ትፈቅዳሁ፡	ትፈቅዳሆሙ፡	ትፈቅዳሃ	ትፈቅዳሆን
He	ይፈቅድ	ይፈቅደኒ	ይፈቅደነ	ይፈቅደከ	ይፈቅደክሙ፡	ይፈቅደኪ	ይፈቅደክን	ይፈቅዶ	ይፈቅዶሙ፡	ይፈቅዳ	ይፈቅዶን
They	ይፈቅዱ	ይፈቅዱኒ	ይፈቅዱነ	ይፈቅዱከ	ይፈቅዱክሙ፡	ይፈቅዱኪ	ይፈቅዱክን	ይፈቅድዎ	ይፈቅድዎሙ፡	ይፈቅድዋ	ይፈቅድዎን
She	ትፈቅድ	ትፈቅደኒ	ትፈቅደነ	ትፈቅደከ	ትፈቅደክሙ፡	ትፈቅደኪ	ትፈቅደክን	ትፈቅዶ	ትፈቅዶሙ፡	ትፈቅዳ	ትፈቅዶን
They	ይፈቅዳ	ይፈቅዳኒ	ይፈቅዳነ	ይፈቅዳከ	ይፈቅዳክሙ፡	ይፈቅዳኪ	ይፈቅዳክን	ይፈቅዳሁ፡	ይፈቅዳሆሙ፡	ይፈቅዳሃ	ይፈቅዳሆን

ii) IndicativeCausative-Stem Verb Forms - ያፈቅድ

- A total of 98 inflected verb forms are obtained

Subject	Main Verb	Object									
		To Me	To Us	To You /2psm/	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	አፈቅድ	-	-	አፈቅደከ	አፈቅደክሙ	አፈቅደኪ	አፈቅደክን	አፈቅዶ	አፈቅዶሙ	አፈቅዳ	አፈቅዶን
We	ናፈቅድ	-	-	ናፈቅደከ	ናፈቅደክሙ	ናፈቅደኪ	ናፈቅደክን	ናፈቅዶ	ናፈቅዶሙ	ናፈቅዳ	ናፈቅዶን
you	ታፈቅድ	ታፈቅደኒ	ታፈቅደነ	-	-	-	-	ታፈቅዶ/ታፈቅዳሁ/	ታፈቅዶሙ/ ታፈቅዳሆሙ/	ታፈቅዳ/ ታፈቅዳሃ/	ታፈቅዶን /ታፈቅዳሆን/
you	ታፈቅዱ	ታፈቅዱኒ	ታፈቅዱነ	-	-	-	-	ታፈቅድዎ	ታፈቅድዎሙ	ታፈቅድዋ	ታፈቅድዎን
you	ታፈቅዲ	ታፈቅድኒ	ታፈቅድነ	-	-	-	-	ታፈቅድዮ	ታፈቅድዮሙ	ታፈቅድያ	ታፈቅድዮን
you	ታፈቅዳ	ታፈቅዳኒ	ታፈቅዳነ	-	-	-	-	ታፈቅዳሁ	ታፈቅዳሆሙ	ታፈቅዳሃ	ታፈቅዳሆን
He	ያፈቅድ	ያፈቅደኒ	ያፈቅደነ	ያፈቅደከ	ያፈቅደክሙ	ያፈቅደኪ	ያፈቅደክን	ያፈቅዶ	ያፈቅዶሙ	ያፈቅዳ	ያፈቅዶን
They	ያፈቅዱ	ያፈቅዱኒ	ያፈቅዱነ	ያፈቅዱከ	ያፈቅዱክሙ	ያፈቅዱኪ	ያፈቅዱክን	ያፈቅድዎ	ያፈቅድዎሙ	ያፈቅድዋ	ያፈቅድዎን
She	ታፈቅድ	ታፈቅደኒ	ታፈቅደነ	ታፈቅደከ	ታፈቅደክሙ	ታፈቅደኪ	ታፈቅደክን	ታፈቅዶ	ታፈቅዶሙ	ታፈቅዳ	ታፈቅዶን
They	ያፈቅዳ	ያፈቅዳኒ	ያፈቅዳነ	ያፈቅዳከ	ያፈቅዳክሙ	ያፈቅዳኪ	ያፈቅዳክን	ያፈቅዳሁ	ያፈቅዳሆሙ	ያፈቅዳሃ	ያፈቅዳሆን

iii) IndicativeCausative-reciprocal stem Verb Forms - ያስተፋቅድ

- A total of 98 inflected verb forms are obtained

Subject	Main Verb	Object									
		To Me	To Us	To You /2psm/	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	አስተፋቅድ	-	-	አስተፋቅደከ	አስተፋቅደክሙ	አስተፋቅደኪ	አስተፋቅደክን	አስተፋቅዶ	አስተፋቅዶሙ	አስተፋቅዳ	አስተፋቅዶን
We	ናስተፋቅድ	-	-	ናስተፋቅደከ	ናስተፋቅደክሙ	ናስተፋቅደኪ	ናስተፋቅደክን	ናስተፋቅዶ	ናስተፋቅዶሙ	ናስተፋቅዳ	ናስተፋቅዶን
you	ታስተፋቅድ	ታስተፋቅደኒ	ታስተፋቅደነ	-	-	-	-	ታስተፋቅዶ/ ታስተፋቅዳሁ	ታስተፋቅዶሙ/ ታስተፋቅዳሆሙ	ታስተፋቅዳ/ ታስተፋቅዳሃ/	ታስተፋቅዶን /ታስተፋቅዳሆን/
you	ታስተፋቅዱ	ታስተፋቅዱኒ	ታስተፋቅዱነ	-	-	-	-	ታስተፋቅድዎ	ታስተፋቅድዎሙ	ታስተፋቅድዋ	ታስተፋቅድዎን
you	ታስተፋቅዲ	ታስተፋቅድኒ	ታስተፋቅድነ	-	-	-	-	ታስተፋቅድዮ	ታስተፋቅድዮሙ	ታስተፋቅድያ	ታስተፋቅድዮን
you	ታስተፋቅዳ	ታስተፋቅዳኒ	ታስተፋቅዳነ	-	-	-	-	ታስተፋቅዳሁ	ታስተፋቅዳሆሙ	ታስተፋቅዳሃ	ታስተፋቅዳሆን
He	ያስተፋቅድ	ያስተፋቅደኒ	ያስተፋቅደነ	ያስተፋቅደከ	ያስተፋቅደክሙ	ያስተፋቅደኪ	ያስተፋቅደክን	ያስተፋቅዶ	ያስተፋቅዶሙ	ያስተፋቅዳ	ያስተፋቅዶን
They	ያስተፋቅዱ	ያስተፋቅዱኒ	ያስተፋቅዱነ	ያስተፋቅዱከ	ያስተፋቅዱክሙ	ያስተፋቅዱኪ	ያስተፋቅዱክን	ያስተፋቅድዎ	ያስተፋቅድዎሙ	ያስተፋቅድዋ	ያስተፋቅድዎን
She	ታስተፋቅድ	ታስተፋቅደኒ	ታስተፋቅደነ	ታስተፋቅደከ	ታስተፋቅደክሙ	ታስተፋቅደኪ	ታስተፋቅደክን	ታስተፋቅዶ	ታስተፋቅዶሙ	ታስተፋቅዳ	ታስተፋቅዶን
They	ያስተፋቅዳ	ያስተፋቅዳኒ	ያስተፋቅዳነ	ያስተፋቅዳከ	ያስተፋቅዳክሙ	ያስተፋቅዳኪ	ያስተፋቅዳክን	ያስተፋቅዳሁ	ያስተፋቅዳሆሙ	ያስተፋቅዳሃ	ያስተፋቅዳሆን

iv) IndicativeReflexive-stem Verb Forms - ይትፈቀድ

- A total of 10 inflected verb forms are obtained

Pronoun	*Reflexive verb*
I	እትፈቀድ
We	ንትፈቀድ
You */2psm/*	ትትፈቀድ
You */2ppm/*	ትትፈቀዱ
You */2psf/*	ትትፈቀዲ
You */2ppf/*	ትትፈቀዳ
He	ይትፈቀድ
They */3ppm/*	ይትፈቀዱ
She	ትትፈቀድ
They */3ppf/*	ይትፈቀዳ

v) IndicativeReciprocal-stem Verb Forms - ይትፋቀድ

- A total of 10 inflected verb forms are obtained

Pronoun	*Reciprocal verb*
I	እትፋቀድ
We	ንትፋቀድ
You */2psm/*	ትትፋቀድ
You */2ppm/*	ትትፋቀዱ
You */2psf/*	ትትፋቀዲ
You */2ppf/*	ትትፋቀዳ
He	ይትፋቀድ
They */3ppm/*	ይትፋቀዱ
She	ትትፋቀድ
They */3ppf/*	ይትፋቀዳ

C. Subjunctive Verbs [ሣልሣይ አንቀጽ]

i) Subjunctive Base-stem Verb Forms - ይፍቅድ

- A total of 10 inflected verb forms are obtained

Subject	*Main verb*	*Object*									
		To Me	To Us	To You */2psm/*	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	እፍቅድ	-	-	እፍቅድከ	እፍቅድክሙ፡	እፍቅድኪ	እፍቅድክን	እፍቅዶ	እፍቅዶሙ፡	እፍቅዳ	እፍቅዶን
We	ንፍቅድ	-	-	ንፍቅድከ	ንፍቅድክሙ፡	ንፍቅድኪ	ንፍቅድክን	ንፍቅዶ	ንፍቅዶሙ፡	ንፍቅዳ	ንፍቅዶን
you	ፍቅድ	ፍቅደኒ	ፍቅደነ	-	-	-	-	ፍቅዶ /ፍቅዳሁ፡/	ፍቅዶሙ፡ /ፍቅዳሆሙ፡/	ፍቅዳ /ፍቅዳሃ/	ፍቅዶን /ፍቅዳሆን/
you	ፍቅዱ	ፍቅዱኒ	ፍቅዱነ	-	-	-	-	ፍቅድዎ	ፍቅድዎሙ፡	ፍቅድዋ	ፍቅድዎን
you	ፍቅዲ	ፍቅድኒ	ፍቅድነ	-	-	-	-	ፍቅዲዮ	ፍቅዲዮሙ፡	ፍቅድያ	ፍቅድዮን
you	ፍቅዳ	ፍቅዳኒ	ፍቅዳነ	-	-	-	-	ፍቅዳሁ፡	ፍቅዳሆሙ፡	ፍቅዳሃ	ፍቅዳሆን
He	ይፍቅድ	ይፍቅደኒ	ይፍቅደነ	ይፍቅድከ	ይፍቅድክሙ፡	ይፍቅድኪ	ይፍቅድክን	ይፍቅዶ	ይፍቅዶሙ፡	ይፍቅዳ	ይፍቅዶን
They	ይፍቅዱ	ይፍቅዱኒ	ይፍቅዱነ	ይፍቅዱከ	ይፍቅዱክሙ፡	ይፍቅዱኪ	ይፍቅዱክን	ይፍቅድዎ	ይፍቅድዎሙ፡	ይፍቅድዋ	ይፍቅድዎን
She	ትፍቅድ	ትፍቅደኒ	ትፍቅደነ	ትፍቅድከ	ትፍቅድክሙ፡	ትፍቅድኪ	ትፍቅድክን	ትፍቅዶ	ትፍቅዶሙ፡	ትፍቅዳ	ትፍቅዶን
They	ይፍቅዳ	ይፍቅዳኒ	ይፍቅዳነ	ይፍቅዳከ	ይፍቅዳክሙ፡	ይፍቅዳኪ	ይፍቅዳክን	ይፍቅዳሁ፡	ይፍቅዳሆሙ፡	ይፍቅዳሃ	ይፍቅዳሆን

ii) Subjunctive Causative-stem Verb Forms - ያፍቅድ

- A total of 94 inflected verb forms are obtained

Subject	Main verb	Object									
		To Me	To Us	To You /2psm/	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	ኣፍቅድ ??	-	-	አፍቅድከ	አፍቅድክሙ	አፍቅድኪ	አፍቅድክን	አፍቅዶ	አፍቅዶሙ	አፍቅዳ	አፍቅዶን
We	ናፍቅድ	-	-	ናፍቅድከ	ናፍቅድክሙ	ናፍቅድኪ	ናፍቅድክን	ናፍቅዶ	ናፍቅዶሙ	ናፍቅዳ	ናፍቅዶን
you	አፍቅድ	አፍቅደኒ	አፍቅደነ	-	-	-	-	አፍቅዶ /አፍቅዳሁ/	አፍቅዶሙ /አፍቅዳሆሙ/	አፍቅዳ /አፍቅዳሃ/	አፍቅዶን /አፍቅዳሆን/
you	አፍቅዱ	አፍቅዱኒ	አፍቅዱነ	-	-	-	-	አፍቅድዎ	አፍቅድዎሙ	አፍቅድዋ	አፍቅድዎን
you	አፍቅዲ	አፍቅድኒ	አፍቅድነ	-	-	-	-	አፍቅዲዮ	አፍቅዲዮሙ	አፍቅድያ	አፍቅድዮን
you	አፍቅዳ	አፍቅዳኒ	አፍቅዳነ	-	-	-	-	አፍቅዳሁ	አፍቅዳሆሙ	አፍቅዳሃ	አፍቅዳሆን
He	ያፍቅድ	ያፍቅደኒ	ያፍቅደነ	ያፍቅድከ	ያፍቅድክሙ	ያፍቅድኪ	ያፍቅድክን	ያፍቅዶ	ያፍቅዶሙ	ያፍቅዳ	ያፍቅዶን
They	ያፍቅዱ	ያፍቅዱኒ	ያፍቅዱነ	ያፍቅዱከ	ያፍቅዱክሙ	ያፍቅዱኪ	ያፍቅዱክን	ያፍቅድዎ	ያፍቅድዎሙ	ያፍቅድዋ	ያፍቅድዎን
She	ታፍቅድ	ታፍቅደኒ	ታፍቅደነ	ታፍቅድከ	ታፍቅድክሙ	ታፍቅድኪ	ታፍቅድክን	ታፍቅዶ	ታፍቅዶሙ	ታፍቅዳ	ታፍቅዶን
They	ያፍቅዳ	ያፍቅዳኒ	ያፍቅዳነ	ያፍቅዳከ	ያፍቅዳክሙ	ያፍቅዳኪ	ያፍቅዳክን	ያፍቅዳሁ	ያፍቅዳሆሙ	ያፍቅዳሃ	ያፍቅዳሆን

iii) SubjunctiveCausative-Reciprocal stem Verb Forms- ያስተፋቅድ

- A total of 94 inflected verb forms are obtained

Subject	Main Verb	Object									
		To Me	To Us	To You /2psm/	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	አስተፋቅድ	-	-	አስተፋቅደከ	አስተፋቅደክሙ	አስተፋቅደኪ	አስተፋቅደክን	አስተፋቅዶ	አስተፋቅዶሙ	አስተፋቅዳ	አስተፋቅዶን
We	ናስተፋቅድ	-	-	ናስተፋቅደከ	ናስተፋቅደክሙ	ናስተፋቅደኪ	ናስተፋቅደክን	ናስተፋቅዶ	ናስተፋቅዶሙ	ናስተፋቅዳ	ናስተፋቅዶን
you	አስተፋቅድ	አስተፋቅደኒ	አስተፋቅደነ	-	-	-	-	አስተፋቅዶ/ አስተፋቅዳሁ	አስተፋቅዶሙ/አስተፋቅዳሆሙ	አስተፋቅዳ/አስተፋቅዳሃ/	አስተፋቅዶን /አስተፋቅዳሆን/
you	አስተፋቅዱ	አስተፋቅዱኒ	አስተፋቅዱነ	-	-	-	-	አስተፋቅድዎ	አስተፋቅድዎሙ	አስተፋቅድዋ	አስተፋቅድዎን
you	አስተፋቅዲ	አስተፋቅድኒ	አስተፋቅድነ	-	-	-	-	አስተፋቅድዮ	አስተፋቅድዮሙ	አስተፋቅድያ	አስተፋቅድዮን
you	አስተፋቅዳ	አስተፋቅዳኒ	አስተፋቅዳነ	-	-	-	-	አስተፋቅዳሁ	አስተፋቅዳሆሙ	ታስተፋቅዳሃ	ታስተፋቅዳሆን
He	ያስተፋቅድ	ያስተፋቅደኒ	ያስተፋቅደነ	ያስተፋቅደከ	ያስተፋቅደክሙ	ያስተፋቅደኪ	ያስተፋቅደክን	ያስተፋቅዶ	ያስተፋቅዶሙ	ያስተፋቅዳ	ያስተፋቅዶን
They	ያስተፋቅዱ	ያስተፋቅዱኒ	ያስተፋቅዱነ	ያስተፋቅዱከ	ያስተፋቅዱክሙ	ያስተፋቅዱኪ	ያስተፋቅዱክን	ያስተፋቅድዎ	ያስተፋቅድዎሙ	ያስተፋቅድዋ	ያስተፋቅድዎን
She	ታስተፋቅድ	ታስተፋቅደኒ	ታስተፋቅደነ	ታስተፋቅደከ	ታስተፋቅደክሙ	ታስተፋቅደኪ	ታስተፋቅደክን	ታስተፋቅዶ	ታስተፋቅዶሙ	ታስተፋቅዳ	ታስተፋቅዶን
They	ያስተፋቅዳ	ያስተፋቅዳኒ	ያስተፋቅዳነ	ያስተፋቅዳከ	ያስተፋቅዳክሙ	ያስተፋቅዳኪ	ያስተፋቅዳክን	ያስተፋቅዳሁ	ያስተፋቅዳሆሙ	ያስተፋቅዳሃ	ያስተፋቅዳሆን

iv) SubjunctiveReflexive-stem Verb Forms- ይትፈቀድ

- A total of 10 inflected verb forms are obtained

Pronoun	*Reflexive verb*
I	እትፈቀድ
We	ንትፈቀድ
You */2psm/*	ተፈቀድ
You */2ppm/*	ተፈቀዱ
You */2psf/*	ተፈቀዲ
You */2ppf/*	ተፈቀዳ
He	ይትፈቀድ
They */3ppm/*	ይትፈቀዱ
She	ትትፈቀድ
They */3ppf/*	ይትፈቀዳ

v) SubjunctiveReciprocal-stem Verb Forms- ይትፋቀድ

- A total of 10 inflected verb forms are obtained

Pronoun	*Reciprocal verb*
I	እትፋቀድ
We	ንትፋቀድ
You */2psm/*	ተፋቀድ
You */2ppm/*	ተፋቀዱ
You */2psf/*	ተፋቀዲ
You */2ppf/*	ተፋቀዳ
He	ይትፋቀድ
They */3ppm/*	ይትፋቀዱ
She	ትትፋቀድ
They */3ppf/*	ይትፋቀዳ

D. Jussive Verbs[ዘንድ አንቀጽ]

i) Jussive Base-stem Verb Forms - ይፍቅድ[66]

- A total of 94 inflected verb forms are obtained

Subject	Main verb	Object									
		To Me	To Us	To You /2psm/	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	እፍቅድ	-	-	እፍቅድከ	እፍቅድክሙ፡	እፍቅድኪ	እፍቅድክን	እፍቅዶ	እፍቅዶሙ፡	እፍቅዳ	እፍቅዶን
We	ንፍቅድ	-	-	ንፍቅድከ	ንፍቅድክሙ፡	ንፍቅድኪ	ንፍቅድክን	ንፍቅዶ	ንፍቅዶሙ፡	ንፍቅዳ	ንፍቅዶን
you	ትፍቅድ	ትፍቅደኒ	ትፍቅደነ	-	-	-	-	ትፍቅዶ /ትፍቅዳሁ/	ትፍቅዶሙ /ትፍቅዳሆሙ/	ትፍቅዳ /ትፍቅዳሃ/	ትፍቅዶን /ትፍቅዳሆን/
you	ትፍቅዲ	ትፍቅዲኒ	ትፍቅዲነ	-	-	-	-	ትፍቅዲዮ	ትፍቅዲዮሙ፡	ትፍቅድየ	ትፍቅዲዮን
you	ትፍቅዳ	ትፍቅዳኒ	ትፍቅዳነ	-	-	-	-	ትፍቅዳሁ፡	ትፍቅዳሆሙ፡	ትፍቅዳሃ	ትፍቅዳሆን
He	ይፍቅድ	ይፍቅደኒ	ይፍቅደነ	ይፍቅድከ	ይፍቅድክሙ፡	ይፍቅድኪ	ይፍቅድክን	ይፍቅዶ	ይፍቅዶሙ፡	ይፍቅዳ	ይፍቅዶን
They	ይፍቅዲ	ይፍቅዲኒ	ይፍቅዲነ	ይፍቅዲከ	ይፍቅዲክሙ፡	ይፍቅዲኪ	ይፍቅዲክን	ይፍቅድዮ	ይፍቅድዮሙ፡	ይፍቅድዋ	ይፍቅድዮን
She	ትፍቅድ	ትፍቅደኒ	ትፍቅደነ	ትፍቅድከ	ትፍቅድክሙ፡	ትፍቅድኪ	ትፍቅድክን	ትፍቅዶ	ትፍቅዶሙ፡	ትፍቅዳ	ትፍቅዶን
They	ይፍቅዳ	ይፍቅዳኒ	ይፍቅዳነ	ይፍቅዳከ	ይፍቅዳክሙ፡	ይፍቅዳኪ	ይፍቅዳክን	ይፍቅዳሁ፡	ይፍቅዳሆሙ፡	ይፍቅዳሃ	ይፍቅዳሆን

[66] Most of the surface forms obtained as the result of the declaration under this category are the same as that of the subjunctive verb forms. Only thirty two of the totals have different morphology. Nevertheless, they are used differently from the subjunctive forms both syntactically and semantically. Usually, they are used to reason out why something is needed to be or supposed to be. They often tend to answer the question „*to be what*?" in the context they are used.

ii) Jussive Causative-stem Verb Forms - ያፍቅድ

- A total of 94 inflected verb forms are obtained

Subject	*Main verb*	*Object*									
		To Me	**To Us**	**To You /2psm/**	**To You /2ppm/**	**To You /2psf/**	**To You /2ppf/**	**To Him**	**To Them /3ppm/**	**To Her**	**To Them /3ppf/**
I	አፍቅድ ??	-	-	አፍቅድከ	አፍቅድክሙ	አፍቅድኪ	አፍቅድክን	አፍቅዶ	አፍቅዶሙ	አፍቅዳ	አፍቅዶን
We	ናፍቅድ	-	-	ናፍቅድከ	ናፍቅድክሙ	ናፍቅድኪ	ናፍቅድክን	ናፍቅዶ	ናፍቅዶሙ	ናፍቅዳ	ናፍቅዶን
you	ታፍቅድ	ታፍቅደኒ	ታፍቅደነ	-	-	-	-	ታፍቅዶ /ታፍቅዳሁ/	ታፍቅዶሙ /ታፍቅዳሆሙ/	ታፍቅዳ /ታፍቅዳሃ/	ታፍቅዶን /ታፍቅዳሆን/
you	ታፍቅዱ	ታፍቅዱኒ	ታፍቅዱነ	-	-	-	-	ታፍቅድዎ	ታፍቅድዎሙ	ታፍቅድዋ	ታፍቅድዎን
you	ታፍቅዲ	ታፍቅድኒ	ታፍቅድነ	-	-	-	-	ታፍቅዲዮ	ታፍቅዲዮሙ	ታፍቅድዮ	ታፍቅድዮን
you	ታፍቅዳ	ታፍቅዳኒ	ታፍቅዳነ	-	-	-	-	ታፍቅዳሁ	ታፍቅዳሆሙ	ታፍቅዳሃ	ታፍቅዳሆን
He	ያፍቅድ	ያፍቅደኒ	ያፍቅደነ	ያፍቅድከ	ያፍቅድክሙ	ያፍቅድኪ	ያፍቅድክን	ያፍቅዶ	ያፍቅዶሙ	ያፍቅዳ	ያፍቅዶን
They	ያፍቅዱ	ያፍቅዱኒ	ያፍቅዱነ	ያፍቅዱከ	ያፍቅዱክሙ	ያፍቅዱኪ	ያፍቅዱክን	ያፍቅድዎ	ያፍቅድዎሙ	ያፍቅድዋ	ያፍቅድዎን
She	ታፍቅድ	ታፍቅደኒ	ታፍቅደነ	ታፍቅድከ	ታፍቅድክሙ	ታፍቅድኪ	ታፍቅድክን	ታፍቅዶ	ታፍቅዶሙ	ታፍቅዳ	ታፍቅዶን
They	ያፍቅዳ	ያፍቅዳኒ	ያፍቅዳነ	ያፍቅዳከ	ያፍቅዳክሙ	ያፍቅዳኪ	ያፍቅዳክን	ያፍቅዳሁ	ያፍቅዳሆሙ	ያፍቅዳሃ	ያፍቅዳሆን

iii) Jussive Causative-Reciprocal stem Verb Forms - ያስተፋቅድ

- A total of 94 inflected verb forms are obtained

Subject	Main Verb	Object									
		To Me	To Us	To You /2psm/	To You /2ppm/	To You /2psf/	To You /2ppf/	To Him	To Them /3ppm/	To Her	To Them /3ppf/
I	አስተፋቅድ	-	-	አስተፋቅደክ	አስተፋቅደክሙ	አስተፋቅደኪ	አስተፋቅደክን	አስተፋቅዶ	አስተፋቅዶሙ	አስተፋቅዳ	አስተፋቅዶን
We	ናስተፋቅድ	-	-	ናስተፋቅደክ	ናስተፋቅደክሙ	ናስተፋቅደኪ	ናስተፋቅደክን	ናስተፋቅዶ	ናስተፋቅዶሙ	ናስተፋቅዳ	ናስተፋቅዶን
you	ታስተፋቅድ	ታስተፋቅደኒ	ታስተፋቅደነ	-	-	-	-	ታስተፋቅዶ/ ታስተፋቅዳሁ	ታስተፋቅዶሙ/ ታስተፋቅዳሆሙ	ታስተፋቅዳ/ ታስተፋቅዳሃ/	ታስተፋቅዶን /ታስተፋቅሆን/
you	ታስተፋቅዱ	ታስተፋቅዱኒ	ታስተፋቅዱነ	-	-	-	-	ታስተፋቅድዎ	ታስተፋቅድዎሙ	ታስተፋቅድዋ	ታስተፋቅድዎን
you	ታስተፋቅዲ	ታስተፋቅድኒ	ታስተፋቅድነ	-	-	-	-	ታስተፋቅድዮ	ታስተፋቅድዮሙ	ታስተፋቅድያ	ታስተፋቅድዮን
you	ታስተፋቅዳ	ታስተፋቅዳኒ	ታስተፋቅዳነ	-	-	-	-	ታስተፋቅዳሁ	ታስተፋቅዳሆሙ	ታስተፋቅዳሃ	ታስተፋቅዳሆን
He	ያስተፋቅድ	ያስተፋቅደኒ	ያስተፋቅደነ	ያስተፋቅደክ	ያስተፋቅደክሙ	ያስተፋቅደኪ	ያስተፋቅደክን	ያስተፋቅዶ	ያስተፋቅዶሙ	ያስተፋቅዳ	ያስተፋቅዶን
They	ያስተፋቅዱ	ያስተፋቅዱኒ	ያስተፋቅዱነ	ያስተፋቅዱክ	ያስተፋቅዱክሙ	ያስተፋቅዱኪ	ያስተፋቅዱክን	ያስተፋቅድዎ	ያስተፋቅድዎሙ	ያስተፋቅድዋ	ያስተፋቅድዎን
She	ታስተፋቅድ	ታስተፋቅደኒ	ታስተፋቅደነ	ታስተፋቅደክ	ታስተፋቅደክሙ	ታስተፋቅደኪ	ታስተፋቅደክን	ታስተፋቅዶ	ታስተፋቅዶሙ	ታስተፋቅዳ	ታስተፋቅዶን
They	ያስተፋቅዳ	ያስተፋቅዳኒ	ያስተፋቅዳነ	ያስተፋቅዳክ	ያስተፋቅዳክሙ	ያስተፋቅዳኪ	ያስተፋቅዳክን	ያስተፋቅዳሁ	ያስተፋቅዳሆሙ	ያስተፋቅዳሃ	ያስተፋቅዳሆን

iv) Jussive Reflexive-stem Verb Forms - ይትፈቀድ

- A total of 10 inflected verb forms are obtained

Pronoun	*ReflexiveVerb*
I	እትፈቀድ
We	ንትፈቀድ
You */2psm/*	ትትፈቀድ
You */2ppm/*	ትትፈቀዱ
You */2psf/*	ትትፈቀዲ
You */2ppf/*	ትትፈቀዳ
He	ይትፈቀድ
They */3ppm/*	ይትፈቀዱ
She	ትትፈቀድ
They */3ppf/*	ይትፈቀዳ

v) Jussive Reciprocal-stem Verb Forms- ይትፋቀድ

- A total of 10 inflected verb forms are obtained

Pronoun	*Reciprocal verb*
I	እትፋቀድ
We	ንትፋቀድ
You */2psm/*	ትትፋቀድ
You */2ppm/*	ትትፋቀዱ
You */2psf/*	ትትፋቀዲ
You */2ppf/*	ትትፋቀዳ
He	ይትፋቀድ
They */3ppm/*	ይትፋቀዱ
She	ትትፋቀድ
They */3ppf/*	ይትፋቀዳ

E. GerundiveVerbs[ቦዝ አንቀጽ]

i) GerundiveBase-stem Verb Forms-ፈቂዶ

- A total of 10 inflected verb forms are obtained

Pronoun	*Base-stem verb*
I	ፈቂድየ
We	ፈቂደነ
You */2psm/*	ፈቂደከ
You */2ppm/*	ፈቂደክሙ
You */2psf/*	ፈቂደኪ
You */2ppf/*	ፈቂደክን
He	ፈቂዶ
They */3ppm/*	ፈቂዶሙ
She	ፈቂዳ
They */3ppf/*	ፈቂዶን

ii) GerundiveCausative-stem Verb Forms-አፍቂዶ

- A total of 10 inflected verb forms are obtained

Pronoun	*Causatíve-stem verb*
I	አፍቂድየ
We	አፍቂደነ
You */2psm/*	አፍቂደከ
You */2ppm/*	አፍቂደክሙ
You */2psf/*	አፍቂደኪ
You */2ppf/*	አፍቂደክን
He	አፍቂዶ
They */3ppm/*	አፍቂዶሙ
She	አፍቂዳ
They */3ppf/*	አፍቂዶን

iii) GerundiveCausative-Reciprocal stem Verb Forms-አስተፋቂዶ

- A total of 10 inflected verb forms are obtained

Pronoun	*Causative-Reciprocal verb*
I	አስተፋቂድየ
We	አስተፋቂደነ
You */2psm/*	አስተፋቂደከ
You */2ppm/*	አስተፋቂደክሙ
You */2psf/*	አስተፋቂደኪ
You */2ppf/*	አስተፋቂደክን
He	አስተፋቂዶ
They */3ppm/*	አስተፋቂዶሙ
She	አስተፋቂዳ
They */3ppf/*	አስተፋቂዶን

iv) GerundiveReflexive-stem Verb Forms-ተፈቂዶ

- A total of 10 inflected verb forms are obtained

Pronoun	*Reflexive-stem verb*
I	ተፈቂድየ
We	ተፈቂደነ
You */2psm/*	ተፈቂደከ
You */2ppm/*	ተፈቂደክሙ
You */2psf/*	ተፈቂደኪ
You */2ppf/*	ተፈቂደክን
He	ተፈቂዶ
They */3ppm/*	ተፈቂዶሙ
She	ተፈቂዳ
They */3ppf/*	ተፈቂደን

v) GerundiveReciprocal-stem Verb Forms-ተፋቂዶ

- A total of 10 inflected verb forms are obtained

Pronoun	*Reciprocal verb*
I	**ተፋቂድየ**
We	**ተፋቂደነ**
You */2psm/*	**ተፋቂደከ**
You */2ppm/*	**ተፋቂደክሙ**
You */2psf/*	**ተፋቂደኪ**
You */2ppf/*	**ተፋቂደክን**
He	**ተፋቂዶ**
They */3ppm/*	**ተፋቂዶሙ**
She	**ተፋቂዳ**
They */3ppf/*	**ተፋቂደን**

F.InfinitiveVerbs [አርእስት አንቀጽ]

Inflected infinitive verbs are two types: (a) **ፈቂድ**, **አፍቅዶ**, **አስተፋቅዶ**, **ተፈቅዶ** and **ተፋቅዶ**; (b) see the following table

Infinitive stems with out SMS	*Infinitive stems with SMS marker*									
	I	**We**	**You /2psm/**	**You /2ppm/**	**You /2psf/**	**You /2ppf/**	**He**	**They /3ppm/**	**She**	**They /3ppf/**
ፈቂዶት	**ፈቂዶትየ**	**ፈቂዶትነ**	**ፈቂዶትከ**	**ፈቂዶትክሙ**	**ፈቂዶትኪ**	**ፈቂዶትክን**	**ፈቂዶቶ**	**ፈቂዶቶሙ**	**ፈቂዶታ**	**ፈቂዶቶን**
አፍቅዶት	**አፍቅዶትየ**	**አፍቅዶትነ**	**አፍቅዶትከ**	**አፍቅዶትክሙ**	**አፍቅዶትኪ**	**አፍቅዶትክን**	**አፍቅዶቶ**	**አፍቅዶቶሙ**	**አፍቅዶታ**	**አፍቅዶቶን**
አስተፋቅዶት	**አስተፋቅዶትየ**	**አስተፋቅዶትነ**	**አስተፋቅዶትከ**	**አስተፋቅዶትክሙ**	**አስተፋቅዶትኪ**	**አስተፋቅዶትክን**	**አስተፋቅዶቶ**	**አስተፋቅዶቶሙ**	**አስተፋቅዶታ**	**አስተፋቅዶቶን**
ተፈቅዶት	**ተፈቅዶትየ**	**ተፈቅዶትነ**	**ተፈቅዶትከ**	**ተፈቅዶትክሙ**	**ተፈቅዶትኪ**	**ተፈቅዶትክን**	**ተፈቅዶቶ**	**ተፈቅዶቶሙ**	**ተፈቅዶታ**	**ተፈቅዶቶን**
ተፋቅዶት	**ተፋቅዶትየ**	**ተፋቅዶትነ**	**ተፋቅዶትከ**	**ተፋቅዶትክሙ**	**ተፋቅዶትኪ**	**ተፋቅዶትክን**	**ተፋቅዶቶ**	**ተፋቅዶቶሙ**	**ተፋቅዶታ**	**ተፋቅዶቶን**

Appendix III

Pseudo-code of some of the algorithms explained in chapter four

A. An algorithm that detaches the SMS and OMS of Perfective and Imperative Verbs

Input: perfective verb
Output: lexeme, SMS, subject, subPNG, OMS, object and objPNG SMS
ObjectFeaturesArray: which contains the OMS, Object and objPNG of the verb
SubjectFeaturesArray: which contains the SMS, subject and subPNG of the verb

```
For (j= 4; j>=1; j--)
    Detach the last j characters from the verb as object marker feature
    Check if the feature exists in the ObjMarkersTable
    If exists
        Remove the object marker feature from the perfective verb
        For (i= 4; i>=1; i--)
            Detach the last i characters from the verb as subject marker feature
            Check if this feature exists in the SubMarkersTable
            If exists
                store the feature as SMS
                find the subject indicated by the SMS and its subPNG from SubMarkersTable
                remove the subject marker feature from the perfective verb
                insert the SMS, subject and subPNG to the SubjectFeatursArray
                break
            end if
        end for
        If the verb has subject maker feature as SMS
            Store the object maker feature as OMS
            find the object indicated by the OMS and its objPNG from ObjMarkersTable
            insert the OMS, object and objPNG to the ObjectFeatursArray
        Else    // means if the verb doesn't have a subject marker suffix
```

```
                Store the object marker feature as SMS
                find the subject indicated by the SMS and its subPNG from SubMarkersTable
                 insert the SMS, subject and subPNG to the SubjectFeatursArray
                break
      end if
end for
Call function makeLexeme (verb fragment) to get the lexeme // the perfective verb with its
                                                                    // SMS and OMS detached
return lexeme, SubjectFeatursArray and ObjectFeaturesArray
```

B. An Algorithm that makes the lexeme of the verb

Input: verb fragment found after all affixes detached
Output: the lexeme of the verb
lexeme: contains the lexeme of the verb fragment to be returned
verbCharactersArray: contains the characters of the passed verb part

```
makeLexeme(verb fragment)
Begin
       insert all the characters of the verb fragment to verbCharactersArray
       replace all occurrences of 'u', 'i', 'a', 'A', 'Y' and 'o' in verbCharactersArray with 'e'

       if the length of verbCharactersArray is less than six
           append 'e' to the end of the verbCharactersArray
           lexeme = verbCharactersArray
       else if the length of verbCharactersArray is greater than six
           remove the extra characters // only six characters are needed
           lexeme = verbCharactersArray else
       else
           lexeme = verbCharactersArray
      return lexeme
End
```

C. An algorithm that detaches the circumfix and OMS of Indicative, Subjunctive and Jussive Verbs

Input: base stem form of a verb and the prefix of the verb
Output: lexeme, SMS, subject, subPNG, OMS, object, objPNG, [either circumfix or suffix or prefix] of the verb
ObjectFeaturesArray: which contains the OMS, Object and objPNG of the verb
SubjectFeaturesArray:which contains theSMS, subject and subjPNG of the verb
prefixPartOfCircumfix: is the prefix part of the circumfix.
SuffixPartOfCicumfix: is the suffix part of the circumfix.
verbFeaturesArray: contains the lexeme, circumfix, suffix and prefix of the verb
verbLexeme: contains the lexeme of the verb

```
detachVerbsCircumfixAndOtherAffixes(verbSegment, verbPrefix)
Start
    // First, detach the prefix of the base form verb
    For (p=2: p>=1; p--)
        Detach the first p characters from the base stem verb as prefix feature
        Check if this prefix feature exists in the circumfixTable
        If exists
            Store this feature in prefixPartOfCircumfix as a prefix part of the circumfix
            remove this prefix feature from the base stem verb
        end if
    end for
// Second, detach the OMS of the base stem verb
For (n=4: n>=1; n--)
        Detach the last n characters from the base stem verb as object marker feature
        Check if this feature exists in the ObjMarkersTable
        If exists
            Store the object marker feature as OMS
            find the object indicated by the OMS and its objPNG from ObjMarkersTable
            insert the OMS, object and objPNG to the ObjectFeatursArray
            remove this object marker feature from the base stem verb
        end if
```

```
        end for

      // Third, detach the suffix part of the circumfix feature of the verb
For (m=4: m>=1; m--)
              Detach the last m characters from the base stem verb as suffix feature
              Check if this suffix feature exists in the circumfixTable
              If exists
                  Store this feature in suffixPartOfCircumfix as a suffix part of the circumfix
                  If the suffix feature found from the circumfixTable is not null
                       remove this suffix feature from the base stem verb
                   end if
              end if
end for

      // fourth, find the SMS, subject and subjPNG of the verb based on the above three features

       find the subject and subjPNG from the circumfixTable using the prefixPartOfCircumfix,
                 suffixPartOfCircumfix and object marker features identified above
      verbLexeme =  makeLexeme (verb fragment) // to get the lexeme of the verb
      insert SMS, subject and subjPNG to the SubjectFeaturesArray
      if the verbPrefix is not null and the suffixPartOfCircumfix is not null
            concatenate the verbPrefix with suffixPartOfCircumfix to form the circumfix of the verb
      else if the verbPrefix is not null and the suffixPartOfCircumfix is null
           store the verbPrefix as the prefix feature of the original verb // verb has only prefix
      else
          store the suffixPartOfCircumfix as a suffix feature of the verb // verb has only suffix
       insert verbLexeme, SubjectFeaturesArray, ObjectFeatursArray, and the identified affix to
           verbFeaturesArray
       return verbFeaturesArray
end // end of the module
```

Appendix IV

Transliteraions used in this thesis work

A. Translitration principle used while writing the document[Leslau, 1967]

No.	1st Ordär	2nd Ordär	3rd Ordär	4th Ordär	5th Ordär	6th Ordär	7th Ordär
1.	ሀ =hä	ሁ = hu	ሂ = hi	ሃ = ha	ሄ = he	ህ = h	ሆ=ho
2.	ለ = lä	ሉ = lu	ሊ = li	ላ = la	ሌ = le	ል= l	ሎ = lo
3.	ሐ = Hä	ሑ = Hu	ሒ = Hi	ሓ = Ha	ሔ = He	ሕ = H	ሖ = Ho
4.	መ = mä	ሙ = mu	ሚ = mi	ማ = ma	ሜ = Me	ም = m	ሞ = mo
5.	ሠ = sä	ሡ = su	ሢ = si	ሣ = sa	ሤ = Se	ሥ = s	ሦ = so
6.	ረ = rä	ሩ = ru	ሪ = ri	ራ = ra	ሬ = re	ር = r	ሮ = ro
7.	ሰ = Sä	ሱ = Su	ሲ = Si	ሳ = Sa	ሴ = Se	ስ = S	ሶ = So
8.	ቀ = qä	ቁ = qu	ቂ = qi	ቃ = qa	ቄ = qe	ቅ = q	ቆ = qo
9.	በ = bä	ቡ = bu	ቢ = bi	ባ = ba	ቤ = be	ብ = b	ቦ = bo
10.	ተ = tä	ቱ = tu	ቲ = ti	ታ = ta	ቴ = te	ት = t	ቶ = to
11.	ኀ = ^hä	ኁ = ^hu	ኂ = ^hi	ኃ = ^ha	ኄ = ^he	ኅ = ^h	ኆ = ^ho
12.	ነ = nä	ኑ = nu	ኒ = ni	ና = na	ኔ = ne	ን = n	ኖ = no
13.	አ = ä	ኡ = u	ኢ = i	ኣ = a	ኤ = e	እ = ə	ኦ = o
14.	ከ = kä	ኩ = ku	ኪ = ki	ካ = ka	ኬ = ke	ክ = k	ኮ = ko
15.	ወ = wä	ዉ = wu	ዊ = wi	ዋ = wa	ዌ = we	ው = w	ዎ = wo
16.	ዐ = ^ä	ዑ = ^u	ዒ = ^i	ዓ = ^a	ዔ = ^e	ዕ = ^ə	ዖ = ^o
17.	ዘ = zä	ዙ = zu	ዚ = zi	ዛ = za	ዜ = ze	ዝ = z	ዞ = zo

No.	1st Ordär	2nd Ordär	3rd Ordär	4th Ordär	5th Ordär	6th Ordär	7th Ordär
18.	የ = yä	ዩ = yu	ዪ = yi	ያ = ya	ዬ = ye	ይ = y	ዮ = yo
19.	ደ = dä	ዱ = du	ዲ = di	ዳ = da	ዴ = de	ድ = d	ዶ = do
20.	ገ = gä	ጉ = gu	ጊ = gi	ጋ = ga	ጌ = ge	ግ = g	ጎ = go
21.	ጠ = ţä	ጡ = ţu	ጢ = ţi	ጣ = ţa	ጤ = ţe	ጥ = ţ	ጦ = ţo
22.	ጰ = pä	ጱ = pu	ጲ = pi	ጳ = pa	ጴ = pe	ጵ = p	ጶ = po
23.	ጸ = şä	ጹ = şu	ጺ = şi	ጻ = şa	ጼ = şe	ጽ = ş	ጾ = şo
24.	ፀ = şä	ፁ = şu	ፂ = şi	ፃ = şa	ፄ = şe	ፅ = ş	ፆ = şo
25.	ፈ = fä	ፉ = fu	ፊ = fi	ፋ = fa	ፌ = fe	ፍ = f	ፎ = fo
26.	ፐ = pä	ፑ = pu	ፒ = pi	ፓ = pa	ፔ = pe	ፕ = p	ፖ = po
27.	ኰ = k^wä	ኲ = k^wə	ኵ = k^wi	ኳ = k^wa	ኴ = k^we		
28.	ቈ = q^wä	ቍ = q^wə	ቊ = q^wi	ቋ = q^wa	ቌ = q^we		
29.	ጐ = gä	ጕ = g^wə	ጒ = g^wi	ጓ = g^wa	ጔ = g^we		
30.	ኈ = h^wä	ኍ = h^wə	ኊ = h^wi	ኋ= h^wa	ኌ = h^we		

B. Translitration principle used during implementation

No.	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	7th Order
1.	ሀ = he	ሁ = hu	ሂ = hi	ሃ = ha	ሄ = hA	ህ = hY	ሆ = ho
2.	ለ = le	ሉ = lu	ሊ = li	ላ = la	ሌ = lA	ል = lY	ሎ = lo
3.	ሐ = He	ሑ = Hu	ሒ = Hi	ሓ = Ha	ሔ = HA	ሕ = HY	ሖ = Ho
4.	መ = me	ሙ = mu	ሚ = mi	ማ = ma	ሜ = MA	ም = mY	ሞ = mo
5.	ሠ = se	ሡ = su	ሢ = si	ሣ = sa	ሤ = SA	ሥ = sY	ሦ = so
6.	ረ = re	ሩ = ru	ሪ = ri	ራ = ra	ሬ = rA	ር = rY	ሮ = ro
7.	ሰ = Se	ሱ = Su	ሲ = Si	ሳ = Sa	ሴ = SA	ስ = SY	ሶ = So
8.	ቀ = qe	ቁ = qu	ቂ = qi	ቃ = qa	ቄ = qA	ቅ = qY	ቆ = qo
9.	በ = be	ቡ = bu	ቢ = bi	ባ = ba	ቤ = bA	ብ = bY	ቦ = bo
10.	ተ = te	ቱ = tu	ቲ = ti	ታ = ta	ቴ = tA	ት = tY	ቶ = to
11.	ጎ = Be	ጉ = Bu	ጊ = Bi	ጋ = Ba	ጌ = BA	ግ = BY	ጎ = Bo
12.	ነ = ne	ኑ = nu	ኒ = ni	ና = na	ኔ = nA	ን = nY	ኖ = no
13.	አ = e	ኡ = u	ኢ = i	ኣ = a	ኤ = A	እ = Y	ኦ = o
14.	ከ = ke	ኩ = ku	ኪ = ki	ካ = ka	ኬ = kA	ክ = kY	ኮ = ko
15.	ወ = we	ዉ = wu	ዊ = wi	ዋ = wa	ዌ = wA	ው = wY	ዎ = wo
16.	ዐ = We	ዑ = Wu	ዒ = Wi	ዓ = Wa	ዔ = WA	ዕ = WY	ዖ = Wo
17.	ዘ = ze	ዙ = zu	ዚ = zi	ዛ = za	ዜ = zA	ዝ = zY	ዞ = zo
18.	የ = ye	ዩ = yu	ዪ = yi	ያ = ya	ዬ = yA	ይ = yY	ዮ = yo
19.	ደ = de	ዱ = du	ዲ = di	ዳ = da	ዴ = dA	ድ = dY	ዶ = do
20.	ገ = ge	ጉ = gu	ጊ = gi	ጋ = ga	ጌ = gA	ግ = gY	ጎ = go
21.	ጠ = Te	ጡ = Tu	ጢ = Ti	ጣ = Ta	ጤ = TA	ጥ = TY	ጦ = To
22.	ጰ = Pe	ጱ = Pu	ጲ = Pi	ጳ = Pa	ጴ = PA	ጵ = PY	ጶ = Po

No.	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	7th Order
23.	ጸ = Xe	ጹ = Xu	ጺ = Xi	ጻ = Xa	ጼ = XA	ጽ = XY	ጾ = Xo
24.	ፀ = xe	ፁ = xu	ፂ = xi	ፃ = xa	ፄ = xA	ፅ = xY	ፆ = xo
25.	ፈ = fe	ፉ = fu	ፊ = fi	ፋ = fa	ፌ = fA	ፍ = fY	ፎ = fo
26.	ፐ = pe	ፑ = pu	ፒ = pi	ፓ = pa	ፔ = pA	ፕ = pY	ፖ = po
27.	ኬ = Ke	ኹ = Ku	ኺ = Ki	ኻ = Ka	ኼ = KA		
28.	ቈ = Qe	ቍ = Qu	ቊ = Qi	ቋ = Qa	ቌ = QA		
29.	ጐ = Ge	ጕ = Gu	ጒ = Gi	ጓ = Ga	ጔ = GA		
30.	ጘ = De	ጙ = Du	ጚ = Di	ጛ = Da	ጜ = DA		

Appendix V

Sample Features Incorporated to the Knowledgebase

A. Sample of the prefixes incorporated to the knowledgebase

Prefixes	Syntactic Functions
e	Causative
Y	Indicative/Subjunctive/Jussive
esYte	Causative-Reciprocal
YtY	Reciprocal/Reflexive
i	Negative
naSYte	Causative-Reciprocal
nY	Indicative/Subjunctive/Jussive
nYtY	Reciprocal/Reflexive

B. Sample SMS features incorporated to the knowledgebase

Subject Marker	Subject	Feature
a	They/He	3ppf/3psm
E	He	3psm
Y	They	3ppm
ka	You	2psm
etY	She	3psf
ku	I	1psn
kY	I/You	1psn/2psf

C. Sample OMS features incorporated to the knowledgebase

Object Marker	Subject	Feature
homu	They	3ppm
wa	She	3psf
hu	He	3psm
ne	Us	1ppm
kYmu	You	2ppm
ni	Me	1psn

D. Sample circumfixes and OMS features of Indicative, Subjunctive and Jussive verbs incorporated to the knowledgebase

Circumfix		Subject	Object
tY	homu	You/2psm/2ppf	Them/3ppm
tY	honY	You/2psm /2ppf	Them/3ppf
Y	Ki	I	You/2psf
Y	Mu	I	Them/3ppm
tY	Ke	She	You/2psm
nY	Ke	We	You/2psm
nY	kYmu	We	You/2ppm
tY	Ki	She	You/2psf
yY	ukYmu	They /3ppm	You/2ppm
yY	ukYnY	They/3ppm	You/2ppf

Appendix VI

Manully Analyzed Testing Verb-Set by the Domain Experts

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
1	weledo	-	-	e	He	o	Him	Perfective	Base	welede
2	tefYBYretY	te	-	tY	She	-	-	Perfective	Reflexive	feBere
3	terekYbetY	te	-	tY	She	-	-	Perfective	Reflexive	rekebe
4	ifeqede	i	-	e	He	-	-	Perfective	Base	feqede
5	yYkYsYta	yY	-	-	He	a	Her	Subjunctive/Jussive	Base	kesete
6	mekere	-	-	e	He	-	-	Perfective	Base	mekere
7	yYHYdYga	yY	-	-	He	a	Her	Subjunctive/Jussive	Base	Hedege
8	tYSemYyo	tY	-	-	She	o	Him	Indicative	Base	Seme
9	nYSYgYdY	-	nY-Y	-	We	-	-	Subjunctive/Jussive	Base	Segede
10	teSeelomu	te	-	o	He	mu	Them-m	Perfective	Base	Seelem
11	negeromu	-	-	o	He	mu	Them-m	Perfective	Base	negere
12	etewu	-	-	u	They-m	-	-	Perfective	Reflexive	etewe
13	teqetYlu	te	-	u	They-m	-	-	Perfective	Reflexive	qetele
14	Helefu	-	-	u	They-m	-	-	Perfective	Reflexive	Helefe
15	yYBesYso	yY	-	-	He	o	Him	Subjunctive/Jussive	Base	Besese
16	nebere	-	-	e	He	-	-	Perfective	Reflexive	nebere
17	tYbeki	-	tY-i	-	She	-	-	Indicative	Reflexive	bekeye
18	ebeyetY	-	-	tY	She	-	-	Perfective	Reflexive	ebeye
19	tegYBese	te	-	e	He	-	-	Perfective	Reflexive	geBese
20	Hedere	-	-	e	He	-	-	Perfective	Reflexive	Hedere
21	Sebeke	-	-	e	He	-	-	Perfective	Base	Sebeke
22	WerYyu		-	u	You-pm	-	-	Imperative	Base	Wereye
23	yaTemYqomu	-	ya-o	-	He	mu	Them-m	Indicative	Causative	Temeqe
24	tamesYTu	-	ta-u	-	You-pm	-	-	Indicative	Causative	meseTe
25	yYdelYwekYmu	-	yY-e	-	He	kYmu	You-pm	Indicative	Reflexive	delewe
26	iyYmYSYlYkYmu	i	yY-Y	-	He	kYmu	You-pm	Subjunctive/Jussive	Reflexive	meSele
27	iyYferi	i	yY-i	-	He	-	-	Indicative	Base	fereye
28	yYgezYmYwo	-	yY-Y	-	They-m	wo	Him	Indicative	Base	gezeme
29	yYwedYyYwo	-	yY-Y	-	They-m	wo	Him	Indicative	Base	wedeye
30	yYwerYdY	-	yY-Y	-	He	-	-	Indicative	Reflexive	werede
31	weSedo	-	-	e	He	o	Him	Perfective	Base	weSede
32	qYnYXY	-	-	Y	You-sm	-	-	Imperative	Reflexive	qeneXe
33	tewerewY	te	-	Y	You-sm	-	-	Subjunctive	Reflexive	werewe
34	yYWYqebuke	-	yY-Y	-	They-m	ke	You-sm	Indicative	Base	Weqebe

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
35	itYtYWeqefY	i	tYtY-Y	-	You-sm	-	-	Jussive	Reflexive	Weqefe
36	Yhubeke	-	yY-e	-	He	-	-	Indicative	Base	wehebe
37	tamYlYkY	-	ta-Y	-	You-sm	-	-	Jussive	Base	meleke
38	yYtYleekYwo	-	yYtY-Y	-	They-m	wo	Him	Indicative	Reflexive	leeke
39	eBezYwo	-	-	Y	They-m	wo	Him	Perfective	Base	eBeze
40	sereqe	-	-	e	He	-	-	Perfective	Base	sereqe
41	meShee	-	-	e	He	-	-	Perfective	Base	Mehere
42	tYlYwuni	-	-	Y	You-pm	ni	Me	Imperative	Base	telewe
43	Wediwo	-	-	wo	He	-	-	Gerundive	Base	Wedewe
44	yYlahYwu	-	yY-Y	-	They-m	-	-	Indicative	Reflexive	lehewe
45	yYwerYSYwo	-	yY-Y	-	They-m	wo	Him	Indicative	Base	wereSe
46	yYmehYrYwomu	-	yY-Y	-	They-m	womu	Them-m	Subjunctive	Base	mehere
47	yYSededu	-	yY-Y	-	They-m	-	-	Indicative	Reflexive	Sedede
48	yYnebu	-	yY-u	-	They-m	-	-	Indicative	Base	nebebe
49	teBaseyu	te	-	u	You-pm	-	-	Imperative	Reflexive	Beseye
50	yYgedYfYwo	-	yY-Y	-	They-m	wo	Him	Indicative	Base	gedefe
51	teHenYXetY	te	-	tY	She	-	-	Perfective	Reflexive	HeneXe
52	iyaBetYwu	i	ya-Y	-	They-m	-	-	Indicative	Base	Betewe
53	YSYWeromu	-	Y-o	-	I	mu	Them-m	Jussive	Base	SeWere
54	Helefe	-	-	e	He	-	-	Perfective	Reflexive	Helefe
55	teHeXYXY	te	-	Y	You-sm	-	-	Indicative	Reflexive	HeXeXe
56	teHeyeSeke	te	-	e	He	ke	You-sm	Perfective	Reflexive	HeyeSe
57	tYfeqYdu	-	tY-u	-	You-pm	-	-	Indicative	Base	feqede
58	fetewa	-	-	a	They-f	-	-	Perfective	Base	fetewe
59	gedefa	-	-	a	They-f	-	-	Perfective	Base	gedefe
60	mYtYra	-	-	Y	You-sm	a	Her	Imperative	Base	metere
61	yYdYBarY	-	yY-Y	-	He	-	-	Jussive	Base	deBere
62	yYXYHYfY	-	yY-Y	-	He	-	-	Indicative	Base	XeHefe
63	ewYSebe	e	-	e	He	-	-	Perfective	Base	weSebe
64	itYmYHelu	i	tY-u	-	You-pm	-	-	Imperative	Base	meHele
65	WebeTeke	-	-	e	He	ke	You-sm	Perfective	Base	WebeTe
66	Seeleke	-	-	e	He	ke	You-sm	Perfective	Base	Seele
67	yYtYeKetu	-	yYtY-u	-	They-m	-	-	Jussive	Reflexive	eKete
68	yeWesYyeke	-	ye-e	-	He	ke	You-sm	Indicative	Base	Weseye
69	nebirY	-	-	-	-	-	-	Infinitive	Base	nebere
70	eSYtedalewe	-	eSYte-e	-	He	-	-	Perfective	Causative-Reciprocal	delewe
71	reHenu	-	-	u	They-m	-	-	Perfective	Base	reHene
72	neXefa	-	-	a	They-f	-	-	Perfective	Base	nexefe
73	iHewezomu	i	-	o	He	mu	Them-m	Perfective	Base	Heweze
74	teregYmetY	te	-	tY	She	-	-	Perfective	Base	regeme
75	ekYreye	e	-	ye	He	-	-	Perfective	Causative	kereye
76	negede	-	-	e	He	-	-	Perfective	Base	negede
77	wegeru	-	-	u	They-m	-	-	Perfective	Base	wegere

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
78	tYdemYqo	tY	-	-	She	o	Him	Indicative	Base	demeqe
79	yYmYSheo	yY	-	-	He	o	Him	Subjunctive	Base	meShee
80	eSYtexamere	eSYte	-	e	He	-	-	Perfective	Causative-Reciprocal	xemere
81	HexewYwomu	-	-	Y	They-m	womu	Them-m	Perfective	Base	Hexewe
82	eSYteWereyYkomu	eSYte	-	ko	You-sm	mu	Them-m	Perfective	Causative-Reciprocal	Wereye
83	yYSeqYlYwo	-	yY-Y	-	They-m	wo	Him	Indicative	Base	Seqele
84	eTYmeqe	e	-	e	He	-	-	Perfective	Causative	Temeqe
85	YTemeqY	-	Y-Y	-	I	-	-	Indicative	Base	Temeqe
86	werede	-	-	e	He	-	-	Perfective	Reflexive	werede
87	eHYseme	e	-	e	He	-	-	Perfective	Causative	Heseme
88	itekela	i	-	e	He	a	Her	Perfective	Base	tekele
89	yYtYgemerY	-	yYtY-Y	-	He	-	-	Indicative	Reflexive	gemere
90	yaHemYmYwo	ya	-	Y	They-m	wo	Him	Indicative	Causative	Hememe
91	lekefomu	-	-	o	He	mu	Them-m	Perfective	Base	lekefe
92	wYhibY	-	-	-	-	-	-	Infinitive	Base	wehebe
93	nekirY	-	-	-	-	-	-	Infinitive	Base	nekere
94	itaSYteHeqYrYwo	i,taSYte	-	Y	You-pm	wo	Him	Jussive	Causative-Reciprocal	Heqere
95	fedYyotY	-	-	-	-	-	-	Infinitive	Base	fedeye
96	Tebeqo	-	-	e	He	o	Him	Perfective	Base	Tebeqe
97	Heneqo	-	-	e	He	o	Him	Perfective	Base	Heneqe
98	yeheyYdYwo	-	ye-Y	-	They-m	wo	Him	Indicative	Base	Heyede
99	yeWelu	-	ye-u	-	He	-	-	Indicative	Base	Welewe
100	yeWexYdu	-	ye-u	-	They-m	-	-	Indicative	Base	Wexede
101	YsYrYwo	-	-	Y	You-pm	wo	Him	Imperative	Base	eSere
102	yeerYyYwo	-	ye-e	-	They-m	wo	Him	Indicative	Base	ereye
103	yYfelYTu	-	yY-u	-	They-m	-	-	Indicative	Base	feleTe
104	eqYdemetY	e	-	tY	She	-	-	Perfective	Base	qedeme
105	yYmYHewY	-	yY-Y	-	He	-	-	Jussive	Base	meHewe
106	feliSo	-	-	o	He	-	-	Gerundive	Base	feleSe
107	yaSYtewadYyYwo	yaSYte	-	Y	They-m	wo	Him	Indicative	Base	Wedeye
108	temakeru	te	-	u	They-m	-	-	Perfective	Reciprocal	mekere
109	iyagYhYdYwo	i	ya-Y	-	They-m	wo	Him	Indicative	Causative	egehed
110	SheeyYku	-	-	Ku	I	-	-	Perfective	Base	Hereye
111	yYzerYweni	-	Yy-e	-	He	ni	Me	Indicative	Base	zerewe
112	yeekYyu	-	yY-u	-	They-m	-	-	Indicative	Base	ekeye
113	serexe	-	-	e	He	-	-	Perfective	Base	serexe
114	beQilo	-	-	o	He	-	-	Gerundive	Base	beKele
115	yYtYqeneyY	-	yYtY-Y	-	He	-	-	Perfective	Reflexive	qeneye
116	nYgYfu	-	-	u	They-m	-	-	Imperative	Base	negefe
117	yYqesYfukYmu	-	yY-u	-	They-m	kYmu	Them-m	Indicative	Base	qesefe

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
118	YfYlYTY	-	Y-Y	-	I	-	-	Subjunctive/Jussive	Base	feleTe
119	yYXemedeni	-	yY-e	-	He	ni	Me	Indicative	Base	xemede
120	gedefa	-	-	a	They-f	-	-	Perfective	Base	gedefe
121	yYtYmaSeTYwa	-	yYtY-Y	-	They-m	wa	Her	Indicative	Base	meSeTe
122	zefenYkYmu	-	-	kYmu	You-pm	-	-	Perfective	Base	zefene
123	YqYbYro	Y	-	-	I	o	Him	Subjunctive/Jussive	Base	qebere
124	yYdefYno	yY	-	-	He	o	Him	Indicative	Base	defene
125	Wedewe	-	-	e	He	-	-	Perfective	Base	Wedewe
126	yYxerYfY	-	yY-Y	-	He	-	-	Indicative	Base	xerefe
127	yYqelYlY	-	yY-Y	-	He	-	-	Indicative	Base	qelele
128	ebedYrY	Y	-	Y	I	-	-	Indicative	Causative	bedere
129	yYTebYqY	-	yY-Y	-	He	-	-	Indicative	Base	Tebeqe
130	yYtYkeWewY	-	yYtY-Y	-	He	-	-	Indicative	Reflexive	keWewe
131	SeHeqYwo	-	-	Y	They-m	wo	Him	Perfective	Base	SeHeqe
132	nebebe	-	-	e	He	-	-	Perfective	Base	nebebe
133	nYtYkedenY	-	nYtY-Y	-	We	-	-	Indicative	Reflexive	kedene
134	seferYkYmu	-	-	kYmu	You-pm	-	-	Perfective	Base	sefere
135	yYqesYmu	-	yY-u	-	They-m	-	-	Indicative	Base	qeseme
136	geseso	-	-	e	He	o	Him	Perfective	Base	gesese
137	yYSekYbY	-	yY-Y	-	He	-	-	Indicative	Reflexive	Sekebe
138	yYrefYqu	-	yY-u	-	They-m	-	-	Indicative	Reflexive	refeqe
139	tYfexYnY	-	tY-Y	-	She	-	-	Indicative	Reflexive	fexene
140	yaSemYkY	-	ya-Y	-	He	-	-	Indicative	Reflexive	Semeke
141	WYxu	-	-	u	You-pm	-	-	Imperative	Base	WeXewe
142	iyeHedYgY	i	ye-Y	-	He	-	-	Indicative	Base	Hedege
143	yYQeXYru	-	yY-u	-	They-m	-	-	Indicative	Base	Qexere
144	HYXYbu	-	-	u	You-pm	-	-	Imperative	Base	HeXebe
145	itYzYgYbu	i	tY-u	-	You-pm	-	-	Indicative	Base	zegebe
146	yYkerYyu	-	yY-u	-	They-m	-	-	Indicative	Base	kereye
147	yYSerYqu	-	yY-u	-	They-m	-	-	Indicative	Base	Sereqe
148	teWexYbY	te	-	Y	You-sm	-	-	Indicative	Reflexive	Wexebe
149	iyeerYru	i	ye-u	-	They-m	-	-	Indicative	Base	erere
150	iyYfetYlu	i	yY-u	-	They-m	-	-	Indicative	Base	fetele
151	teXemYdo	te	-	-	-	-	-	Infinitive	Reflexive	Xemede
152	genezo	-	-	e	He	o	Him	Perfective	Base	geneze
153	ewYqere	e	-	e	He	-	-	Perfective	Causative	weqere
154	teeki	te	-	i	You-sm	-	-	Indicative	Reflexive	ekeye
155	HetemYwa	-	-	Y	They-m	wa	Her	Perfective	Base	Heteme
156	XeHefe	-	-	e	He	-	-	Perfective	Base	XeHefe
157	eSYteHemYmo	eSYte	-	-	-	-	-	Infinitive	Causative-Reciprocal	Hameme
158	teBeyeyu	te	-	u	You-pm	-	-	Perfective	Reflexive	Beyeye

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
159	XeWelYwo	-	-	Y	They-m	wo	Him	Perfective	Base	XeWele
160	tefeXeme	te	-	e	He	-	-	Perfective	Reflexive	feXeme
161	yeWelYwY	-	ye-Y	-	He	-	-	Indicative	Base	Welewe
162	yeHexYna	ye	-	-	He	a	Her	Indicative	Base	Hexene
163	yeHeXYronY	ye	-	-	He	onY	Them-f	Perfective	Base	HeXere
164	yeSheYXa	ye	-	-	He	a	Her	Indicative	Base	HereXe
165	itYSYmYyu	i	tY-u	-	You-pm	-	-	Subjunctive/Jussive	Base	Semeye
166	teedYwu	te	-	Y	You-pm	-	-	Indicative	Reflexive	edewe
167	teTemiqo	te	-	o	He	-	-	Gerundive	Reflexive	Temeqe
168	tYneTYfa	-	tY-a	-	You-pf	-	-	Indicative	Base	neTefe
169	emYsYTo	e	-	-	-	-	-	Infinitive	Causative	meseTe
170	iyYtYnesetY	i	yYtY-Y-	-	He	-	-	Indicative	Base	nesete
171	helewe	-	-	e	He	-	-	Perfective	Base	helewe
172	etiwY	-	-	-	-	-	-	Infinitive	Base	etewe
173	yYzebYTY	-	yY-Y	-	He	-	-	Indicative	Base	zebeTe
174	yYSeTYqo	yY	-	-	He	o	Him	Indicative	Base	SeTeqe
175	negede	-	-	e	He	-	-	Perfective	Base	negede
176	yeheyYdYwo	-	ye-Y	-	They-m	wo	Him	Indicative	Base	heyede
177	yYtYfeTerY	-	yYtY-Y	-	He	-	-	Indicative/Subjunctive/Jussive	Reflexive	feTere
178	Werequ	-	-	u	They-m	-	-	Perfective	Base	-Wereq
179	deweyYku	-	-	ku	I	-	-	Perfective	Base	deweye
180	yYzYkYrYwa	-	yY-Y	-	They-m	wa	Her	Subjunctive/Jussive	Base	zekere
181	BeyeSo	-	-	e	He	o	Him	Perfective	Base	BeyeSe
182	yYnYqu	-	yY-u	-	He	-	-	Jussive	Base	neqewe
183	yYHYzYnY	-	yY-Y	-	He	-	-	Subjunctive/Jussive	Base	Hezene
184	yYfetu	-	yY-u	-	He	-	-	Indicative	Base	fetewe
185	SeWemYkYwo	-	-	kY	I	wo	Him	Perfective	Base	SeWeme
186	neseteto	-	-	tY	She	o	Him	Perfective	Base	nesete
187	SeTeTe	-	-	e	He	-	-	Perfective	Base	SeTeTe
188	werequ	-	-	u	They-m	-	-	Perfective	Base	wereqe
189	itYtYHelefY	te	tYtY-Y	-	She	-	-	Indicative/Subjunctive/Jussive	Reflexive	Helefe
190	SelebYwo	-	-	Y	They-m	wo	Him	Perfective	Base	Selebe
191	WebeTYwo	-	-	Y	They-m	wo	Him	Perfective	Base	WebeTe
192	TYWimo	-	-	o	He	-	-	Gerundive	Base	TeWeme
193	tekafelu	te	-	u	They-m	-	-	Perfective	Reciprocal	kefele
194	teexewu	te	-	u	They-m	-	-	Perfective	Reflexive	exewe
195	ebYSere	e	-	e	He	-	-	Perfective	Causative	beSere
196	YdYnYnY	-	Y-Y	-	I	-	-	Subjunctive/Jussive	Base	denene

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
197	YfYtaHY	-	Y-Y	-	I	-	-	Jussive	Base	fetewe
198	teSeTYqe	te	-	e	He	-	-	Perfective	Causative	SeTeqe
199	yYHYreyY	-	yY-Y	-	He	-	-	Jussive	Base	Hereye
200	meSheomu	-	-	o	He	mu	Them-m	Perfective	Base	meHere
201	eSYterageXo	eSYte	-	-	He	o	Him	Perfective	Causative-Reciprocal	regeXe
202	telYYketomu	te	-	to	She	mu	Them-m	Perfective	Reflexive	leeket
203	yeWerYbY	-	ye-Y	-	He	-	-	Indicative	Base	Werebe
204-	iyagemYromu	i	Ya-o	-	He	mu	Them-m	Perfective	Base	gemere
205	wefere	-	-	e	He	-	-	Perfective	Base	wefere
206	esereto	-	-	tY	She	o	Him	Perfective	Base	esere
207	yeWelYwu	-	ye-u	-	They-m	-	-	Perfective	Base	Welewe
208	fetewe	-	-	e	He	-	-	Perfective	Base	fetewe
209	yeBetYwu	-	ye-u	-	They-m	-	-	Perfective	Base	Betewe
210	iyYtYkebetY	i	yYtY-Y	-	He	-	-	Indicative	Base	kebete
211	ferYyotY	-	-	-	-	-	-	Infinitive	Base	fereye
212	feqedYnahomu	-	-	na	We	homu	Them-m	Perfective	Base	feqede
213	tYbeQYlY	-	tY-Y	-	She	-	-	Indicative	Base	beQele
214	neWedu	-	-	u	They-m	-	-	Perfective	Base	neWede
215	gesesomu	-	-	o	He	mu	Them-m	Perfective	Base	gesese
216	tekebYto	te	-	-	-	-	-	Infinitive	Reflexive	kebee
217	Hedega	-	-	e	He	a	Her	Perfective	Base	Hedege
218	Befereni	-	-	e	He	ni	Me	Perfective	Base	Befere
219	bereqe	-	-	e	He	-	-	Perfective	Base	bereqe
220	yeHeyYwu	-	ye-u	-	They-m	-	-	Indicative	Base	Heyewe
221	egYWero	e	-	e	He	o	Him	Perfective	Reflexive	geWere
222	eHYSemo	e	-	e	He	o	Him	Perfective	Reflexive	HeSeme
223	yalemYdY	-	ya-Y	-	He	-	-	Indicative	Reflexive	lemede
224	ewYSebe	e	-	e	He	-	-	Perfective	Reflexive	weSebe
225	teSYYletY	te	-	tY	She	-	-	Perfective	Reflexive	Seelee
226	nYsYtetY	-	nY-Y	-	We	-	-	Subjunctive/Jussive	Base	setete
227	negirotY	-	-	-	-	-	-	Infinitive	Base	negere
228	eSYtedalewa	eSYte	-	wa	They-f	-	-	Perfective	Causative-Reciprocal	delewe
229	eY##to	e	-	o	He	-	-	Gerundive	Reflexive	eKete
230	enYbibomu	e	-	mu	They-m	-	-	Gerundive	Reflexive	nebebe
231	teHalYfotY	te	-	-	-	-	-	Infinitive	Reflexive	Helefe
232	yYtYWeXefY	-	yYtY-Y	-	He	-	-	Indicative	Base	WeXefe
233	yYSYHYnY	-	yY-Y	-	He	-	-	Indicative	Base	SeHene
234	Heteto	-	-	e	He	o	Him	Perfective	Base	Hetete

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
235	SeTeTe	-	-	e	He	-	-	Perfective	Base	SeTeTe
236	neqewe	-	-	e	He	-	-	Perfective	Base	neqewe
237	gYWiro	-	-	o	He	-	-	Gerundive	Base	geWere
238	yeWeTYnY	-	ye-Y	-	He	-	-	Indicative	Base	WeTene
239	eYmYro	e	-	-	-	-	-	Infinitive	Reflexive	emere
240	ebYsera	e	-	e	He	a	Her	Perfective	Reflexive	besere
241	tYtYHaseyY	-	tYtY-Y	-	She	-	-	Indicative	Base	Heseye
242	yYgYzYrYwo	-	yY-Y	-	They-m	wo	Him	Subjunctive/Jussive	Base	gezere
243	qeXebYwo	-	-	Y	They-m	wo	Him	Perfective	Base	qeXebe
244	yYXYHefY	-	yY-Y	-	He	-	-	Subjunctive/Jussive	Base	XeHefe
245	eSYkebeto	e	-	tY	She	o	Him	Perfective	Base	Sekebe
246	tYSYWYro	-	tY-o	-	You-sm	-	-	Indicative	Base	SeWere
247	yYtYweqeSu	-	yYtY-u	-	They-m	-	-	Indicative	Reflexive	weqeSe
248	geneyetY	-	-	tY	She	-	-	Perfective	Base	geneye
249	teHexYne	te	-	e	He	-	-	Perfective	Reflexive	Hexe
250	enYgefomu	e	-	o	He	mu	Them-m	Perfective	Reflexive	negefe
251	kedene	-	-	e	He	-	-	Perfective	Base	kedee
252	tenedYqetY	te	-	tY	She	-	-	Perfective	Reflexive	nedeqe
253	inekeyo	i	-	e	He	o	Him	Perfective	Base	nekeye
254	HeSeyu	-	-	u	They-m	-	-	Perfective	Base	HeSeye
255	meHewu	-	-	u	They-m	-	-	Perfective	Base	meHewe
256	eWYmeqe	e	-	e	He	-	-	Perfective	Reflexive	Wemeqe
257	rekebYwo	-	-	Y	They-m	wo	Him	Perfective	Base	rekebe
258	iyYHYnYkYwo	i	yY-Y	-	They-m	wo	Him	Subjunctive/Jussive	Base	Heneke
259	enYXere	e	-	e	He	-	-	Perfective	Base	neXere
260	telewYwo	-	-	Y	They-m	wo	Him	Perfective	Base	telewe
261	yeSheYSY	-	ye-Y	-	He	-	-	Indicative	Base	SheeSe
262	gereru	-	-	u	They-m	-	-	Perfective	Base	gerere
263	yYnekYyekYmu	-	yY-e	-	He	kYmu	You-pm	Indicative	Base	nekee
264	eSYteHememe	eSYte	-	e	He	-	-	Perfective	Causative-Reciprocal	Hememe
265	mYHYretY	-	-	-	-	-	-	Infinitive	Base	meShee
266	eSYfeTe	e	-	e	He	-	-	Perfective	Reflexive	SefeTe
267	yYzalefakYmu	-	yY-a	-	They-f	kYmu	You-pm	Indicative	Base	zelefe
268	itYlekYfYwo	i	tY-Y	-	You-pm	wo	Him	Indicative	Base	lekefe
269	yYnYWewYwo	-	yY-Y	-	They-m	wo	Him	Subjunctive/Jussive	Base	neWewe
270	teWexYbotY	te	-	-	-	-	-	Infinitive	Reflexive	Wexebe
271	enYdedetomu	e	-	to	She	mu	Them-m	Perfective	Base	nedede
272	defeneto	-	-	tY	She	o	Him	Perfective	Base	defene

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
273	teBYdYgotY	te	-	-	-	-	-	Infinitive	Reflexive	Bedege
274	yYtYbaderu	-	yY-u	-	They-m	-	-	Indicative	Reciprocal	bedere
275	Heqefo	-	-	e	He	o	Him	Perfective	Base	Heqefe
276	yYTebebu	-	yY-u	-	They-m	-	-	Indicative	Base	Tebebe
277	teqenYyo	te	-	-	-	-	-	Infinitive	Reciprocal	qeneye
278	qeXebYwo	-	-	Y	They-m	wo	Him	Perfective	Base	qeXebe
279	yaQYrYreni	-	ya-e	-	He	ni	Me	Jussive	Reflexive	Qerere
280	qYnYtY	-	-	Y	You-sm	-	-	Imperative	Base	qenete
281	iyYtYHekeyu	i	yYtY-u	-	They-m	-	-	Subjunctive/Jussive	Base	Hekeye
282	eWelY	e	-	Y	I	-	-	Jussive	Base	Wele
283	rYgYzYwomu	-	-	Y	You-pm	womu	Them-m	Imperative	Base	regeze
284	yeWegYtuki	-	ye-u	-	They-m	ki	Her	Indicative	Base	Wegete
285	tegYBisomu	te	-	mu	They-m	-	-	Gerundive	Reflexive	geBese
286	tewaqesu	te	-	u	They-m	-	-	Perfective	Reciprocal	weqese
287	tYtYkeweSY	-	tYtY-Y	-	You-sm	-	-	Indicative	Reflexive	keweSe
288	teYBYzotY	te	-	-	-	-	-	Infinitive	Reflexive	eBezee
289	enYdedu	e	-	u	They-m	-	-	Perfective	Base	nedede
290	YBizo	-	-	o	He	-	-	Gerundive	Base	eBeze
291	HedegetY	-	-	tY	She	-	-	Perfective	Base	Hedege
292	iyYtYHeweSu	i	yYtY-u	-	They-m	-	-	Indicative	Reflexive	HeweSe
293	weridomu	-	-	mu	They-m	-	-	Gerundive	Base	werede
294	SeHebo	-	-	e	He	o	Him	Perfective	Base	SeHebe
295	gezeru	-	-	u	They-m	-	-	Perfective	Base	gezere
296	denene	-	-	e	He	-	-	Perfective	Base	denee
297	kesita	-	-	a	She	-	-	Gerundive	Base	kesete
298	teHexYbY	-	te-Y	-	She/You-2psm	-	-	Indicative	Base	Hexebe
299	qenete	-	-	e	He	-	-	Perfective	Base	qenete
300	HedegahonY	-	-	a	They-f	honY	Them-f	Perfective	Base	Hedege
301	yYbeQYXu	-	yY-u	-	They-m	-	-	Indicative	Base	beQexe
302	inYgYmYdY	i	nY-Y	-	We	-	-	Subjunctive/Jussive	Base	gemede
303	Seribo	-	-	o	He	-	-	Gerundive	Base	Serebe
304	edYnene	e	-	e	He	-	-	Perfective	Base	denee
305	bedero	-	-	e	He	o	-	Perfective	Base	bedere
306	ewYridomu	e	-	mu	They-m	-	-	Gerundive	Base	werede
307	SeHebomu	-	-	o	He	mu	Them-m	Perfective	Base	SeHebe
308	SeHebe	-	-	e	He	-	-	Perfective	Base	SeHebe
309	reWeyY	-	-	Y	You-sm	-	-	Imperative	Base	reWeye
310	yeHelYmu	-	ye-u	-	They-m	-	-	Indicative	Base	Heleme
311	yYsegYrY	-	yY-Y	-	He	-	-	Indicative	Base	segere

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
312	feqido	-	-	o	He	-	-	Gerundive	Base	feqede
313	qeSeTu	-	-	u	They-m	-	-	Perfective	Base	qeSeTe
314	Heqeyu	-	-	u	They-m	-	-	Perfective	Base	Heqeye
315	itYSYHeTYwomu	i	tY-Y	-	They-m	womu	Them-m	Subjunctive/Jussive	Base	SeHeTe
316	eHYdegetomu	e	-	to	She	mu	Them-m	Perfective	Reflexive	Hedege
317	eqYxeru	e	-	u	They-m	-	-	Perfective	Reflexive	qexere
318	yYWYrYqomu	-	yY-o	-	He	mu	Them-m	Subjunctive/Jussive	Base	Wereqe
319	leHewYwo	-	-	Y	They-m	wo	Him	Perfective	Base	leHewe
320	yYdebi	-	yY-i	-	He	-	-	Indicative	Base	debeye
321	yYqerYxo	yY	-	-	He	o	Him	Indicative	Base	qerexe
322	regexenY	-	-	e	He	nY	Them-f	Perfective	Base	regexe
323	erezetonY	-	-	to	She	nY	Them-f	Perfective	Base	ereze
324	HYrYdY	-	-	Y	You-sm	-	-	Imperative	Base	Sheede
325	eqYtelYwomu	e	-	Y	They-m	womu	Them-m	Perfective	Reflexive	qetele
326	teWeXefY	-	te-Y	-	He	-	-	Indicative	Base	Wexefa
327	eXYyo	-	-	o	He	-	-	Gerundive	Base	exeye
328	eYtete	e	-	e	He	-	-	Perfective	Base	etete
329	wehekYwonY	-	-	Y	They-m	wonY	Them-f	Perfective	Base	wehee
330	negefa	-	-	a	They-f	-	-	Perfective	Base	negefe
331	eXYWerYwa	e	-	Y	They-m	wa	Her	Perfective	Reflexive	XeWere
332	yakerYmY	-	ya-Y	-	He	-	-	Indicative	Reflexive	kereme
333	itaSYkYmYwomu	i	ta-Y	-	They-m	womu	Them-m	Subjunctive/Jussive	Reflexive	Sekeme
334	YnedYqY	-	Y-Y	-	I	-	-	Indicative	Base	nedeqe
335	yYtYregezY	-	yYtY-Y	-	He	-	-	Indicative/Subjunctive/Jussive	Reflexive	regeze
336	qesefYwomu	-	-	Y	They-m	womu	Them-m	Perfective	Base	qesefe
337	yaTaWYwY	-	ya-Y	-	He	-	-	Indicative	Causative	TeWewe
338	yYrYqYyu	-	yY-u	-	They-m	-	-	Subjunctive/Jussive	Base	reqeye
339	iSerequ	i	-	u	They-m	-	-	Perfective	Base	Sereqe
340	SeWemomu	-	-	o	He	mu	Them-m	Perfective	Base	SeWeme
341	iyaXYbYbY	i	ya-Y	-	He	-	-	Subjunctive/Jussive	Causative	Xebebe
342	HetitYye	-	-	ye	I	-	-	Gerundive	Base	Hetete
343	Wexebeni	-	-	e	He	ni	Me	Perfective	Base	Wexebe
344	narYgYzY	-	na-Y	-	We	-	-	Subjunctive/Jussive	Causative	regeze
345	taHegizene	ta	-	ne	We	-	-	Gerundive	Causative	Hegeze
346	wegeru	-	-	u	They-m	-	-	Perfective	Base	wegere
347	iyYXYbYtu	i	yY-u	-	They-m	-	-	Subjunctive/Jussive	Base	Xebete

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
348	neSeketo	-	-	tY	She	o	Him	Perfective	Base	neSeke
349	meleSu	-	-	u	They-m	-	-	Perfective	Base	meleSe
350	eSYnequne	e	-	u	They-m	ne	Us	Perfective	Causative	Seneqe
351	yaHesYru	-	ya-u	-	They-m	-	-	Indicative	Causative	Hesere
352	yYqelYyomu	-	yY-o	-	He	mu	Them-m	Indicative	Base	qeleye
353	yabexYWY	-	ya-Y	-	He	-	-	Indicative	Causative	bexeWe
354	Wetebene	-	-	e	He	ne	Us	Perfective	Base	Wetebe
355	sereyYku	-	-	ku	I	-	-	Perfective	Base	sereye
356	yYgelYwomu	-	yY-o	-	He	mu	Them-m	Indicative	Base	gelewe
357	teqesYfu	te	-	u	They-m	-	-	Perfective	Reflexive	qesefe
358	mYHirY	-	-	-	-	-	-	Infinitive	Base	meShee
359	feqidY	-	-	-	-	-	-	Infinitive	Base	feqede
360	feteweta	-	-	tY	She	a	Her	Perfective	Base	fetewe
361	qeSeTYku	-	-	ku	I	-	-	Perfective	Base	qeSeTe
362	SeKeyetY	-	-	tY	She	-	-	Perfective	Base	SeKeye
363	yYdeGYxeni	-	yY-e	-	He	ni	Me	Indicative	Base	deGexe
364	teHemYyo	te	-	-	You-sm	o	Him	Indicative	Base	Hemeye
365	eWYbeyo	e	-	e	He	o	Him	Perfective	Reflexive	Webeye
366	SheiXY	-	-	-	-	-	-	Infinitve	Base	SheeXe
367	nesitY	-	-	-	-	-	-	Infinitve	Base	nesete
368	tYtYnaSeku	-	tYtY-u	-	You-pm	-	-	Indicative	Reciprocal	neSeke
369	itYtYHemeyu	i	tYtY-u	-	You-pm	-	-	Indicative	Reflexive	Hemeye
370	Weqeme	-	-	e	He	-	-	Perfective	Base	Weqeme
371	ebYTele	e	-	e	He	-	-	Perfective	Causative	beTele
372	tefaqYro	te	-	-	-	-	-	Infinitve	Reflexive	feqere
373	taQYrYru	-	ta-u	-	You-pm	-	-	Imperative	Reflexive	Qerere
374	Seelu	-	-	u	You-pm	-	-	Perfective	Base	Seele
375	feqedetomu	-	-	to	She	mu	Them-m	Perfective	Base	feqede
376	heyYdo	-	-	o	He	-	-	Gerundive	Base	heyede
377	telYYko	te	-	-	-	-	-	Infinitve	Reflexive	leee
378	yaSYteHamemYwa	-	yaSYte-Y	-	They-m	wa	Her	Indicative	Causative-Reciprocal	Hememe
379	Seela	-	-	a	They-f	-	-	Perfective	Base	Seele
380	SelebetY	-	-	tY	She	-	-	Perfective	Base	Selebe
381	SelibotY	-	-	-	-	-	-	Infinitve	Base	Selebe
382	teHezYlY	-	te-Y	-	You-sm	-	-	Indicative	Base	Hezele
383	itYtYhewelYwo	i	tYtY-Y	-	They-m	wo	Him	Indicative/Subjunctive/Jussive	Reflexive	hewele
384	ewYkeku	e	-	u	They-m	-	-	Perfective	Causative	wekee
385	Xerefe	-	-	e	He	-	-	Perfective	Base	Xerefe
386	teganeyahonY	te	-	a	They-f	honY	Them-f	Perfective	Reciprocal	geneye
387	iyaSYtedaGYxa	i	yaSYte-a	-	They-f	-	-	Indicative	Causative-Reciprocal	deGexe

No.	Verb	Prefix	Circumfix	SMS	Subject	OMS	Object	TenseMood	Stem	Lexeme
388	eSYtedaGixo	eSYte	-	-	-	-	-	Infinitive	Causative-Reciprocal	deGexe
389	teSedo	te	-	-	-	-	-	Infinitive	Reflexive	Sedede
390	iyYqYSYTu	i	yY-u	-	They-m	-	-	Subjunctive/Jussive	Base	qeSeTe
391	BeyeSe	-	-	e	He	-	-	Perfective	Base	BeyeSe
392	emYrere	e	-	e	He	-	-	Perfective	Causative	merere
393	emYrerYwo	e	-	Y	They-m	wo	Him	Perfective	Causative	merere
394	tewekefeto	te	-	tY	She	o	Him	Perfective	Reflexive	wekefe
395	telYWYlo	te	-	-	-	-	-	Infinitive	Reflexive	leWele
396	iyaleGYmo	i,ya	-	-	He	o	Him	Indicative	Causative	leGeme
397	SeHenu	-	-	u	They-m	-	-	Perfective	Base	SeHene
398	egYreromu	e	-	o	He	mu	Them-m	Perfective	Base	gerere
399	geeze	-	-	e	He	-	-	Perfective	Base	geeze
400	tYSewi	-	tY-u	-	She	-	-	Indicative	Base	Seweye
401	tYtYWexedY	-	tYtY-Y	-	You-2psm/ She	-	-	Indicative	Base	Wexede
402	tewarYSo	te	-	-	-	-	-	Infinitive	Reflexive	wereSe
403	reWeyu	-	-	u	They-m	-	-	Perfective	Base	reWeye
404	TYbebu	-	-	u	You-pm	-	-	Imperative	Base	Tebebe
405	eSYteHawezYwa	-	eSYte-Y	-	They-m	wa	Her	Perfective	Causative-Reciprocal	Heweze
406	teXefYru	te	-	u	They-m	-	-	Perfective	Causative	Xefere
407	WeXiwo	-	-	o	He	-	-	Gerundive	Base	WeXe
408	yYserYrY	-	yY-Y	-	He	-	-	Indicative	Base	serere
409	kesesYwo	-	-	Y	They-m	wo	Him	Perfective	Base	kesese
410	teTewYmetY	te	-	tY	She	-	-	Perfective	Reflexive	Teweme
411	yYnedYfY	-	yY-Y	-	He	-	-	Indicative	Base	nedefe
412	emYrereta	e	-	tY	She	a	Her	Perfective	Causative	merere
413	teXelYbe	te	-	e	He	-	-	Perfective	Reflexive	Xelebe
414	Serebeto	-	-	tY	She	o	Him	Perfective	Base	Serebe
415	yeBelYyu	-	ye-u	-	They-m	-	-	Indicative	Base	Beleye
416	WYxYdY	-	-	yY	You-pm	-	-	Imperative	Base	Wexede
417	WexedYkYnY	-	-	kYnY	You-pf	-	-	Perfective	Base	Wexede
418	keWewe	-	-	e	He	-	-	Perfective	Base	keWewe

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all sources of materials for the thesis have been duly acknowledged.

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Desta Berihu Weldegiorgis

This thesis has been submitted for examination with my approval as an advisor.

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