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Machine Transliteration for English to Amharic Proper Nouns

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ABSRACT
In the advent of modern technology machine transliteration has gained a center of attention for research. Both machine translation and transliteration are important for e-governance and web based online multilingual applications. Machine translation is the process of translating the source language to target language which results in wrong translation for proper nouns, technical terms and cultural specific words. Therefore, transliteration is the way of keeping correct translation for such type of case. Machine transliteration is the process of transcribing the source language script to the target language script by preserving the source language pronunciation. In this work, the main focus is the transliteration of English to Amharic proper nous. The proposed work follows the rule based approach of machine transliteration technique. Different challenges arise during the development of this work, such as the repetitive nature of Amharic scripts, one to multi mapping, multi to one mapping, character gap and the creation of wrong word due to different rules. Solutions for such problems and appropriate algorithm have been developed. The result is evaluated using precision and it shows that 90.08% of the input proper nouns are correctly transliterated.

Keywords: - Machine transliteration, Rule based approach, Grapheme Based Model, Phoneme Based Model, Tokenization.

I. INTRODUCTION

Ethiopia is [10] a multilingual country with over 85 different languages and having more than 200 different dialects spoken having largest ethnic and linguistic groups of the Oromos, Amharas and Tigrayans with Amharic language as official language of the country. Amharic language has its own writing system which is the version of Geez, is called Ethiopic script or fidel. Currently, the language's writing system is non-unicode environment that has 34 base character with their 6 tabular column forms called ranges, orders or sometimes called family. Now a day it true that English is the most important and universal language. The globalization has come up with the use of languages using computer system. Machine transliteration is one of the application areas of natural language processing that investigates the use of computer software to transliterate text from one natural language to another natural language script. Machine transliteration helps to translate out of vocabulary words, such as proper nouns, cultural specific words and technical terms by preserving their pronunciation.

II. DETAIL STUDY OF THE PROBLEM AND LITERATURE REVIEW

A. LITERATURE REVIEW

This work is the first attempt for the development of transliteration system between the English and Amharic languages. Due to this reason, there are no related works that have been done between these language pairs. But different research works that have been done on machine transliteration is reviewed and included on this paper. **Lehal et al.** [1] have presented Sahmukhi to Gurmukhi Machine Transliteration System has been presented which is a highly accurate transliteration system between the target and source language scripts. The paper discusses the important issues in Gurmukhi to Shahmukhi transliteration with statistical results. **Singhal and Tyagi** [2] propose a named entity transliteration as utmost requirement for machine translation purpose. There is no specific rule developed for the conversion of Hindi akshra to English syllable up to this work has been done. The developers use a hybrid approach transliteration technique. **G. Abbas Malik** [3] has developed Punjabi Machine Transliteration System which uses transliteration rules (character mappings and dependency rules) for transliteration of Shahmukhi words into Gurmukhi. **Vijaya et al**. [4] have

developed Rule based system for English to Tamil Transliteration system and named it WEKA. They have demonstrated a transliteration model based on multi class classification approach. **Kamaljeet and Parminder** [5] have conducted a system which transliterate Hindi words are into Punjabi words. Hindi and Punjabi are closely related languages and hence it is comparatively easy to develop than the system between very different language pairs like Hindi and English. This system is openly available for online use. **Kaur et al**. [6] have designed and developed Hindi to English Transliteration System which focuses on the transliteration of proper nouns Hindi proper nouns written on Devangari script to English proper nouns written on Roman script. The performance is sufficiently high and used in various government offices in India. **Chang et al**. [12] have designed web based learning method English for Chines. In the approach they have used, proper nouns are expanded into new queries aimed at maximizing the probability of retrieving transliterations from existing search engines. **Jung et al**. [13] developed English to Korean transliteration using Extended Markov Window Model. The model is designed to exploit various information sources by extending a conventional Markov window. They have described an alignment and syllabification of pronunciation units instead of a statistical method proposed for accurate and fast operation. **David Matthews** [14] has designed and developed machine transliteration of proper names between English-Chinese and Arabic-English. They have designed separate transliteration and target side language models and combined them during decoding to find the most likely transliteration.

B. AMHARIC WRITING SYSTEM

Amharic (አማርኛ) is a Semitic Language of the Afro-Asiatic language group that is related to Arabic, Hebrew, and Syrian [7]. Amharic language has its own writing system which is the version of Geez, is called Ethiopic script or fidel. The language has about 310 characters including base characters, labialized characters, punctuation marks, and numbering systems of the language. Currently, there are 34 base characters with their 6-tabular form called ranges or families and around forty labialized characters. As noted on [8] however, the language has its own numbering system due to the complexity of mathematical computation on the absence of decimal representation and the symbols for zero Arabic numbers are used for calculation. The writing system has 8 its own punctuation marks. The following are Amharic base characters

ሀ	ሁ	ሂ	ሃ	ሄ	ህ	ሆ
ለ	ሉ	ሊ	ላ	ሌ	ል	ሎ
ሐ	ሑ	ሒ	ሓ	ሔ	ሕ	ሖ
መ	ሙ	ሚ	ማ	ሜ	ም	ሞ
ሠ	ሡ	ሢ	ሣ	ሤ	ሥ	ሦ
ረ	ሩ	ሪ	ራ	ሬ	ር	ሮ
ሰ	ሱ	ሲ	ሳ	ሴ	ስ	ሶ
ሸ	ሹ	ሺ	ሻ	ሼ	ሽ	ሾ
ቀ	ቁ	ቂ	ቃ	ቄ	ቅ	ቆ
በ	ቡ	ቢ	ባ	ቤ	ብ	ቦ
ተ	ቱ	ቲ	ታ	ቴ	ት	ቶ
ቸ	ቹ	ቺ	ቻ	ቼ	ች	ቾ
ኀ	ኁ	ኂ	ኃ	ኄ	ኅ	ኆ
ነ	ኑ	ኒ	ና	ኔ	ን	ኖ
ኘ	ኙ	ኚ	ኛ	ኜ	ኝ	ኞ
አ	ኡ	ኢ	ኣ	ኤ	እ	ኦ
ከ	ኩ	ኪ	ካ	ኬ	ክ	ኮ

idels

ኸ	ኹ	ኺ	ኻ	ኼ	ኽ	ኾ
ወ	ዉ	ዊ	ዋ	ዌ	ው	ዎ
ዐ	ዑ	ዒ	ዓ	ዔ	ዕ	ዖ
ዘ	ዙ	ዚ	ዛ	ዜ	ዝ	ዞ
ዠ	ዡ	ዢ	ዣ	ዤ	ዥ	ዦ
የ	ዩ	ዪ	ያ	ዬ	ይ	ዮ
ደ	ዱ	ዲ	ዳ	ዴ	ድ	ዶ
ጀ	ጁ	ጂ	ጃ	ጄ	ጅ	ጆ
ገ	ጉ	ጊ	ጋ	ጌ	ግ	ጎ
ጠ	ጡ	ጢ	ጣ	ጤ	ጥ	ጦ
ጨ	ጩ	ጪ	ጫ	ጬ	ጭ	ጮ
ጰ	ጱ	ጲ	ጳ	ጴ	ጵ	ጶ
ጸ	ጹ	ጺ	ጻ	ጼ	ጽ	ጾ
ፀ	ፁ	ፂ	ፃ	ፄ	ፅ	ፆ
ፈ	ፉ	ፊ	ፋ	ፌ	ፍ	ፎ
ፐ	ፑ	ፒ	ፓ	ፔ	ፕ	ፖ
ቨ	ቩ	ቪ	ቫ	ቬ	ቭ	ቮ

C. ENGLISH SCRIPT

According to [11], English is a West Germanic language related to Scots, Dutch, Frisian and German having with a significant amount of vocabulary from Norman French, Old Norse, Latin and Greek, and loanwords from many

other languages. It is known that there is no doubt that today English is an extremely popular international language in the world both on the way of writing and speaking. The language has writing system called Roman Script. It has a total of 26 letters, which are 5 vowels and 21consonants. Unlike Amharic script, called Ethiopic or Fidel, English writing system has upper case and lower case distinction. Here for each of 26 English letters they have upper case and lower case symbols. In addition to this, English writing system does not have the problem of repetitive characters having same sound with different symbol. The following are English consonants and vowels representations respectively.

B C D F G H J K L M N

P Q R S T V W X Y Z

and A E I O U

D. CHARACTER MAPPING OF AMHARIC AND ENGLISH SCRIPT

In the previous topics, writing system for both English and Amharic languages have been discussed in detail. In this section, the mappings of these two writing systems characters were discussed. Amharic characters are mapped with English characters on basis of their sound, for example to represent the family or order of ሀ (ha) it takes the sound of h in English with preceding of vowels as sound indicator. For example, **ha** for ሀ, **hu** for ሁ, **hi** for ሂ etc.

During the mapping of each of the families of Amharic fidels to English characters the first and fifth order, the third and sixth order of the Amharic script has same mapping characters of English language. It causes the problem of one to multi mapping which is a bit difficult task of machine transliteration. The problem of multi mapping is not occurred in the same family only; it also has the same English mapping character for different Amharic character family like ፀ and ሐ. Therefore, in each case only the native speaker of Amharic language knows the correct word formation. For non-native speakers, some of Amharic fidels are difficult to pronounce. The following table shows mapping between English and Amharic base characters.

Table 1 Mapping of Amharic and English Characters

		E	U	I	A	e	i	O
1	L	□	□	□	□	□	□	□
2	M	□	□	□	□	□	□	□
3	S	□	□	□	□	□	□	□
4	R	□	□	□	□	□	□	□
5	S	□	□	□	□	□	□	□
6	SH	□	□	□	□	□	□	□
7	K	□	□	□	□	□	□	□
8	B	□	□	□	□	□	□	□
9	T	□	□	□	□	□	□	□
10	CH	□	□	□	□	□	□	□
11	N	□	□	□	□	□	□	□
12	GN	□	□	□	□	□	□	□
13		□	□	□	□	□	□	□
14	K	□	□	□	□	□	□	□
15	H	□	□	□	□	□	□	□
16	W	□	□	□	□	□	□	□
17		□	□	□	□	□	□	□
18	Z	□	□	□	□	□	□	□
19	ZH	□	□	□	□	□	□	□
20	Y	□	□	□	□	□	□	□
21	D	□	□	□	□	□	□	□
22	J	□	□	□	□	□	□	□
23	G	□	□	□	□	□	□	□
24	T	□	□	□	□	□	□	□
25	CH	□	□	□	□	□	□	□
26	P	□	□	□	□	□	□	□
27	TS	□	□	□	□	□	□	□
28	TS	□	□	□	□	□	□	□
29	F	□	□	□	□	□	□	□
30	P	□	□	□	□	□	□	□
31	V	□	□	□	□	□	□	□

Amharic fidels ሀ, ሐ and ኀ all take the base sound H and E as sound indicator for the first order and for the other six families of these fidels it the same as the above table format.

III. METHODOLOGY OF THE STUDY AND CHALLENGED FACED

A. METHODOLOGY OF THE STUDY

The choice of the transliteration techniques depends on the availability of resources such as parallel corpus, knowledge base which consists of the transliterated text of the source and target languages, the relationship of the languages. Between these two source and target languages there is no such resources available. Therefore, Rule Based approach

is proposed for the development of this work. A rule based machine transliteration system consists of collection of rules called grammar rules, lexicon and software programs to process the rules. However, RBA has its own disadvantages such as time consuming, needs large number of rules to get good result it also has its advantage. In RBA if the rules are created properly it gives good result. On the basis of the source and target language rules has been created. Mainly the following basic rules are created. In this work about more than 60 rules are created.

1. *Rules of vowel at the first position or after another vowel*

If any English vowels appear at the first position, it will be mapped with equivalent Amharic vowels. Eg **A**bebe= **አ**በበ and Amanu**el** አ**ኤ**ማኑ**ኤ**ል

2. *Rules for consonants at any position*

If any English consonant follows vowels E, U, I, A and O, then it will map with equivalent 1st or 5th, 2nd, 4th, 3rd or 6th and 7th order of Amharic fidels.

3. *Rules for handling combination of C and H*

a) If English characters C and H appears consecutively and if H is at the end or if the third character is a consonant, then it will be mapped with as single Amharic character ች or ቼ eg Beletech = በለጠች
b) If English characters C and H appear consecutively and if the third character is u then it will be mapped with as single Amharic character ቹ or ጩ. Eg chuchu =ቹቹ
c) If English characters C and H appear consecutively and if the third character is **i** then it will be mapped with as single Amharic character ቺ or ጪ.
d) If English characters C and H appears consecutively and if the third character is **a** then it will be mapped with as single Amharic character ቻ or ቻ. Eg Achamelesh = አቻመለሽ
e) If English characters C and H appear consecutively and if the third character is **e** then it will be mapped with as single Amharic character ቸ, ጨ, ቼ or ጬ. Eg Chernet =ቸርነት
f) If English characters C and H appear consecutively and if the third character is **e** then it will be mapped with as single Amharic character ቾ or ቿ.

4. *Rules for the combinations S and H*

a) If English characters S and H appear consecutively and if H is at the end or if the third character is a consonant, then it will be mapped with as single Amharic character ሽ. Eg Asmelash =አስመላሽ
b) If English characters S and H appear consecutively and third character is **u** then it will be mapped with as single Amharic character ሹ. Eg Shumet= ሹመት
c) If English characters S and H appear consecutively and third character is **i** then it will be mapped with as single Amharic character ሺ or ሽ. Eg Sileshi = ስለሺ
d) If English characters S and H appears consecutively and third character is **a** then it will be mapped with as single Amharic character ሻ. Eg Ashagre = አሻግሬ
e) If English characters S and H appear consecutively and third character is **e** then it will be mapped with as single Amharic character ሸ or ሼ. Eg Shemsu = ሸምሱ
f) If English characters S and H appear consecutively and third character is **o** then it will be mapped with as single Amharic character ሾ.

5. *Rules for combination of T and S*

a) If English characters T and S appear consecutively and if S is at the end or if the third character is a consonant, then it will be mapped with as single Amharic character ፅ.
Eg Bekretsyon = በክርፅዮን
b) If English characters T and S appear consecutively and third character is **u** then it will be mapped with as single Amharic character ፁ.
c) If English characters T and S appears consecutively and third character is **a** then it will be mapped with as single Amharic character ፃ. Eg Gebretsadik = ገብረፃዲቅ
d) If English characters T and S appear consecutively and third character is **i** then it will be mapped with as single Amharic character ፂ or ፅ. Eg Tsinat = ፅናት
e) If English characters T and S appear consecutively and third character is **e** then it will be mapped with as single Amharic character ፀ or ፄ. Eg Tsebelu =ፀበሉ

f) If English characters T and S appear consecutively and third character is **o** then it will be mapped with as single Amharic character ፆ.

6. Rules for combinations G and N

a) If English characters G and N appear consecutively and if N is at the end or if the third character is a consonant, then it will be mapped with as single Amharic character ኘ.

b) If English characters G and N appear consecutively and third character is **u** then it will be mapped with as single Amharic character ኙ. Eg Yimegnushal = ይመኙሻል

c) If English characters G and N appears consecutively and third character is **a** then it will be mapped with as single Amharic character ኛ. Eg Adugna = አዱኛ

d) If English characters G and N appear consecutively and third character is **i** then it will be mapped with as single Amharic character ኚ or ኝ. Eg Tarekegn =ታረቀኝ

e) If English characters G and N appear consecutively and third character is **e** then it will be mapped with as single Amharic character ኘ or ኜ. Eg Agengehu = አገኘሁ

f) If English characters G and N appear consecutively and third character is **o** then it will be mapped with as single Amharic character ኞ.

7. Rules for combination of P and H

If English characters P and H appears consecutively and if H is at the end or the third character is a consonant, then it will be mapped with as single Amharic character ፍ. The other families of these Amharic fidels depend on the third position vowel and rule 2 will be applied. Eg Philimon = ፊሊሞን

8. Rules for combination of Z and H

If English characters S and H appears consecutively and if H is at the end or the third character is a consonant, then it will be mapped with as single Amharic character ሯ. The other families of these Amharic fidels depend on the third position vowel and rule 2 will be applied.

9. Rules for double occurrences

Some characters like D, M, S, M, L and R will happen in double in some proper nouns. For such characters rules are applied to consider as single character. E.g. **Assefa, Addis Abeba**

10. Rules of ia and io

a) If characters **i** and **a** appears consecutively, then both characters should be mapped with Amharic character ያ, instead of mapping one by one. Eg Soma**lia**= ሶማሊያ

b) If characters **i** and **o** appears consecutively, then both characters should be mapped with Amharic character ዮ, instead of mapping one by one. Eg Eth**io**pia = ኢትዮጵያ

11. Rules for missing sounds

Sometimes characters are missed or omitted during pronunciation eg in "Modjo" 'd' is missing and read as **"ሞጆ"**, rules are contracted for such type of missing sounds.

12. Rules for characters which have no Amharic equivalents.

Characters like C and Q have no mapped Amharic characters Therefore, mostly used Amharic graphemes are mapped for such type characters. Here C is mapped as base character of ከ and Q as ቀ and families of these characters are applied as rule 2.

Eg Moroco = ሞሮኮ, Debarq = ደባርቅ

13. Rules for Labialized Amharic characters

If consonants H, L, M, R, S, K, B, N, T, D, J, G, P etc follows W or U and the third character is either consonant or vowels, then all together mapped with its equivalent Amharic labialized fidels. Eg **lwa** is mapped with ሏ. These Amharic characters are used rarely. Eg Para**gua**y = ፓራጓይ

B. CHALLENGES FACED AND ITS RESOLUTION

There are many challenges in English to Amharic transliterations, some of which are given below.

Repetitive Amharic characters: - Amharic writing system has a problem of repetitive characters. In Amharic writing system one word can be written with different character symbol with same meaning. For example, the word "Tsehay" can be written as ፀሀይ or ጸሀይ etc. But these two words carry same meaning with different Amharic symbols. These repetitive characters are used interchangeably.

Table 2 Amharic Repetitive Characters

1	2	3	4	5	6	7
ሀ ሐ ኀ	ሁ ሑ ኂ	ሂ ሒ ኂ	ሃ ሓ ኃ	ሄ ሔ ኄ	ህ ሕ ኅ	ሆ ሖ ኆ
ሰ ሠ	ሱ ሡ	ሲ ሢ	ሳ ሣ	ሴ ሤ	ስ ሥ	ሶ ሦ
አ ዐ	ኡ ዑ	ኢ ዒ	ኣ ዓ	ኤ ዔ	እ ዕ	ኦ ዖ
ፀ ጸ	ፁ ጹ	ፂ ጺ	ፃ ጻ	ፄ ጼ	ፅ ጽ	ፆ ጾ

Therefore, instead of using all these repetitive characters normalization has been done to the most standard used character among them. Accordingly, all families of **ሐ** and **ኀ** are normalized to the respective families of **ሀ**.

One –to- Multi Mapping: - This problem is the main difficult task in English to Amharic transliteration; more than one character has a single English mapping character. This problem occurs not only on different families of Amharic character, the problem occurs on the same family with different order or range. For example, ጠ and ተ are represented in a single English character mapping "Te". The first and forth order, sometimes the third and sixth order of all Amharic have the same mapping English character with the respective families. Here only the native speakers can identify the correct transliteration. The following table shows the problems one to multi problem between the languages.

Table 3 Amharic to English Multi Mapping Characters

	English Mapping Character	Amharic Equivalent of English Character
1	Te	ጠ, ተ, ቴ, ጤ
2	Che	ቸ, ቼ, ቼ, ቼ
3	Ke	ቀ, ከ, ቄ, ኬ
4	Pe	ጰ, ፐ, ጴ, ፔ

One to Multi mapping problem has been solved by storing these mapping equivalents in different tables and algorithm has been developed for the transliteration. Alternatives are suggested as output, so that only native speakers know the correct transliteration.

Double occurrence: - There are certain English characters whose double occurrences are used as single representation of that alphabet. For example, in "Addis Abeba" the occurrence of double '**d**' represents the same mapping character with that of single '**d**'. Therefore, when certain characters with double occurrence are used it should not affect the transliteration. This causes the transliteration makes a bit difficult. For example, A**ss**efa, Ji**mm**a, A**dd**is Abeba, here ss, mm and dd are doubled but mapped as single s, m and d and mapping has been done based on the rules mentioned above.

Wrong Word Creation Due to Rules: - This problem occurs when certain rules are created to handle the transliteration process and such rules may cause wrong solution for other words. For example, in the word "Germany" Ge sound as J, so if such rule is handle it causes wrong transliterations for other words like Geremew, Gemeda, Gebeyehu etc.

IV. EVALUATION AND RESULT

The transliteration system is evaluated with different real life proper noun domains, such as personal names,

locations, all Ethiopian Commercial Bank branch names, rivers, organization names, cities, world countries along with their currency measurements. During evaluation, the system has been evaluated by Amharic native speaker and English fluent speakers. The accuracy rate is calculated by using the following formula.

Accuracy Rate (Precision) = $\frac{\text{Total Correct Transliterated}}{\text{Total input given to transliterate}}$ X 100%

=90.08%

The system has been evaluated for both single word proper nouns and more than one word proper nouns.

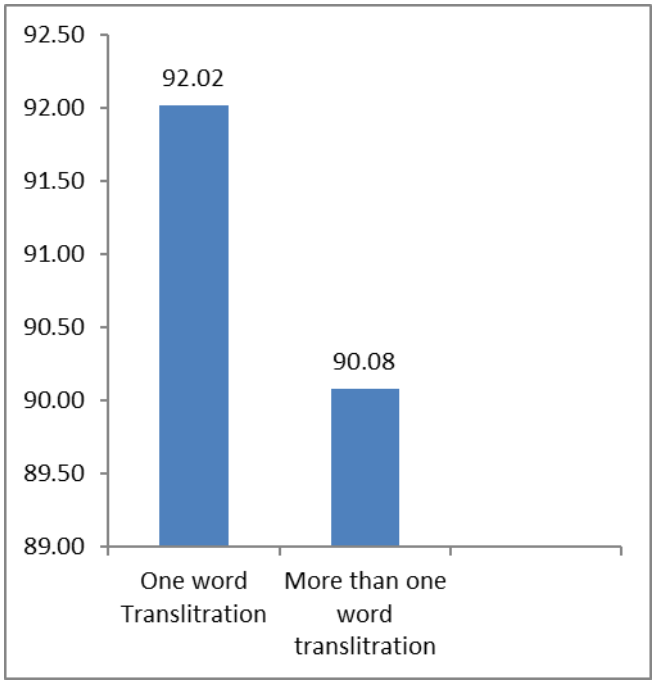

Figure 2 Transliteration Accuracy Rate

From the evaluation of the transliteration, cases for failures have been identified. All most all rules created give the desired results. Rules listed on rule number 10 did not work at all, it gives wrong transliteration. The rules G and N (rule 6) also contradicts when separate mapping of G and N is necessary, for example, Degnet should be transliterated as ደግነት but the system gives ደኘት by applying rule 6.

V. CONCLUSION

In this work, the transliteration of proper nouns from English to Amharic has been done following rule based approach. As the first work between the languages, the result is quite good. The work has been evaluated with different domain entities such as personal names, locations, organization names, country names and cites and different countries currency measurement. The bit difficult work between the source and target language is the nature of one to multi mapping problem. An algorithm has been developed for this problem which show an alternative output for such cases. Only native speakers will know the correct transliteration between the suggested alternatives. The accuracy is not as good as a single word transliteration when the number of words increases with in the given text. So that, in future work we have planned to explore this limitation.

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