

Formation of Word Dictionary of Bangla Vowel Ended Roots for First Person for Universal Networking Language

Md. Nawab Yousuf Ali¹, Golam Sorwar², and Md. Shamsujjoha¹

¹Computer Science & Engineering Dept., East West University, Dhaka, Bangladesh

²School of Business and Tourism, Southern Cross University, NSW, Australia

Email: nawab@ewubd.edu, golam.sorwar@scu.edu.au, dishacse@yahoo.com

Abstract - *Interlingua approach plays a vital role in designing a multilingual machine translation system. The Universal Networking Language (UNL) is an international project with an aim to create an interlingua. The motivation behind UNL is to develop an interlingua representation as to semantically equivalent sentences of all languages can have the same interlingua representation. The word dictionary plays an important role to represent native language words in UNL. This paper develops format for word dictionary of Bangla Vowel Ended roots to be incorporated into UNL. The proposed entries are to be used to combine with their inflexions to produce verbs, and hence these verbs can be used for conversion of native language sentences into the UNL expressions. This paper provides the format of vowel ended roots along with their alternatives based on the framework of UNL provided by the UNL center of the Universal Networking Digital Language (UNDL) Foundation.*

Keywords: Dictionary, UNL, Universal Words, Vowel

1 Introduction

The UNL project is a large scale international cooperation with a goal to providing information on the Internet in all national languages of the members of the United Nations [1]. Under this project, a tool, called Enconverter [2], converts each native language sentence into a UNL expression; another tool, called Deconverter [3], translates UNL expression to any native language. The development of language specific components such as dictionary and analysis rules, is carried out by researchers across the world. Dictionary plays a vital role in conversion processes by presenting native languages' words in UNL formats. This paper addresses the following key points associated with the development of format of word dictionary for Bangla vowel ended roots:

- analysis of Bangla vowel ended roots (VER)
- grouping them into categories how verbal inflexions are added with them to form verbs
- finding the alternative roots of the VERs
- outlining the format of VERs, and
- development of dictionary entries of VERs

The rest of the paper is organized as follows. Section 2 describes the structure of UNL. Format of word dictionary of UNL is explained in Section 3. Analysis of Bangla vowel ended roots (VER) is presented in Section 4. This section explains all categorizations of roots with alternative roots of the VERs. In Section 5, we explain the dictionary format of Bangla vowel ended roots and developed dictionary entries of all the VERs along with their attributes. Finally, Section 6 summarizes the paper with some future research plan.

2 Universal Networking Language

The UNL [4] has been defined as a digital meta-language for describing, summarizing, refining, storing, and disseminating information in a machine independent and human language neutral form. It represents information, i.e. meaning, sentence by sentence. Each sentence is represented as a hypergraph, where nodes represent concepts with arcs relationship between the concepts. This hypergraph is also represented as a set of directed binary relations between the pair of concepts present in a sentence. Concepts are represented as character-strings called Universal Words (UWs). Knowledge within a UNL document is expressed in the following three dimensions [4].

2.1 Universal Words (UWs)

Word knowledge is expressed by Universal Words which are language independent. UWs constitute the UNL vocabulary and the syntactic and semantic units which are combined according to the UNL laws in forming UNL expressions. They are tagged using restrictions describing the sense of the word in a current context. For example, *drink(icl>liquor)* denotes the noun sense of drink restricting the sense to a type of liquor. Here icl stands for inclusion and forms an is-a relation as in semantic nets [1].

2.2 Relation Labels (RL)

Conceptual knowledge is captured by the relationship between Universal Words (UWs) through a set of UNL relations. For example, *Human affects the environment* is described in the UNL expression as:

{unl}

```

agt
(affect(icl>do).@present.@entry:01,human(icl>animal).@pl)
obj(affect(icl>do).@present.@entry:01,environment
(icl>abstract
thing).@pl)
{/unl}

```

where, *agt* and *obj* mean the agent and object respectively. The terms *affect(icl>do)*, *human(icl>animal)* and *environmen(icl>abs-tract thing)* are the UWs denoting concepts.

2.3 Attribute Labels (AL)

Speaker's view, aspect, time of event, etc. are captured by UNL attributes. For instance, in the above example, the attribute *@entry* denotes the main predicate of the sentence, *@present* denotes the present tense, *@pl* is for the plural number and *:01* represents the scope ID. A UNL expression can also be represented as a graph. For example, the UNL expressions and the UNL graph for the sentence, *I went to Malaysia from Bangladesh by aeroplane to attend a conference*, are shown in Fig 1. In the Fig. 1(a), *agt* denotes the agent relation, *obj* the object relation, *plt* the place relation denoting the place to go, *plf* is also a place relation that denotes the place from, *pur* states the purpose relation, whereas *met* is for method relation. UNL expressions provide the *meaning content* of the text. Hence, search could be carried out on the meaning rather than on the text. This, of course, means developing a novel kind of search engine technology. The merit of such a system is that the information in one language can be stored in multiple languages.

```

{/unl}
agt(go (icl>move>do,plt>place,plf>place, agt>thing).
.@entry.@past,
i(icl>person))
plt(go (icl>move>do, plt>place, plf>place, agt>thing)
.@entry.@past,
Malaysia (iof>asian_country>thing)) plf(go (icl>move>do,
plt>place, plf>place,
agt>thing) .@entry.@past, Bangladesh (iof> asian_country>
thing))
met(go (icl>move>do, plt>place, plf>place, agt>thing)
.@entry .@past,
aeroplane (icl> heavier-than-air_ craft>thing, equ> airplane))
obj:01 (attend (icl>go_to>do, agt>person, obj>place) .@entry,
conference (icl>meeting>thing) .@indef pur(go
(icl>move>do, plt>place,
plf>place,
agt>thing) .@entry .@past, :01)
{/unl}

```

Fig. 1(a): UNL expression of the sentence.

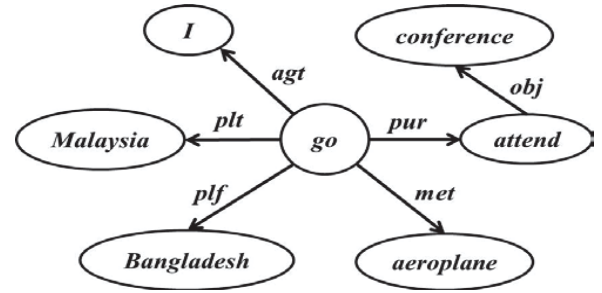


Fig. 1(b): UNL graph of the sentence.

3 Word Dictionary

A Word Dictionary is a collection of word dictionary entries. Each entry of a Word Dictionary is composed of three kinds of elements: the *Headword (HW)*, the *Universal Word (UW)*, and the *Grammatical Attribute (GA)*. A Headword (*HW*) is a notation/surface of a word of a natural language composing the input sentence and is to be used as a trigger for obtaining equivalent UWs from the Word Dictionary in EnConversion. An UW expresses the meaning of the word and is to be used in creating UNL networks (UNL expressions) of output. GAs are the information on how the word behaves in a sentence and they are to be used in enconversion rules. Each Dictionary entry has the following format of any native language word [5, 6].

Data Format:

[HW]{ID}"UW"(Attribute1, Attribute2,...)<FLG, FRE, PRI> Here,

HW ← Head Word (Bangla word)

ID ← Identification of Head Word (omitable)

UW ← Universal Word

ATTRIBUTE ← Attribute of the HW

FLG ← Language Flag

FRE ← Frequency of Head Word

PRI ← Priority of Head Word

Elements of Bangla-UNL Dictionary format are shown in Fig. 2.

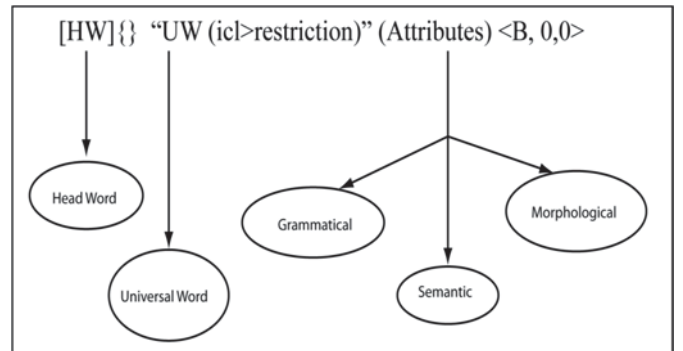


Fig. 2: Format of a Bangla Word Dictionary.

Table 1: Variations of Vowel Ended Roots and their Verbal Inflexions of VEG1 to VEG4 for First Person.

	Tenses	পা (pa)	খা (kha)	গা (ga)	চা (cha)	ছা (ccha)	নি (ni)	দি (ni)	যা (ja)
Present	Pres. Indef.		ই	ই	ই	ই	ই	ই	ই
	Pres. Cont.	ছি	ছি	ছি	ছি	ছি	ছি	ছি	ছি
	Pres. Perf.	পা>পে য়েছি	খা>খে য়েছি	গা>গে য়েছি	চা>চে য়েছি	ছা>ছে য়েছি	য়েছি	য়েছি	যা>গি য়েছি
Past	Past Indef.	পা>পে লাম	খা>খে লাম	গা>গাই লাম	চা>চাই লাম	ছা>ছাই লাম	লাম	লাম	যা>গে লাম
	Past Habit.	পা>পে তাম	খা>খে তাম	গা>গাই তাম	চা>চাই তাম	ছা>ছাই তাম	তাম	তাম	যা>যে তাম
	Past Cont.	ছিলাম	ছিলাম	ছিলাম	ছিলাম	ছিলাম	ছিলাম	ছিলাম	ছিলাম
	Past Perfect	পা>পে য়েছিলাম	খা>খে য়েছিলাম	গা>গে য়েছিলাম	চা>চে য়েছিলাম	ছা>ছে য়েছিলাম	য়েছিলাম	য়েছিলাম	যা>গি য়েছিলাম
Future	Fut. Indef.	বো, ব	বো, ব	বো, ব	বো, ব	বো, ব	বো, ব	বো, ব	বো, ব
		VEG1		VEG2		VEG3		VEG4	

Some examples of dictionary entries of Bangla language are as follows:

[আপনাকে]{} “you(icl>person)” (PRON, HPRON, HON,SG,P2)

[আপনাদি গকে]{} “you(icl>person)” (PRON,HPRON,HON,PL,P2,,SHD)

[ওরা]{} “they(icl>person)” (PRON, HPRON, PL,GEN, P3,CHL)

[তারা]{} “they(icl>person)” (PRON, HPRON, PL,HON, P3, CHL)

[তুই]{} “you(icl>person)” (PRON, HPRON, SG,NEG, P2)

where, attributes PRON for pronoun, HPRON for human pronoun, GEN for general, NEG for neglect, HON for respect, SG for singular, PL for plural, CHL for conversation language, SHD for literature language, P1 for first person, P2 for second person and P3 for third person respectively.

4 Analysis of Bangla Vowel Ended Roots

For appropriate morphological analysis and design verb root templates, verb roots have been divided into two broad categories: Vowel Ended Group (VEG) and Consonant Ended Group (CEG), according to tenses and persons. Each of them is again divided into sub-groups. Our paper focuses on only vowel ended groups. In Bangla language, 25 vowel ended roots have been found so far [7-10]. After analyzing these roots we have categorized them into 10 groups based on how verbal inflexions are added with them to form verbs. During this categorization, we have considered the behavior of verbal inflexions with first person and tenses (present, past and future). For example: আমি বিশ্ববিদ্যালয়ে যাই, *aami*

bishabiddaloye jai means “I go to university”. Here, verb is ‘যাই’, *jai*. In this verb, root ‘যা’ is a vowel ended root and ‘ই’ is verbal inflexion. If we write the sentence in present continuous form, we get, আমি বিশ্ববিদ্যালয়ে যাচ্ছি, *aami bishabiddaloye jachhi* means “I am going to university”. Although the root is the same as previous sentence but due to a change in tense, the verbal inflexion of the verb is ‘ছি’. Whereas, the present perfect form of this sentence is, আমি বিশ্ববিদ্যালয়ে গিয়েছি, *Ammi bishabiddaloye giechhi* means “I have gone to university”. In this sentence, the original root ‘যা’ is changing its form to ‘গি’, *gi* for making verb গিয়েছি, ‘*giechhi*’, where য়েছি, ‘*echhi*’ is the verbal inflexion. Similar changes have been observed in different roots for different tenses. Tables 1, 2, and 3 present the subgroups of VEG1, VEG2, VEG3, VEG4, VEG5, VEG6, VEG7, VEG8, VEG9, VEG10 and VEG11 along with their inflexions respectively. The tables show the roots with their corresponding tenses for first person. In Table 1, roots পা (pa) and খা (kha) fall into VEG1. They do not change in present indefinite, present continuous, past continuous and future indefinite tenses. But they change themselves from পা (pa) to পে (pe) and খা (kha) to খে (khe) in other tenses. Similarly, roots গা (ga), চা (che), and ছা (chha) in VEG2 are changed to গে (ge), চে (che), and ছে (chhe) in present perfect and past perfect tenses respectively. Roots নি (ni), and দি (di) of VEG3 remain unchanged in all tenses, whereas root যা (ja) in VEG4 is changed to গি (gi) in present perfect and past perfect tenses, গে (ge) in past indefinite and যে (je) in past habitual tenses respectively.

Table 2: Variations of Vowel Ended Roots and their Verbal Inflexions of VEG5 to VEG8 for First Person.

	Tenses	Vowel Ended Roots								
		ছুঁ (chhu)	থু (thu)	শু (shu)	ধু (dhu)	ন (no)	দু (du)	নু (nu)	রু (ru)	ল (lo)
Present	Pres. Indef.	ই	ই	ই	ই	ই	ই	ই	ই	ই
	Pres. Cont.	ছি	ছি	ছি	ছি		ছি	ছি	ছি	ছি
	Pres. Perf.	য়েছি	য়েছি	য়েছি	য়েছি		য়েছি	য়েছি	য়েছি	য়েছি
Past	Past Indef.	লাম	লাম	লাম	লাম		লাম	লাম	লাম	লাম
	Past Cont.	ছিলাম	ছিলাম	ছিলাম	ছিলাম		ছিলাম	ছিলাম	ছিলাম	ছিলাম
	Past Perfect	য়েছিলাম	য়েছিলাম	য়েছিলাম	য়েছিলাম		য়েছিলাম	য়েছিলাম	য়েছিলাম	য়েছিলাম
Future	Fut. Indef.	ব	ব	ব	বো, ব		বো, ব	বো, ব	বো, ব	বো, ব
		VEG5				VEG6	VEG7			VEG8

Table 3: Variations of Vowel Ended Roots and their Verbal Inflexions of VEG9 to VEG11 for First Person.

	Tenses	Vowel Ended Roots						
		হ (ha)	ধা (dha)	না (na)	বা (ba)	ক (ko)	ব (bo)	র (ro)
Present	Pres Indef.	ই	ই	ই	ই	ই	ই	ই
	Pres Cont.	ছি	ছি	ছি	ছি	ছি	ছি	ছি
	Present Perfect	য়েছি	ধা>ধে য়েছি	না>নে য়েছি	বা>বে য়েছি	য়েছি	য়েছি	য়েছি
Past	Past Indefinite	লাম	ধা>ধাই লাম	না>নাই লাম	বা>বাই লাম	ক>কই লাম	ব>বই লাম	র>রাম
	Past Habitual	তাম	ধা>ধাই তাম	না>নাই তাম	বা>বাই তাম	ক>কই তাম	ব>বই তাম	র>রই তাম
	Past Cont.	ছিলাম	ছিলাম	ছিলাম	ছিলাম	ছিলাম	ছিলাম	ছিলাম
	Past Perfect	য়েছিলাম	ধা>ধে য়েছিলাম	না>নে য়েছিলাম	বা>বে য়েছিলাম	য়েছিলাম	য়েছিলাম	য়েছিলাম
Future	Fut. Indef.	ব	ব	ব	ব	বো, ব	বো, ব	বো, ব
		VEG9	VEG10			VEG11		

In Table 2, roots ছুঁ (chhu), থু (thu), শু (shu), ধু (dhu), ন (no), দু (du), নু (nu), রু (ru) and ল (lo) of VEG5, VEG6, VEG7 and VEG8 remain unchanged in all tenses. In Table 3, roots ধা (dha), না (na) and বা (ba) in VEG10 are changing to ধে (dhe), নে (ne) and বে (be) in present perfect and past perfect tenses and to ধাই (dhai), নাই (nai) and বাই (bai) in past indefinite and past habitual tenses respectively. And roots ক (ko), ব (bo), র (ro) and ল (lo) in VEG11 change themselves to কই (koi), বই (boi), রই (roi) and লই (loi) in past indefinite and past habitual tenses respectively.

5 Development of Format for Word Dictionary of Bangla Vowel Ended Roots

After detailed analysis of the Bangla vowel ended roots, following template has been developed based on the format in Section 3. We have also meticulously considered the different roots and their alternatives along with their inflexions in the Tables 1, 2 and 3 for generating templates. [HW]{}“UW(icl/iof...>concept1>concept2...,REL1>...,REL2>...,” (ROOT, VEND, DEF/ [ALT1 / ALT2/ALT3..], VEGn, #REL1, #REL2, ... <FLG, FRE, PRI>

where, HW ← Head Word (Bangla Word; in this case it is Bangla root);

UW ← Universal Word (English word from knowledge base);

icl/iof/... means *inclusion/instance of* ...to represent the concept of universal word

REL1/REL2..., indicates the related relations regarding the corresponding word.

ROOT ← It is an attribute for Bangla roots. This attribute is immutable for all Bangla roots.

VEND ← is the attribute for vowel ended roots.

VEGn ← attribute for the group number of vowel ended roots (n=1, 2...11).

CEGn ← attribute for the group number of consonant ended roots (n=1, 2...11).

ALT1, ALT2, ALT3 etc. are the attributes for the first, second and third alternatives of the vowel ended roots respectively.

DEF ← attribute for default root.

#REF1, #REF2 etc. are the possible corresponding relations regarding the root word.

Here, attributes, ROOT, VEND are fixed for all Bangla roots whereas, ALT1 or ALT2 etc. is not necessary for all roots because they are used only for alternative roots.

In the following examples, we are constructing the dictionary entries for some sample verb roots using our designed template:

[গা] {} “go(icl>move>do, plf>place, plt>place, agt>thing)” (ROOT, VEND, VEG3, #PLF, #PLT, #AGT) <B, 0, 0>

[গি] {} “go(icl>move>do, plf>place, plt>place, agt>thing)” (ROOT, VEND, ALT, VEG3, #PLF, #PLT, #AGT) <B, 0, 0>

[খা] {} “eat(icl>consume>do, agt>living_thing, ins>thing, obj>concrete_thing, plf>thing, tim>abstract_thing)” (ROOT, VEND, VEG1, #PLF, #PLT, #AGT) <B, 0, 0>

For first two entries the relation *plf* (place from) indicates from where agent go/goes, *plt* (place to) means to where go/goes, *agt* (agent) for who go/goes and attribute ALT1 indicates that root “গি” (*gi*) is the first alternative of root “গা” (*ja*) shown in Table 1. Attributes #PLF, #PLT and #AGT indicate that relations *plf*, *plt* and *agt* can be made with roots “গি” (*gi*) and “গা” (*ja*). Similarly, other entries have been developed according to the format discussed above. Our Proposed Dictionary Entries of vowel ended roots along with their alternatives are given below.

- Dictionary Entries of VEG1:

[পা] {} “get((icl>do, equ>obtain, src>uw, agt>thing, obj>thing)” (ROOT, VEND, DEF, VEG1, #OBJ, #AGT) <B, 0, 0>

[পা] {} “get((icl>do, equ>obtain, src>uw, agt>thing, obj>thing)” (ROOT, VEND, ALT1, VEG1, #OBJ, #AGT) <B, 0, 0>

[খা] {} “eat(icl>consume>do, agt>living_thing, obj>concrete_thing, ins>thing)” (ROOT, VEND, DEF, VEG1, #AGT, #OBJ, #INS) <B, 0, 0>

[খা] {} “eat(icl>consume>do, agt>living_thing, obj>concrete_thing, ins>thing)” (ROOT, VEND, ALT1, VEG1, #AGT, #OBJ, #INS) <B, 0, 0>

- Dictionary Entries of VEG2:

[গা] {} “sing(icl>do, com>music, cob>thing, agt>living_thing, obj>song, rec>living_thing)” (ROOT, VEND, DEF, VEG2, #AGT, #OBJ, #COM, #COB, #REC) <B, 0, 0>

[গা] {} “sing(icl>do, com>music, cob>thing, agt>living_thing, obj>song, rec>living_thing)” (ROOT, VEND, ALT1, VEG2, #AGT, #OBJ, #COM, #COB, #REC) <B, 0, 0>

[গা] {} “sing(icl>do, com>music, cob>thing, agt>living_thing, obj>song, rec>living_thing)” (ROOT, VEND, ALT2, VEG2, #AGT, #OBJ, #COM, #COB, #REC) <B, 0, 0>

[চা] {} “want(icl>desire>be, obj>uw, aoj>volitional_thing, pur>thing)” (ROOT, VEND, DEF, VEG2, #OBJ, #AOJ, #PUR) <B, 0, 0>

[চা] {} “want(icl>desire>be, obj>uw, aoj>volitional_thing, pur>thing)” (ROOT, VEND, ALT1, VEG2, #OBJ, #AOJ, #PUR) <B, 0, 0>

[চা] {} “want(icl>desire>be, obj>uw, aoj>volitional_thing, pur>thing)” (ROOT, VEND, ALT2, VEG2, #OBJ, #AOJ, #PUR) <B, 0, 0>

[ছা] {} “roof(icl>cover>do, agt>volitional_thing, obj>thing, ins>thing)” (ROOT, VEND, DEF, VEG2, #AGT, #OBJ, #INS) <B, 0, 0>

[ছা] {} “roof(icl>cover>do, agt>volitional_thing, obj>thing, ins>thing)” (ROOT, VEND, ALT1, VEG2, #AGT, #OBJ, #INS) <B, 0, 0>

[ছা] {} “roof(icl>cover>do, agt>volitional_thing, obj>thing, ins>thing)” (ROOT, VEND, ALT2, VEG2, #AGT, #OBJ, #INS) <B, 0, 0>

- Dictionary Entries of VEG3:

[নি] {} “take(icl>capture>do, agt>thing, obj>thing)” (ROOT, VEND, DEF, VEG3, #AGT, #OBJ) <B, 0, 0>

[দি] {} “give(icl>do, equ>hand_over, agt>living_thing, obj>concrete_thing, rec>person)” (ROOT, VEND, DEF, VEG3, #AGT, #OBJ, #REC) <B, 0, 0>

- Dictionary Entries of VEG4:

[গা] {} “go(icl>move>do, plf>place, plt>place, agt>thing)” (ROOT, VEND, VEG4, #PLF, #PLT, #AGT) <B, 0, 0>

[গি] {} “go(icl>move>do, plf>place, plt>place, agt>thing)” (ROOT, VEND, VEG4, #PLF, #PLT, #AGT) <B, 0, 0>

[গা] {} “go(icl>move>do, plf>place, plt>place, agt>thing)” (ROOT, VEND, VEG4, #PLF, #PLT, #AGT) <B, 0, 0>

[গা] {} “go(icl>move>do, plf>place, plt>place, agt>thing)” (ROOT, VEND, VEG4, #PLF, #PLT, #AGT) <B, 0, 0>

- Dictionary Entries of VEG5:

[ছুঁ] {} “touch(icl>come_in_contact>do, agt>person, obj>concrete_thing, ins>thing)” (ROOT, VEND, DEF, VEG5, #AGT, #OBJ, #INS) <B, 0, 0>

[ছুঁ] {} “put(icl>displace>do, plc>thing, agt>thing, obj>thing)” (ROOT, VEND, DEF, VEG5, #AGT, #OBJ, #PLC) <B, 0, 0>

[সু] {} “sleep(icl>rest>be, aoj>living_thing)” (ROOT, VEND, VEG5, #AOJ, #PLC) <B, 0, 0>

[ধু]{}“wash(icl>serve>do,agt>living_thing,obj>concrete_thing,ins>functional_thing)” (ROOT, VEND, DEF, VEG5, #AGT, #OBJ, #INS)<B, 0, 0>

- Dictionary Entries of VEG6:

[ন]{}“be(icl>be>not, aoj>thing)” (ROOT, VEND, DEF, VEG6, #AOJ)<B, 0, 0>

- Dictionary Entries of VEG7:

[মু]{}“milk(icl>draw>do,agt>thing,obj>thing)” (ROOT, VEND, DEF, VEG7, #AGT, #OBJ)<B, 0, 0>

[বু]{}“bath(icl>vessel>thing)” (ROOT, VEND, VEG7, #PLF, #PLT, #AGT)<B, 0, 0>

[সু]{}“sow(icl>put>do,plt>thing,agt>thing,obj>concrete_thing)” (ROOT, VEND, DEF, VEG7, #PLT, #AGT, #OBJ)<B, 0, 0>

- Dictionary Entries of VEG8:

[ল]{}“take(icl>require>be,obj>thing,aoj>thing,ben>person)” (ROOT, VEND, DEF, VEG8, #OBJ, #AOJ, #BEN)<B, 0, 0>

- Dictionary Entries of VEG9:

[হ]{}“be(icl>be, equ>be_located, aoj>thing, plc>uw)” (ROOT, VEND, DEF, VEG9, #AOJ, #PLC)<B, 0, 0>

- Dictionary Entries of VEG10:

[ধা]{}“urge(icl>rede>do,agt>volitional_thing,obj>volitional_thing,gol>thing)” (ROOT, VEND, DEF, VEG10, #AGT, #OBJ, #GOL)<B, 0, 0>

[না]{}“bath(icl>vessel>thing)” (ROOT, VEND, VEG10, #AGT, #PLC)<B, 0, 0>

[বা]{}“row(icl>move(icl>cause)>do,plt>thing,agt>person,obj>boat,ins>thing)” (ROOT, VEND, DEF, VEG10, #PLF, #PLT, #AGT, #OBJ, #INS)<B, 0, 0>

- Dictionary Entries of VEG11:

[ক]{}“talk(icl>communicate>do, cob>uw, agt>person, obj>thing, ptn>person)” (ROOT, VEND, DEF, VEG11, #AGT, #OBJ, #PTN, #COB)<B, 0, 0>

[ব]{}“bear(icl>have>be, obj>property, aoj>thing)” (ROOT, VEND, DEF, VEG11, #OBJ, #AOJ)<B, 0, 0>

[ত্র]{}“stay(icl>dwell>be, aoj>person, plc>uw)” (ROOT, VEND, DEF, VEG11, #AOJ, #PLC)<B, 0, 0>

6 Conclusions and Future Work

This paper has analyzed the Bangla vowel ended roots and grouped them into different categories based on how verbal inflexions are added with them to form verbs for first person, and then outlined the format of word dictionary for the roots. In this paper, we have also developed word dictionary entries for all vowel ended roots. These entries

can be used to create verbs combining with their respective verbal inflexions. A Bangla native language sentence with verb can be easily converted into UNL expression by analysis rules which can later be converted into any other languages using language specific generation rules. Our future research is to develop formats of Bangla vowel and consonant ended roots for first, second and third person of all tenses. The proposed format is expected to be equally applicable to other languages with verb roots.

7 References

- [1] M. E. H. Choudhury, M. N.Y. Ali, M.Z.H. Sarkar, R. Ahsan, “Bridging Bangla to Universal Networking Language- a Human Language Neutral Meta- Language”, International Conference on Computer and Information Technology (ICIT), Dhaka, pp.104-109, 2005.
- [2] EnConverter Specification, Version 3.3, UNL Center/UNDL Foundation, Tokyo 150-8304, Japan 2002.
- [3] DeConverter Specification, Version 2.7, UNL Center, UNDL Foundation, Tokyo 150-8304, Japan 2002.
- [4] H. Uchida, M. Zhu, and T. C. D. Senta, Universal Networking Language, UNDL Foundation, International environment house, Geneva, Switzerland, 2005/06.
- [5] UNDL Foundation: The Universal Networking Language (UNL) specifications version 3.2, 2003.
- [6] J. Pairkh, J. Khot, S. Dave, P. Bhattacharyya, “Predicate Preserving Parsing”, Department of Computer Science and Engineering, Indian Institute of Technology, Bombay.
- [7] H. Bondopoddaye, “Bongioi Shobdokosh”, Shahitto Okademy, Calcutta, 2001.
- [8] D. M. Shahidullah, “Bangala Vyakaran”, Maola Brothers Prokashoni, Dhaka, pp.110-130, August 2003.
- [9] D. C. Shniti Kumar, “Vasha-Prokash Bangla Vyakaran”, Rupa and Company Prokashoni, Calcutta, pp.170-175, 1999.
- [10] D. S. Rameswar, “Shadharan Vasha Biggan and Bangla Vasha”, Pustok Biponi Prokashoni, pp.358-377, 1996.