Grapheme-to-Phoneme Conversion for Myanmar Language

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Abstract

Grapheme-to-Phoneme (GTP) conversion is one of the most important parts for text-to-speech synthesis of Myanmar language. TTS system is firstly faced with the conversion of input text into linguistic representation usually called text-to-phonetic or grapheme-to-phoneme conversion. This paper presents the Grapheme-to-Phoneme conversion with dictionary-based approach. Conversion can be divided in two main phases, text preprocessing and creation of linguistic data for correct pronunciation. Myanmar number converter and syllable segmentation includes in the task of text preprocessing. Myanmar number converter is a vital task in Grapheme-to-Phoneme (GTP) conversion that is transforming from a numeric form to textual form to easily analyze in speech synthesis. Syllable segmentation is used the automatic segmentation software to segment the words to syllables. Dictionary-based approach for Myanmar phonetic promotes to get correct pronunciation with linguistic data in this paper. This method has a benefit is quick and accurate in extraction data.

Keywords: Grapheme-to-Phoneme, linguistic representation, Dictionary-based method

1. Introduction

Grapheme-to-phoneme conversion (or letter-to-sound transcription) systems are very useful for speech recognition and speech production applications [10]. Grapheme-to-Phoneme (GTP) conversion is a difficult task for Myanmar language. Because Myanmar writing system depends on the Unicode and they have no spaces to mark the boundaries of words. So this system will preprocess of Myanmar input text to get the correct GTP conversion. Myanmar language differs from other languages, such as tone level, pronunciation style and linguistics information.

GTP conversion comes under two-main approaches: dictionary-based and rule-based approach. The simplest approach to GTP conversion is the dictionary-based approach, where a large dictionary containing all the words of a language and their correct pronunciations is stored by the program. Determining the correct pronunciation of each word is a matter of looking up each word in the dictionary and replacing the spelling the pronunciation specified in the dictionary [11].

In this study, we proposed the building of Myanmar phonetic dictionary to extract the phoneme sequences and correct pronunciations of each syllable. Firstly, we must collect the possibility words in Myanmar language to build the phonetic dictionary. Secondly, we must record each word in Myanmar words collection. Finally, we must segment the recorded speech and store these to corresponding words.

In the next section we will discuss related works. Section 3 will describe about Myanmar Language. The detail of our model will be explained in Section 4, and Myanmar Phonetic Dictionary will be presented in Section 5. Section 6 will be presented about conclusion and further extension of my research.

2. Related Works

The framework for building Myanmar language text-to-speech system is the essential issues in developing the text-to-speech synthesis for Myanmar text analysis, prosody generation and speech synthesis. In the step of text analysis, this system segmented the words by using the dictionary-based method. So complexity is larger than the syllable segmentation. In the synthesis work, demisyllable was selected because it had a reasonable number of sound units and acceptable quality [1]. A rule-based speech synthesis system is demisyllables with Level tone. They used Myanmar official language for the TTS system. To construct the TTS system, monosyllabic words were analyzed and the parameters were obtained for synthesis of Myanmar tones. This TTS system used a source filter model and furthermore a Log Magnitude Approximation Filter [2].A Standard-Malay (SM) phoneme set and an inclusive set of phone database have been constructed carefully for this phone-based speech synthesizer. By applying the generative phonology, a comprehensive letter-to-sound (LTS) rules and a pronunciation lexicon had been invented for SMaTTS [5]. Concatenation at syllable boundaries for India Language could lead to smaller error owing to the spectrum being similar across

different syllable boundaries.A group delay based algorithm automatically segments continuous speech at syllable-like boundaries. It used International Phonetic Alphabet (IPA) notation to convert raw text entered by the user into phonetic notation. After conversion into phonemes, it used a homogeneous set of prerecorded sub-syllabic synthesis units to generate tokens. It contained 1372 sub-syllabic synthesis units that consist of open syllables, vowel-consonant clusters, vowel-consonant-vowel clusters, and long duration consonants. The synthesizer component concatenated these synthesis units to produce the final speech [3]. The speech unit selection was preceded by the linguistic analysis of the text. During the selection step, a target cost and a concatenation cost were computed. Features of the target cost had been automatically weighted during the training step: for each phoneme, each feature was weighted by computing its Gain Ratio from clusters of similar acoustic realizations [4]. Speech unit selection built its features set exclusively from the linguistic information generated by the natural language analysis. It used K Means Algorithm to get the weighting of linguistic features. Eric Lewis and Mark Tatham submitted the TTS system depending on the 2000 words of weather forecasting from MeteoSPRUCE database. MeteoSPRUCE is a limited domain syllable and word based system which has an inventory consisting of recordings of 2000 monosyllabic and polysyllabic words. A strategy was required for recombining syllables in contexts other than those from which they were extracted. Therefore, the concatenation phase consisted essentially of having recombining rules for joining two syllables depending on the final class of the first syllable and the initial class of the second syllable.

3. Nature of Myanmar Language

Myanmar writing does not use white spaces between words or between syllables. Thus, the computer has to determine syllable and word boundaries by means of an algorithm such as finite-state and rule-based. Moreover, a Myanmar syllable can be composed of multiple characters. Syllable segmentation is the process of determining word boundaries in a piece of text.

Myanmar language can consist of one or more morphemes that are linked more or less tightly together. Typically, a word will consist of a root or stem and zero or more affixes. Words can be combined to form phrases, clauses and sentences. A word consisting of two or more stems joined together is known as a compound word. To process text computationally, words have to be determined first [6].

The purpose of this paper is to develop Myanmar Text-To-Speech system and to improve the performance of Grapheme-to-Phoneme (GTP) conversion for the Myanmar language, which is used by more than fifty million people. The Myanmar language is the official language of Myanmar and is more than one thousand years old. Texts in the Myanmar language use the Myanmar script, which is descended from the Brahmi script of ancient South India. Other Southeast Asian descendants, known as Brahmic or Indic scripts, include Thai, Khmer and Lao.

Table1. Myanmar Character

Basic Consonants (ဗျည်းအက္ခရာ)				
က	ခ	ဂ	ဃ	င
စ	ဆ	ဇ	ဈ	ည/ဉ
ဋ	ဌ	ဍ	ဎ	ဏ
တ	ထ	ဒ	ဓ	န
ပ	ဖ	ဗ	ဘ	မ
ယ	ရ	လ	ဝ	သ
ဟ	ဠ	အ		
Basic Medials (ဗျည်းတွဲ)				
ျ				
ြ				
ွ				
ှ				
Combined Medials (ဗျည်းတွဲ)				
ျ	+	ွ		
ြ	+	ွ		
ျ	+	ှ		
ြ	+	ှ		
ျ	+	ှ	+	ွ
ြ	+	ှ	+	ွ

Vowels(သရ)				
ေ	ါ	ော		
ိ	ီ	ဲ	ော်	
Special Characters				
၏	၍	ဤ	၌	သြော်

Numerals				
၀	၁	၂	၃	၄
၅	၆	၇	၈	၉
Punctuation marks				
၊	။			

A Myanmar text is a string of characters without explicit word boundary markup, written in sequence from left to right without regular inter-word spacing,

although inter-phrase spacing may sometimes be used. Myanmar characters can be classified into three groups: consonants, medials and vowels. The basic consonants in Myanmar can be multiplied by medials. Syllables or words are formed by consonants combining with vowels. However, some syllables can be formed by just consonants, without any vowel. Other characters in the Myanmar script include special characters, numerals, punctuation marks and signs.

There are 34 basic consonants in the Myanmar script, as displayed in Table1. They are known as "Byee" in the Myanmar language. [6]. Consonants serve as the base characters of Myanmar words, and are similar in pronunciation to other Southeast Asian scripts such as Thai, Lao and Khmer.

Medials are known as "Byee Twe" in Myanmar. There are 4 basic medials and 6 combined medials in the Myanmar script. The 10 medials can modify the 34 basic consonants to form 340 additional multi-clustered consonants. Therefore, a total of 374 consonants exist in the Myanmar script, although some consonants have the same pronunciation.

Vowels are known as "Thara". Vowels are the basic building blocks of syllable formation in the Myanmar language, although a syllable or a word can be formed from just consonants, without a vowel. Like other languages, multiple vowel characters can exist in a single syllable.

3.1 Phonology of Myanmar Language

A phoneme is the smallest unit that distinguishes words and morphemes. Therefore, changing a phoneme of a word to another phoneme produces a different word or a nonsense utterance, whereas changing a phone to another phone, when both belong to the same phoneme, produces the same word with an odd or an incomprehensible pronunciation. Phonemes are not physical segments themselves, but mental abstractions of them. Different acoustic realizations of a phoneme are called allophones. The acoustic characteristics of phonemes come from the vocal tract movement during their articulation. There are three types of phonetic parameters in phonology of Myanmar language: first is place of articulation, second is articulator and third is manner of articulation [7]. The pronunciation of Myanmar words depend on these parameters. A phoneme is a contrastive unit in the sound system of a particular language. It is a minimal unit that serves to distinguish between meanings of words. Phoneme can pronounce in one or more ways, depending on the number of allophones. It can represent between slashes by convention. Table2 describes the inventory of Myanmar consonant phonemes defined by the International Phonetic Association (IPA).

Table2. The inventory of Myanmar consonant phonemes

		Labial (ဗျည်းစုံဗျပ္ပ)	Dental of Inter-dental (ဝဏ္ဏ)	Alveolar (လုလ္လဋ္ဌဍ္ဍဏ)	Palato-alveolar (အာလယ်ဝဏ္ဏဋ္ဌဍ္ဍ အာလယ်ဝဏ္ဏစုံဇျပ္ပ)	Palatal (အာလယ်ဝဏ္ဏစုံ)	Velar (အာလယ်ဂဠ)	Glottal (အသံစင်အဃဝိဇ္ဇ)
Stops (Plosives)	Unvoiced	p,ph		t,th			k,kh	
	Voiced	b		d			g	
Fricatives	Unvoiced		θ	s,sh	ʃ			h
	Voiced			z				
Affricates	Unvoiced				ʧ, ʧh			
	Voiced				ʤ			
Nasals	Voiced	m		n	ɲ		ŋ	
Frictionless Approximants	Voiced	w		l		j		

3.2 Myanmar Phonological Tones

Myanmar language has four tones and a simple syllable structure that consists of an initial consonant followed by a vowel with an associate tone. This means all syllables in Myanmar have prosodic features. Different tone makes different meanings for syllables with the same structure of phonemes. In the Myanmar writing system, a tone is presented by a diacritic mark.

The fundamental frequency as shown in figure 1 rises gradually from Tone 1 to Tone 4. Tone 1 starts at a relatively level range and tends to go down slightly; Tone 2 starts at a relatively level range, goes up, and then falls down relatively low; Tone 3 starts at a relatively high range, usually higher than or as high as the peak of Tone 2, and falls down relatively low; Tone 4 stats at a high range, frequently higher or as high as the peak of Tone 2 and falls low, but not as low as Tone 3 because it stops very suddenly before it can drop lower [7]. The general contrastive features of the four phonological tones offered by the analysis of their fundamental frequency can be described as figure1:

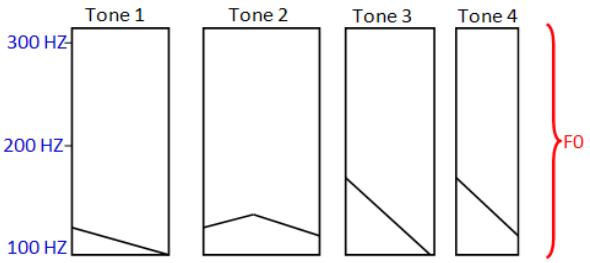

Figure1. Four Tones of Myanmar Language

There are four tones in Myanmar language. The lengths of tones are:

- Tone 1 has 18.50 Cs
- Tone 2 has 21.03 Cs
- Tone 3 has 15.44 Cs and

- Tone 4 has 10.35 Cs.

So Myanmar toneme is described with the variety of rate or duration. Length of the tone is defined as rate or duration. Tone 2 is defined as a longest rate and tone 4 is defined as a shortest rate in these four tones. Now we describe with the redundant features of these four tones in Table3.

Table3. Features of Myanmar Tones

Description	Tone1	Tone2	Tone3	Tone4
Rate	2	3	1	0
Duration	18.5	21.03	15.44	10.35
Low	+	+	-	-
High	-	+	+	+
Low-Falling	+	+	+	-

3.3 Phonological Structure

The Myanmar language uses a rather large set of 50 vowel phonemes, including diphthongs, although its 22 to 26 consonants are close to average. Some languages, such as French, have no phonemic tone or stress, while several of the Kam-Sui languages have nine tones, and one of the Kru languages, Wobe, has been claimed to have 14, though this is disputed. The most common vowel system consists of the five vowels /i/, /e/, /a/, /o/, /u/. The most common consonants are /p/, /t/, /k/, /m/, /n/. Relatively few languages lack any of these, although it does happen: for example, Arbic lacks /p/, standard Hawaiian lacks /t/, Mohawk and Tlingit lack /p/ and /m/, Hupa lacks both /p/ and a simple /k/, colloquial Samoan lacks /t/ and /n/, while Rotokas and Quileute lack /m/ and /n/ [12]. Table4 shows the phonetic signs of 50 Myanmar vowels to pronounce the Myanmar words. These 50 phonemes show the basic symbol with four tone levels [7].

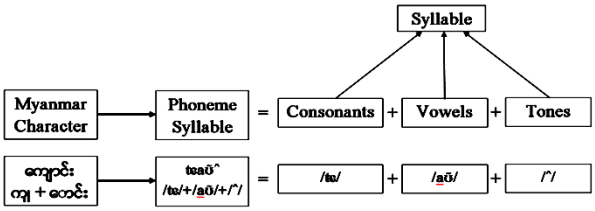

Figure2. Combination of Phoneme Syllable

Phonology is how speech sounds are organized and affect one another in pronunciation. The combination of consonant phoneme and a vowel phoneme produces a syllable in figure2. The phonetic alphabet is usually divided in two main categories, vowels and consonants. Vowels are always voiced sounds and they are produced with the vocal cords in vibration, while consonants may be either voiced or unvoiced. Vowels have considerably higher amplitude than consonants and they are also more stable and easier to analyze and describe acoustically. Because consonants involve very rapid changes they are more difficult to synthesize properly [8].

Table4. Phonetic Signs of Myanmar Vowels

Basic Symbol	Non-nasalized (နာသံမဲ့သရ)								Nasalized (နာသံပါသောသရ)					
	Tone 1		Tone 2		Tone 3		Tone 4		Tone1		Tone 2		Tone3	
i အိ	i˜	အီ	iˆ	အီး	i´	အိ	iˀ	အစ်	ĩ˜	အင်	ĩˆ	အင်း	ĩ´	အင့်
e အေ	e˜	အေ	eˆ	အေး	e´	အေ့	eIˀ	အိတ်	eĩ˜	အိန်	eĩˆ	အိန်း	eĩ´	အိန့်
ɛ အယ်	ɛ˜	အယ်	ɛˆ	အဲ	ɛ´	အယ့်	ɛˀ	အက်	aĩ˜	အိုင်	aĩˆ	အိုင်း	aĩ´	အိုင့်
							aIˀ	အိုက်						
a အာ	a˜	အာ	aˆ	အား	a´	အာ	aˀ	အတ်	ã˜	အန်	ãˆ	အန်း	ã´	အန့်
ɔ အော်	ɔ˜	အော်	ɔˆ	အော	ɔ´	အော့	aʊˀ	အောက်	aũ˜	အောင်	aũˆ	အောင်း	aũ´	အောင့်
o အို	o˜	အို	oˆ	အိုး	o´	အို့	oʊˀ	အုပ်	oũ˜	အုန်	oũˆ	အုန်း	oũ´	အုန့်
u အူ	u˜	အူ	uˆ	အူး	u´	အု	uˀ	အုတ်	ũ˜	အွန်	ũˆ	အွန်း	ũ´	အွန့်

4. Grapheme-To-Phoneme Conversion

Grapheme-to-Phoneme conversion converts the orthographical symbols into phonological ones using a phonetic alphabet. We have already seen on this course *IPA, the alphabet of the International Phonetic Association*. Since the IPA symbols are rather complicated and there are several symbols that cannot be found in typewriters, other phonetic alphabets have also been developed. They are better compatible with computers and often based on Unicode characters. The degree of challenge in phonetic analysis is strongly language dependent. For example, Finnish is actually one of the easiest languages in this respect because the pronunciation is not so different from the written form of the utterance [9]. The block diagram of Phonetic analysis is presented in figure3.

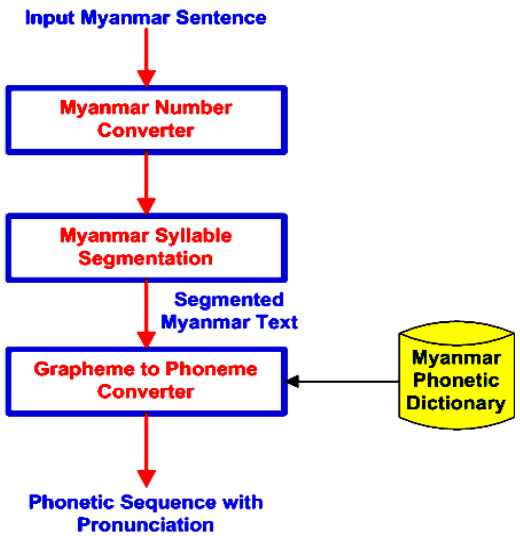

Figure3. Grapheme-to-Phoneme Conversion

The system design of Grapheme-to-Phoneme has three parts: Myanmar number converter, Myanmar syllable segmentation and Grapheme-to-Phoneme converter by applying constructed Myanmar phonetic dictionary. Myanmar number converter is a difficult task to convert from numeric form to textual form in a Myanmar sentence. Firstly, we check the number exists in input Myanmar sentence. If it is, we extract this number and check it with Myanmar 3 Unicode database. And then extracted numbers must be divided with the whole numbers according to their positions. Divided numbers must be regarded their count by naming with Myanmar words. In the step of Myanmar syllable segmentation, we used segmentation software to segment the Myanmar sentence. In Grapheme-to-Phoneme conversion step, this system uses the dictionary-based approach to convert the phoneme sequences. In building Myanmar phonetic dictionary, we collect and record the Myanmar syllables and we segment the syllables to consonants, vowels and recorded speech.

4.1 Myanmar Number Converter

Number converter for Myanmar number is a difficult and vital task in Grapheme-to-Phoneme (GTP) conversion. Myanmar number is not defined as a number like English because it has a Unicode for each number. The computer does not easily understand the Myanmar number like English number. So, the system will translate these to machine-language. Myanmar number 0 to 9 has a Unicode for each. If a number string has 4 words, system will check with their each Unicode. So, number converter will control a number string with a whole number Unicode according to the counting of number string. And then the system will divide the input number with whole number such as 1000, 100, 10 and it marks the positions of the quotients. But this number converter cannot transfer the decimal Myanmar number. It can only change the integral number. The transforming of Myanmar number to textual form is shown in figure4.

Input number string: ၅၄၃၂

Number Count စာလုံးအရေအတွက်	Divisor Whole Number စားကိန်းပြည့်	Numerator တည်ကိန်း	Quotient စားလဒ်	Remainder အကြွင်း	Textual Form စာသားပုံစံ
၅	၁၀၀၀၀	၅၄၃၂	၅	၄၃၂	ငါးသောင်း
၄	၁၀၀၀	၄၃၂	၄	၃၂	လေးထောင်
၃	၁၀၀	၃၂	၃	၂	သုံးရာ
၂	၁၀	၂	၂	၀	နှစ်ဆယ်
၁	၁	၀	၀	၀	ငါး

Output textual form: ငါးသောင်းလေးထောင်သုံးရာနှစ်ဆယ်ငါး

Figure4. Transforming from Numeric to Textual form of Myanmar Number

5. Myanmar Phonetic Dictionary

The purpose of this paper presents about the dictionary-based approach for Grapheme-to-Phoneme (GTP) conversion. There are five steps to construct the Myanmar phonetic dictionary:

[1]. Collecting of possibility words
[2]. Separating of consonants and vowels of Myanmar words
[3]. Storing consonants and vowels of phonetic signs
[4]. Recording of Myanmar syllables and
[5]. Segmenting of recorded speech.

In the works of possibility words collection, we find the Myanmar words by looking at Myanmar dictionary book. Myanmar word is collated based on syllables. A Myanmar syllable encoded in Unicode can be broken into 5 parts for collation: <consonant> <medial> <vowel> <final> <tone>. Only the consonant is always present, one or more of the other parts may be empty in any given syllable. In practice the vowel may be displayed before the consonant e.g. □□□□, but it is encoded as U+1000 (Myanmar letter □) U+1031U+102CU+103A (Myanmar vowel □□□).The resulting collation sequence has 5 levels, order of priority: <consonant>, <medial>, <final>, <vowel>, <tone>. Note, that the final and vowel have been switched from their encoded order. Each of these parts of the syllable may be composed of one or more characters as the following table5 show. Collation Order read left to right and then down. The data is presented in the traditional layout of the Myanmar alphabet [6].

Table5. Unicode of Consonants

Character	Unicode	Character	Unicode	Character	Unicode	Character	Unicode	Character	Unicode
က	U+1000	ဈ	U+1007	ဎ	U+100E	ဝ	U+1015	ဝ	U+101C
ခ	U+1001	ဉ	U+1008	ဏ	U+100F	ဗ	U+1016	ဝ	U+101D
ဂ	U+1002	ည	U+1009	တ	U+1010	ဘ	U+1017	သ	U+101E
ဃ	U+1003	ဋ	U+100A	ထ	U+1011	ဘ	U+1018	ဟ	U+101F
င	U+1004	ဌ	U+100B	ဒ	U+1012	မ	U+1019	ဠ	U+1020
စ	U+1005	ဍ	U+100C	ဓ	U+1013	ယ	U+101A	အ	U+1021
ဆ	U+1006	ဎ	U+100D	န	U+1014	ရ	U+101B		

The step of separating of consonants and vowels is the important step in Grapheme-to-Phoneme conversion. Storing the separated consonants and separated vowels to database decrease the complexity of searching times because the total compound Myanmar syllables have about near 2000 reduce to the total consonants and vowels have about near 500. To become a Myanmar syllable is combining the possible compound vowels

and consonants. So this system is not inserting the whole Myanmar syllable because one consonant has near 60 compound vowels. If the system saved 33 consonants x 60 vowels = 1980 syllables to the database, the searching time and complexity will increase. The advantage of dictionary-based approach is quick and accurate, but completely fails if it is given a word which is not in its dictionary. As dictionary size grows, so too does the memory space requirements of the synthesis system. Table6 describes about the separated consonants and vowels of Myanmar syllables.

Table6. Separated Consonants and Vowels of Myanmar Words

Character	Unicode
က	U+1000
ခ	U+1001
ဂ	U+1002
ာ	U+102C
ား	U+102CU+1038
ော	U+1031U+102C
ော်	U+1031U+102CU+103A
ေါ	U+1031U+102B
ု	U+102F
ုတ်	U+102FU+1010U+103A
ုန်	U+102FU+1014U+103A
….	…..

There is no problem in inserting the phonetic signs for consonants but single vowel and compound vowels have a little problem to match the pronounced of the whole syllable. In this step, we must insert the data carefully to get the correct phoneme sequences and pronounced of Myanmar syllables because of producing high quality speech synthesis depend on the performance of Grapheme-to-Phoneme conversion step. The phonetic signs are important for Myanmar language analysis and it promotes for the whole system of Grapheme-to-Phoneme (GTP) conversion [7]. Table7 shows the phonetic signs for Myanmar characters to produce the phonetic sequences.

Table7. Phonetic Signs of Myanmar Characters

Characters	Compound Unicodes	Phonetic Signs
က	U+1000	k
ခ	U+1001	kh
ဂ	U+1002	g
သ	U+101E	θ
ဟ	U+101F	h
ဠ	U+1020	l
အ	U+1021	a ˊ
ော့	U+1031U+102CU+1037	ɔˊ
ော်	U+1031U+102CU+103A	ɔ¯
ံ့	U+1036U+1037	ãˊ
ိုဲ့	U+102DU+102F	oˉ
ိုဲ့	U+102DU+102FU+1037	oˊ
ိုဲ့း	U+102DU+102FU+1038	oˆ
တ်	U+1000U+103A	ɛˀ
ုတ်	U+102FU+1000U+103A	oʊˀ
ော်တ်	U+1031U+102CU+1000U+103A	aʊˀ
ိုဲ့တ်	U+102DU+102FU+1000U+103A	aiˀ
ဒ်	U+1004U+103A	ĩˉ
ဒ်း	U+1004U+103AU+1038	ĩˆ
ော်ဒ်	U+1031U+102CU+1004U+103A	aʊ̃ˉ
ော်ဒ်း	U+1031U+102CU+1004U+103AU+1038	aʊ̃ˆ
ိုဲ့ဒ်	U+102DU+102FU+1004U+103A	aĩˉ
ိုဲ့ဒ်း	U+102DU+102FU+1004U+103AU+1038	aĩˆ

After storing the phonetic signs to database, this system stores the segmented recorded speech according to their compound Unicode. Firstly, we record the phone level of the whole syllable. Concerning to constituent phones and syllabic neighboring context, syllable is designed in the form of onset-nucleus-coda. Onset and coda represent single consonants. Nucleus covers short and long vowels, and, short and long diphthongs. Table8 presents that only current phone and syllable constituent phones are adopted in phone-level model. The current phone covers all phones that defined in onset, nucleus and coda. In case of the constituent phone factors, they are applied at phone level to contribute syllabic structure information in phone modeling.

Table8. Control factors for phone-level model

Control Level	Control factors
Phone	-Syllabic constituent phones (onset, nucleus and coda)

This data contains fluently read speech recorded by a Myanmar female student thus this reading style is general reading style. In syllable level data set, it contains approximately 2000 syllables. In phone-level data set, it contains approximately 4600 phones. Phones are segmented automatically using HMM-based segmentation. The segmentation errors were corrected by hand. The example of grapheme-to-phoneme conversion is shown in below:

Input Sentence : ကျိုက်ထီးရိုးတွင်ဘောင်တက်ဘောင်ဆင်းဖြင့်အဆင်းအတက်များသည်

Number Converter : ကျိုက်ထီးရိုးတွင်တစ်ဘောင်တက်တစ်ဘောင်ဆင်းဖြင့်အဆင်းအတက်များသည်

Phoneme Sequence : tɕai² thiˆ joˇ twīˉ tiˀ taʊ̃ˉ tɛˀ tiˀ taʊ̃ˉ shīˆ phjīˇ aˊ shīˆ aˊ tɛˀ mjaˆ eiˉ

6. Conclusions

In this paper, we proposed a dictionary-based approach of Grapheme-to-Phoneme (GTP) conversion

for Myanmar language and syllable accommodation. This system analyzes only the simple Myanmar syllable that is not for Pali and Sanskrit. The advantages of this model can serve quick and accurate with less complexity. It has one drawback that is depend on its database. If the database size increase, the memory space and searching time will increase. So the database size and memory space are directing ratio. We avoid this drawback by compressing the database size.

In future works, to get the better Grapheme-to-Phoneme we will use the hybrid approach with dictionary-based and rule-base approach. The hybrid approach is quite successful in prediction of the pronunciation of words based on their spellings like foreign names and borrowing.

References

[1] Ko Ko Oo, Nilar Thein, "*Myanmar Language Text-To-Speech Synthesis*", University of Computer Studies, Yangon, 2004.

[2] Kyawt Yin Win, "*Myanmar Text-To-Speech System with Rule-Based Synthesis*", University of Ryukyus, Japan, 2011.

[3] Pardeep Gara, "*TEXT-TO-SPEECH SYNTHESIS FOR PUNJABI LANGUAGE*", School of Mathematics and Computer Applications Thapar Institute of Engineering and Technology, Patiala, May 2006.

[4] Vincent Colotte, Richard Beaufort, "*Linguistic features weighting for a Text-To-Speech system without prosody model*", Interspeech 2005.

[5] Othman O.Khalifa, Zakiah Hanim Ahmad, and Teddy Surya Gunawan, "Standard Malay Text-to-Speech System", 2007.

[6] Tun Thura Thet; Jin-Cheon Na; Wunna Ko Ko, "*Word segmentation for the Myanmar language*".

[7] Dr. Thein Tun, "*Acoustic Phonetics and the Phonology of the Myanmar Language*", School of Human Communication Sciences, La Trobe University, Melbourne, Australia, 2007.

[8] D.J. RAVI Research Scholar, "*Kannada Text to Speech Synthesis Systems: Emotion Analysis*", JSS Research Foundation, S.J College of Engg, Mysore-06, 2010.

[9] International Phonetic Association (1999), *"Phonetic description and the IPA chart"*, Handbook of the International Phonetic Association: a guide to the use of the international phonetic alphabet, Cambridge University Press.

[10] M. Bisani, H. Ney, "Joint-sequence models for grapheme-to-phoneme conversion", Speech Communication, Vol.50, 2008, pp.434-451.

[11] *Speech Synthesis*", http://en.wikipedia.org/w/index.php, January 2012.

[12] "*Phoneme*", http://en.wikipedia.org/w/index.php, April 2012.

Appendix

Phonetic Signs	Pronunciations	Myanmar Syllables
p	pa	□
ph	pha	□
b	Ba	□□□
t	ta	□□ဋ
th	tha	□□ဌ
d	da	□□ဓ၃း
k	ka	□
kh	kha	□
g	ga	□□□
ɵ	tha	□
s	sa	□
sh	sa	□
z	za	□□□□
ʃ	sha	ရ
h	ha	□
tɕ	kya	□□
tɕh	cha	□□
dʒ	gha	□□
m	ma	□
n	na	ဏ□□
ɲ	nya	□
ŋ	nga	□
w	wa	ဝ
l	la	□□ဋ
j	ya	ဃ□□