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Collection

Abstract:

In this paper we proposed a system for Taiwanese teaching and word collection. The system can translate the input Chinese sentence or word into Taiwanese speech. Also we design a platform through which we can collect words and their pronunciation for Taiwanese lexicon by the help of users and some experts who participated in our project. The collection for words and speech through the collaboration of people is a new experiment. A high quality Text-to-Speech system is required for a system to teach Taiwanese speaking. We improve the quality of Taiwanese TTS system in the following ways: (a) We collect many synthesis units by finding more consonants [20], vowels [100], and tones [9]. (b) We modify the general tone sandhi rules for entering tones to get higher intelligibility and naturalness of the synthesized speech. (c) With the help of CFSs, we get a better lexicon for Taiwanese. The output of word segmentation will be more suitable for Taiwanese TTS.

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Keywords: Taiwanese, Min Nan, Taiwanese teaching, Text-to-Speech

(TTS) system, word collection, and Chinese Frequent Strings (CFS)

A System for Taiwanese Teaching and Word Collection

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Abstract

In this paper we proposed a system for Taiwanese teaching and word collection. The system can translate the input Chinese sentence or word into Taiwanese speech. Also we design a platform through which we can collect words and their pronunciation for Taiwanese lexicon by the help of users and some experts who participated in our project. The collection for words and speech through the collaboration of people is a new experiment. A high quality Text-to-Speech system is required for a system to teach Taiwanese speaking. We improve the quality of Taiwanese TTS system in the following ways: (a) We collect many synthesis units by finding more consonants [20], vowels [100], and tones [9]. (b) We modify the general tone sandhi rules for entering tones to get higher intelligibility and naturalness of the synthesized speech. (c) With the help of CFSs, we get a better lexicon for Taiwanese. The output of word segmentation will be more suitable for Taiwanese TTS.

Key words: *Taiwanese, Min Nan, Taiwanese teaching, Text-to-Speech (TTS) system, word collection, and Chinese Frequent Strings (CFS)*

1. Introduction

We know that every culture or language is very precious. There is wisdom in it. They are the common property of human beings. In recent years, the government of Taiwan is devoted to the education of local culture. Taiwanese teaching is a very important task. We try to design a system for to teach people the speaking of Taiwanese. Such a system should be able to pronounce the word or sentence asked by the user. In the area of speech and language processing, it is related to the study of Text-to-Speech (TTS) systems [Jurafsky and Martin, 2000; Dutoit, 1997].

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Mandarin and Taiwanese (Min Nan) are two of the major languages in Taiwan, and they are also commonly used around the world. In the past, there are many papers proposed for Mandarin Text-to-Speech (TTS) Systems [Chen etc., 1998; Lee etc., 1989; Lee etc., 1993; Lin and Yu, 1998; Shih and Sproat, 1996] or related researches. In contrast to the large amount of researches in Mandarin, there are only a few papers dealing with Taiwanese [Lin and Chen, 1999; Wang etc., 1999; Lin, 2000; Fu, 2000].

A Mandarin TTS system can be described as in Figure 1. The input sentence is first passed to the Text Analysis module. In this module, word segmentation and character-to-phoneme conversion is done. Some text analysis module also outputs the part-of-speech (POS) information and parsing results. Then the words and phonemes are passed to the Prosody Generation module. In this module, the prosodic information of each syllable (corresponding to a character) is obtained. They are duration, coarticulation or pause, volume, and pitch contours. Finally the Speech Synthesis module extracts the required synthesis units and does some signal processing to get the desired speech.
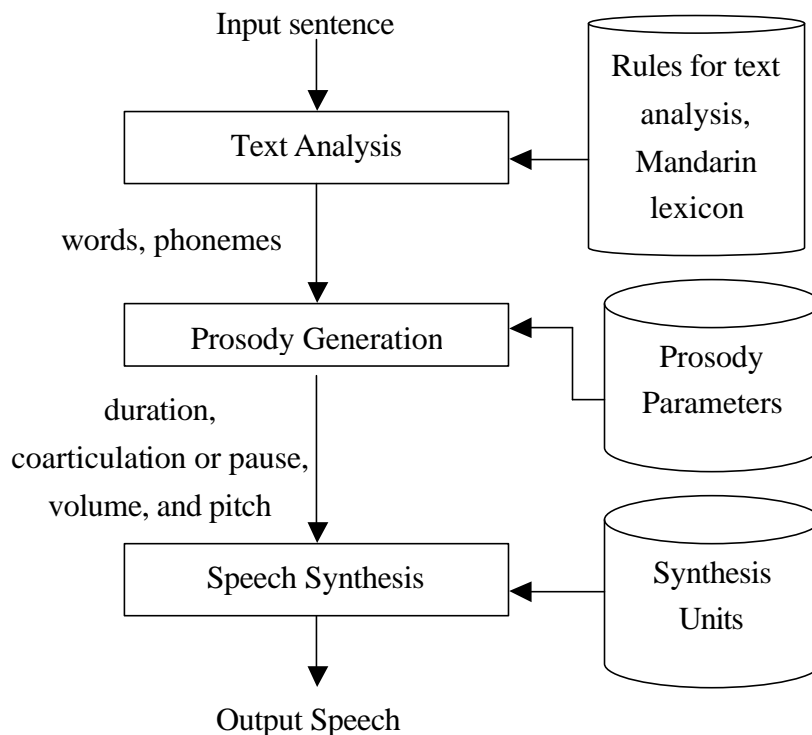

Fig. 1: A general architecture for Mandarin TTS system.

We have many research results in Mandarin TTS systems. Also we have studied Taiwanese for a long time. Hence we have a good background in developing a Taiwanese TTS system. Some of our accomplishments in Mandarin TTS systems are:

(1) We have developed an efficient Mandarin TTS system in time domain [Lin and Yu, 1998].

(2) We have developed a good method to disambiguate the senses of non-text symbols [Yu and Huang, 2002]. For example, "3/4" may be "   (san yue si ri)" or "   (si fen jhi san)". This is a difficult task.

(3) We have developed techniques to do word segmentation, character-to-phoneme conversion, and phoneme-to-character conversion [Lin and Yu, 2001].

(4) We have designed a prosody generator with hierarchical structure, which can predict all the prosodic information for each syllable in a given sentence [Pan etc., 2000; Yu and Pan, 2002].

(5) We have designed a method for speech synthesis to get the desired output speech [Hwang etc., 1996; OuYang etc., 1996].

(6) We also have a method to evaluate the quality of synthetic speech [Wei, 1997], and a good method to segment speech [Chai, 1997], and good tools to find the pitches in speech.

This paper is organized as follows. Section 2 describes the system function for Taiwanese teaching and word collection. Section 3 presents our Taiwanese TTS system. Section 4 focuses on the part of word and speech collection. Section 5 is the summary and future works.

2. System Function for Taiwanese Teaching and Word Collection

The function of our system is described as in Figure 2. The user can ask for the pronunciation of a Chinese sentence or word through an input box. When the user clicks [   ](Sure) button, the system responds with a list of the possible spellings. The user can listen to the speech of a spelling by clicking that spelling. Then the user is asked to mark the spellings, which he/she thinks are good through the check box associated with each spelling. Then he/she ends the teaching and feedback process of this word by clicking the [   ](Send Evaluation) button.

When the system detected the [   ] action, it checks the evaluation of the user. If any choice is " (Good)", the system records those good spellings and the word in a database. If no " (Good)" is selected, the system sends the question (the word asked) to an expert in Taiwanese through an email. This expert will answer the question by speaking the Taiwanese.

The interface for a Taiwanese expert to answer the question is as in Figure 3. The word asked is displayed. The expert can start recording his speech by clicking the [   ](Record) button. The input speech is show in the window for the expert to check the recording quality of the speech. For instance, he can check whether the volume is

too large or small, and whether the speech is completed recorded. He can also listen to his speech by clinking the [   ](Play) button. It is even better if the expert can input the spelling. The system will supply a list of possible spellings for the expert to use. After the answering is completed. He clicks the [   ](Save) button to send his answer. When the system received the answer from an expert. It sends the answer back to the user who asked the question. Also the answer will be recorded in our database.
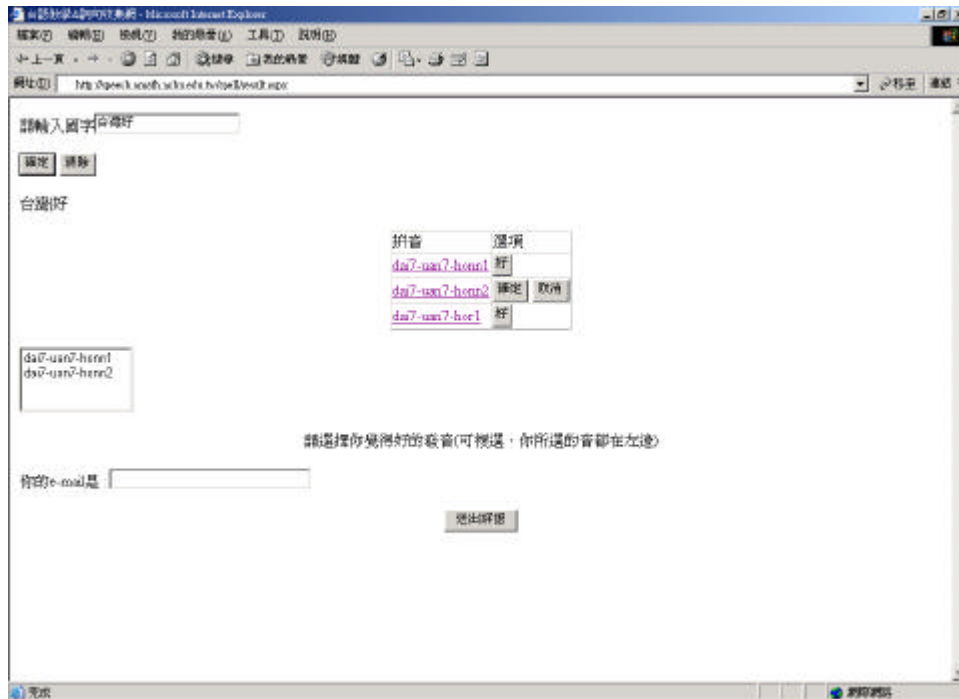

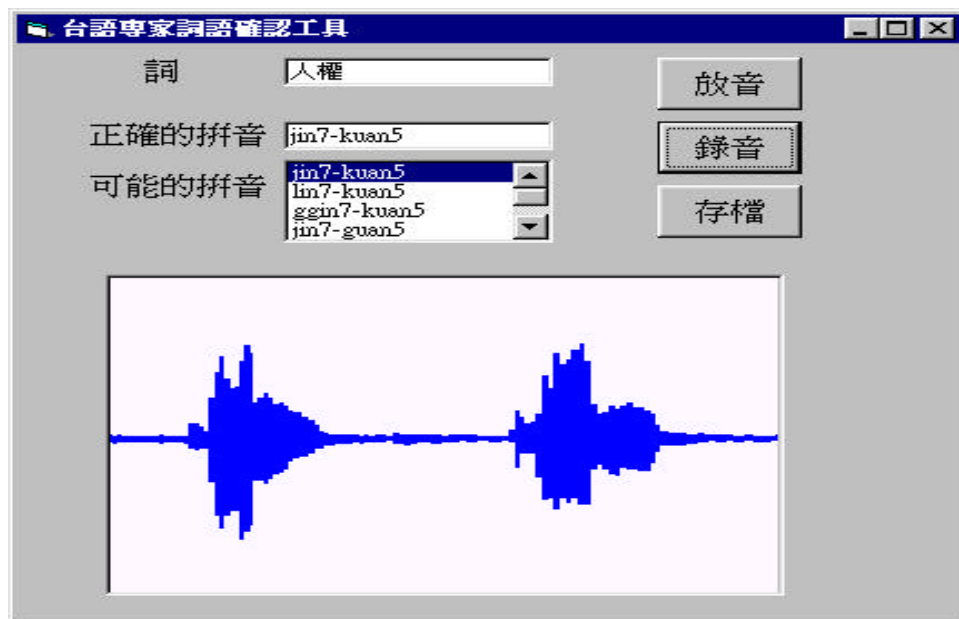Figure 2. The system function of Taiwanese teaching and word collection.

Figure 3. The interface for an expert to answer the question by speaking that word.

3.　Taiwanese Text-to-Speech system

We design a system that can teach Taiwanese speaking. Namely, people enter words or sentences into the system and the system responds with the pronunciation of the question. Hence, we need a high-quality Taiwanese TTS system. We will introduce our system in the order of speech synthesis, prosody generation, and text analysis modules. We think that synthesis units, tone-sandhi rules, and word segmentation are the most important factors in the above three modules, correspondingly.

3.1 Speech Synthesis

Speech synthesis in TTS is the task to modify the synthesis units when needed. There are many approaches for speech synthesis [Dutoit, 1997]. The method PSOLA (Pitch Synchronous OverLap-Add) [Moulines and Charpentier, 1990; Hamon etc., 1989] is probably the most widely used synthesis method in TTS. Yet we also know that the more modification is made, the worse quality the synthetic speech is. Hence we try to record as many synthesis units as possible. Such a work can reduce the required modification on synthesis units.

Taiwanese is a tonal language; each Taiwanese syllable is composed of consonant (optional), vowel, and tone. The numbers of consonant and vowel types between different systems are different. We combine the list of several systems to get a more complete list, as can be found in Tables 1 and 2.

Table 1: The 20 consonant types in our Taiwanese TTS system.

	Chinese Character	Taiwanese Pinyin		Chinese Character	Taiwanese Pinyin
1		b	11		z
2		p	12		c
3		m	13		s
4		d	14		zi
5		t	15		ci
6		n	16		si
7		l	17		bb
8		g	18		gg
9		k	19		j
10		h	20		Null

Table 2: The 100 vowel types in our Taiwanese TTS system. (" " means that there is no corresponding Chinese Character.)

	Chinese Character	Taiwanese Pinyin	Chinese Character	Entering Tone		Chinese Character	Taiwanese Pinyin	Chinese Character	Entering Tone
1		a		ah	26		iaunn		iaunnh
2		e		eh	27		uann		uannh
3		i		ih	28		uenn		uennh
4		o		oh	29		uinn		uinnh
5		or		orh	30		uainn		uainnh
6		u		uh	31		m		mh
7		ai		aih	32		ng		ngh
8		au		auh	33		am		ap
9		ia		iah	34		an		at
10		ior		iorh	35		ang		ak
11		iu		iuh	36		om		op
12		iau		iauh	37		ong		ok
13		ua		uah	38		im		ip
14		ue		ueh	39		in		it
15		ui		uih	40		ing		ik
16		uai		uaih	41		iam		iap
17		ann		annh	42		en		et
18		enn		ennh	43		iang		iak
19		inn		innh	44		iong		iok
20		onn		onnh	45		un		ut
21		ainn		ainnh	46		uan		uat
22		aunn		aunnh	47		uang		uak
23		iann		iannh	48		er		erh
24		ionn		ionnh	49		io		ioh
25		iunn		iunnh	50		ir		irh

The recently designed Tong-Yuong spelling (   ) is used in the column Taiwanese Pinyin. We use the second type of Tong-Yuong spelling for Taiwanese spelling. Namely, we use "bb" and "gg" instead of "v" and "q" that are used in the first type of Tong-Yuong spelling. There are two major differences between our and other system's consonant types list. First, We don't think that "ng" is a consonant. (Some systems think "ng" is a kind of consonant types, and it is also a kind of vowel types.) Secondly, We think "zi", "ci", and "si" are three kinds of consonant types. They are not the same the combination of consonant "z" (or "c", or "s") and the vowel

"i". Totally, we get the most consonants among all the other Taiwanese TTS systems we know. We get Table 2 by adding three kinds of vowel types, which are "er", "io", and "ir", into the list of Taiwanese vowel types in Fu's system [Fu, 2000]. Thus totally we have 100 vowel types. This is also the most we know.

3.2 Prosody Generation

Traditionally we say that there are eight tones in Taiwanese [Yang, 1998]. They are upper even, high falling, upper departing, lower entering, lower departing, high falling, lower even, and upper entering. The 2nd and 6th tones are the same, and -p, -t, -k, -h are the four kinds of endings for the 4th and 8th tones. A typical example is show in Table 3.

Table 3: A typical example for Taiwanese 8 tones.

Tone Number	1	2	3	4	5	6	7	8
Chinese Character								
Taiwanese Pinyin	dong1	dong2	dong3	dok4	dong5	dong2	dong7	dok8
Means	East	Party	A quantifier for buildings	Supervision	The same	Party	Hole	Virus

Since tones 2 and 6 are the same, many people say that there are totally seven tones in Taiwanese. Each Taiwanese character has at lease one base tone. When we read a word in Taiwanese, all characters will read their sandhi tones except the last character in that word which will remain its base tone. The general Taiwanese tone sandhi rules in most system or documents are show in Fig. 4 [Lin and Chen, 1999].
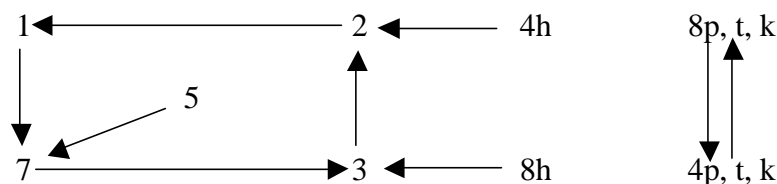

Fig. 4: The general tone sandhi rules in most system and documents for Taiwanese.

It means that the sandhi tone for syllable with base tone 5 is 7, and sandhi tone for a syllable with base tone 7 is 3, and so on. As an example, consider the word " "(computer) /den3-nau2/. The base tones are " "/den7/ and " "/nau2/. The tone

of " " will be remain its base tone. However, we found that the sandhi tones of the 4th and 8th tones need more elaboration. Consider first the cases of 4p and 8p. An example of 4p is " "(rob) with base tone /giap4/. According to the tone sandhi rules in Fig. 4, it should read /giap8-ci5/ in " "(abduct). Yet this reading is not correct. The correct reading is like /giap2-ci5/. This is indicated in the first row of Table 4. An example of 8p is " "(enter) with base tone /jip8/. According to the tone sandhi rules in Fig. 4, it should read /jip4-kau2/ in " "(entrance). Yet the correct reading is like /jip3-kau2/. It is shown in the second row of Table 4. Similar cases for 4t, 8t, 4k,and 8k are shown in rows 3 to 6 of Table 4.

Table 4: Some examples of 4th and 8th tones.

Character	Base tone	Word	Sandi tone
(rob)	giap4	(abduct)	giap2-ci5
(enter)	jip8	(entrance)	jip3-kau2
(bone)	gut4	(bone)	gut2-tau5
(turn off)	bbet8	(to kill accomplices, witnesses, etc.)	bbet3-kau2
(north)	bak4	(north)	bak2-hong1
(bureau)	giok8	(the head of a bureau)	giok3-diunn2
(meat)	bbah4	(a steamed pie with meat stuffing)	bbah2-bau1
(rear)	auh8	(rear part)	Auh3-bbin7

Hence we know that there should be two more tones for the sandhi tones of -p, -t, -k. We call them 2p, 3p, 2t, 3t, 2k, and 3k. A similar idea is pointed out in [Huang, 2001] for the entering tones -h. Although the readings of tones 4h and 8h are very similar to tones 4 and 8. We adopted this idea and get a unified tone sandhi rule as shown in Fig. 5. Therefore we have totally nine tones in our Taiwanese TTS system.
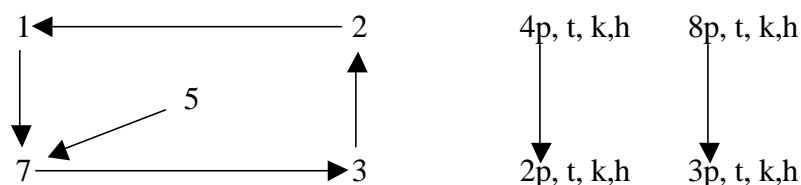

Fig. 5: The tone sandhi rules for Taiwanese in our system.

Some characters have special tone sandhi rules. The spelling many even change too. Consider the example " " with base tone /a2/. It was mentioned in [Huang, 2001] that some characters preceding " " should change their tones. We found the phenomenon that when " " is preceded by a nasal ending , the pronunciation of " " will be nasalized. Some examples are " "(meat ball) /uan7-na2/, " "(tuna)

/en7-na2/, "   "(shop) /diam1-ma2/, "   "(gold) /gim7-ma2/.

When the tones and tone sandhi rules are set. We can use a prosody generator to get the prosody. We have a high accuracy prosody generator for Mandarin TTS system [Yu and Pan, 2002]. There are four levels in that model; they are syllable level, word level, prosodic phrase level, and utterance level. Each lower level is a subset of a high level. The prosodic information is first found in each level, and then they are combined to get the predicted prosody. Our structure has the advantage that it does not need a very large corpus in training. Besides, it can modify the emphasis easily. We will use its framework to develop a version for Taiwanese TTS system.

3.3 Text Analysis

Our Taiwanese TTS system can translate the input Chinese sentence or word into its corresponding speech. We already have very high precision in word segmentation and character-to-phoneme conversion for Mandarin TTS [Lin and Yu, 2001; Lin, 2002]. Yet text analysis in Taiwanese TTS has its own problems. The major problem we think is that the lexicon of Taiwanese is different from that of Mandarin. Our new concept CFS (Chinese Frequent Strings) [Lin and Yu, 2001; Lin, 2002] can help us in this issue.

Word segmentation of a Taiwanese TTS system is more important than a Mandarin TTS system, because the tone sandhi problems in Taiwanese occur more than that in Mandarin, and tone sandhi is related to both the correctness and fluency in a Taiwanese TTS system. For example, "   " (the internet) is a CFS. Their base tones are /bbang7/, /ze3/, /bbang7/, /lo7/. It should be read continuously as /bbang3-ze2-bbang3-lo7/ in Taiwanese or else people can't understand what you said. If we segment this word by using a traditional lexicon, this word will split into 3 words, namely " " (net), " " (border), "   " (network). This will result in the incorrect reading /bbang7/, /ze3/, /bbang3-lo7/. We can extract CFSs automatically from corpus. Many of them are the words (those satisfying tone sandhi rules) of Taiwanese. They are different from traditional words in Mandarin. Some examples are shown in Table 5.

Our word segmentation tool can reduce the tone sandhi problems that are caused by wrong segmentation results. One reason is that many unknown words and proper nouns are in our CFS. Currently we have got more than 400,000 CFSs. A traditional Chinese dictionary may have about 100,000 words. We will design a tool to get more Taiwanese words from our CFSs.

Table 5: Some examples that should be read continuously in a Taiwanese TTS [Lin, 2002].

The Chinese frequent string	Segmentation by using a traditional lexicon	Interpretation in English
		A research institute of physics
		Department of chemistry
		Being beginning
		Industrialization
		Very good
		A long string of
		A sentence
		Never again
		Make one feel
		The second semester
		The internet
		Our school

We should also have good morphological rules. Atypical example in morphology is about the numbers and quantifiers. In Taiwanese there are two kinds of readings for digit: literal and speaking. They are listed in Table 6. Some problems should be resolved. For instance "   "(a person) may read as /it2-jin5/ or /ji3-lang5/.

Table 6: Pronunciations of Taiwanese digit.

Digit	0	1	2	3	4	5	6	7	8	9
Literal	kong3	it4	ji7	sam1	su3	ggonn2	liok8	cit4	bat4	giu2
Speaking	ling5	zit4	nng7	sann1	si3	ggo7	lak8	cit4	beh4	gau2

4. Word and Speech Collection

In our system, the databases are very important. If we have more Taiwanese words and their associated speech, we can avoid many errors caused by word segmentation tone sandhi. We design a platform through which we can collect more Taiwanese words and their associated speech. The main idea is that when we detected that our TTS system cannot pronounce a word in Taiwanese correctly, we will trigger a mechanism to seek the help of an expert.

There are three kinds of people in our system. One is that the common users who visit our web site to ask Taiwanese speaking. Another is some Taiwanese experts who answer the user's question by recording the words. They will also record words and

sentences in our database. The other is that the system managers who maintain and update the databases by viewing the user judgments and expert answers. The programmers are also considered as system managers.

There are five major databases in our system. They are modified by the above mentioned people. Following is a sketch of our databases.

(1) "Words": This is our main database. It stores the spelling and pronunciation of words. There are six fields in "Words", as shown in Table 7. The field "Pinyin" is the Tong-Yuong spelling of the Taiwanese word. The field "Pronunciation" is the file name of the speech from an expert. The field "Frequency" is the occurrence times of the good spelling that adjudge by user. The field "Ratio" is the ratio of some spelling of a given word. Sometimes there are different words in Mandarin and Taiwanese. " "(tomorrow) is an example. Many entries, especially those words that are long or rarely used, may have no pronunciation. It will be synthesized from synthesis units.

Table 7. An example of the database "Words".

Mandarin word	Taiwanese word	Pinyin	Pronunciation	Frequency	Ratio
		lang5	lang5_msyu	123	0.615
		jin5	jin5_msyu	56	0.28
		lin5	lin5_msyu	21	0.105
		gen3	gen3_msyu	106	0.53
		ginn3	ginn3_msyu	94	0.47
		bbing7_ten1	bbing7_ten1_msyu	63	0.17
		mi7_a1_zai3	mi7_a1_zai3_msyu	237	0.63
		bbing7_jit8		52	0.2

(2) "Expert_Words": It stores the words recorded by the experts. It has four fields, as shown in Table 8.

Table 8. An example of the database "Expert_Words".

Mandarin word	Taiwanese word	Pinyin	Prounciation
		hong7_tai1	hong7_tai1_msyu

(3) "Expert_Sentences": It stores the sentences recorded by the experts. It has a structure similar to "Expert_Words". This Table is mainly used to collect training data that can be used to get the prosodic parameters.

(4) "User_Words": It stores the words that are judged as good by the user. It has six

fields as shown in Table 9.

Table 9. An example of the database "User_Words".

Mandarin word	Taiwanese word	Pinyin	Pronunciation	Frequency	Ratio
		diong7_iang7_zing2_hu2		18	0.34
		diong7_iong7_zing2_hu2	diong7_iong7_zing2_hu2_msyu	33	0.66

(5) "Experts_Emails": It stores the names of the experts and their email addresses. Their available dates and times are also recorded. An example is shown in Table 10.

Table 10. An example of the database "Expert_Emails".

Expert' s name	Expert' s e-mail	Available date	Available time
Ming-Shing Yu	msyu@dragon.nchu.edu.tw	2002/7/13	8:00_11:30
Ming-Shing Yu	msyu@dragon.nchu.edu.tw	2002/7/24	13:00_20:30

We have five major databases like above. When users input a sentence, system will search databases in the order "Words" and "User Words". If it is found in any database, then the system output the searched pinyins and pronunciations. If we can't find the input word in the above two databases, we do tone sandhi based on the pinyins in "Words". For example, as user input "　　" which means see you tomorrow, the word will be spilt into two parts, namely "　　"(tomorrow), and "　　"(see). System will output six pinyins to the user, since there are three spellings for "　　" and two pinyins for "　". The combination with high probability will be put in the front. Sometimes we will only output a limited number of combinations.

The system managers will add every record in "Expert_Words" to "Words", unless there are obvious errors. Some pinyin may need checking since not every one is familiar with Tong-Yuong spelling. The system managers will also examine "User_Words". They will add (some modification may be needed) the good records into "Words", and discard the incorrect records. The system keeps the available times of the experts in "Expert_Emails". It will dispatch the question to an available expert or the expert who will be available soon. The expert can update their available times. When an available time passed, its entry will be deleted.

5. Summary and Future Works

In this paper we proposed a system for Taiwanese teaching and word collection. The system can translate the input Chinese sentence or word into Taiwanese speech. We improve the quality of Taiwanese TTS system in the following ways:

(1) We collect many synthesis units by finding more consonants [20], vowels [100], and tones [9].

(2) We modify the general tone sandhi rules for entering tones to get higher intelligibility and naturalness of the synthesized speech.

(3) With the help of CFSs, we get a better lexicon for Taiwanese. The output of word segmentation will be more suitable for Taiwanese TTS.

We also design a platform through which we can collect words and their pronunciation for Taiwanese lexicon by the help of users and some experts who participated in our project.

At this stage our system is to teach Taiwanese speaking. After more words are collected, we can develop better system for Taiwanese, such as word segmentor and prosody generator for Taiwanese TTS system, speech recognizer for Taiwanese, and so on.

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