

Lao Text-to-speech synthesis

HMM- based Method

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Status

- Phone inventory design for TTS (Done)
- Preparing resources and tools (Done)
- Designing and creating Lao text processing tools (Done)
- Sentence selection & speech corpus preparation (Done)
- Training and Creating synthesizer by HMM-based speech synthesis system toolkit (being trained)

Overview

- ▶ Lao language and Lao writing system
- ▶ Phonemes design for Lao TTS
- ▶ Lao Sound systems
- ▶ Syllable structure and syllable breaking
- ▶ Lao TTS Development process

Introduction to Lao language

- ▶ Lao language is the official language of Laos. It is a tonal Language of Tai family and is closely related to the Isan Language of the northeast region of Thailand
- ▶ Lao spoken Language can be divided into 3 main groups
 - Vientiane Lao
 - Northern Lao (Luang Prabang)
 - Southern Lao (Champasak)

Writing systems

- Lao language are write from left to right
- No space between word and sentence
- One word can be one or more syllables
- Lao alphabets: Lao language are contained 78 characters, divided in to 5 groups such as:
 - 33 consonants
 - 28 vowels
 - 4 tone mark
 - 10 Lao digits
 - 3 special characters

Writing system Cont.

→ Mixed Consonants

ຫ + ນ = ຫນ ຫຼື ຫນ	ຫ + ຍ = ຫຍ
ຫ + ມ = ຫມ ຫຼື ຫມ	ຫ + ວ = ຫວ
ຫ + ລ = ຫລ ຫຼື ຫລ	ຫ + ງ = ຫງ

Writing system Cont.

→ Vowels: we separated into 2 group

Single vowels and mix vowels as you see the first line of image bellow is a single vowels, last two line is mix vowels.

ឃ ា ិ ី ឺ ឺ ុ ួ េ េ ៃ ំ ៃ ខ
េ េ ៃ ោ ិ ិ ើ
ើ ោ ាំ ើ ើ ៀ ៀ

Writing system Cont.

1. Tone marks

Tonal marks are another group of alphabet letters which are symbols characterizing the change of the sounds of a syllable to follow the rule of consonants sounds with short, medium, low, high tone.



Writing system Cont.

1. Special symbol

“ ” “ ” “ ”
◌ ◌ ◌

2. Lao digits

0; 1; 2; 3; 4; 5; 6; 7; 8; 9

Sun; Nung; Song; Sam; Sii; Haa; Hok; Jet; Peed; Kao

Phoneme design for Lao TTS

Vowels		Diphthongs	
a	xɛ	ai	ໄ
a:	xɤ	ai	ໄ
i	ື	eo	ເືາ
i:	ື	eo:	ເືາວ
ʌ?	ື	ou	ໂວຍ
ɜ?	ື	ou:	ໂວ
u	ຸ	eɪ	ເື້ຍ
u:	ຸ	ei	ເື້ຍ
e	ເື	o	ໂຂຍ
e:	ເື	o:	ໂຂ
e	ເື	ɔ	ເືາຍ
ae	ແື	ʌs	ເື້ອ
o:	ໂ	ʌl	ເື້ອ
am	xɤ		

Lao Consonants	
k	ກ
k ^h	ຂ
k ^h	ຄ
ŋ	ງ
tʃ	ຈ
s	ສ
s	ຊ
ʃ	ຢ
d	ດ
t	ຕ
t ^h	ຖ
t ^h	ທ
n	ນ
b	ບ
p	ປ

p ^h	ຜ
f	ຝ
p ^h	ຟ
f	ຟ
m	ມ
j	ຢ
l	ລ
w	ວ
h	ຫ
ʔ	ອ
h	ຮ

[See All](#)

12/20/08

Sound systems

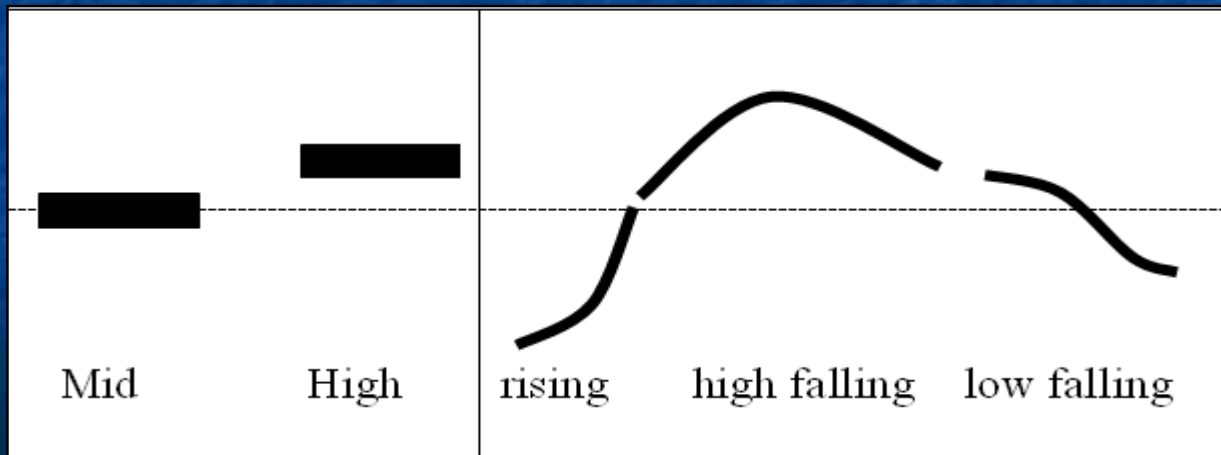
1. Consonants sound

➤ High consonants: kh,s,th,ph,f,h (ຂ ສ ຖ ຜ ຜ ຫ)

➤ Mid consonants: k,c,d,t,b,p,j,z (ກ ຈ ດ ຕ ບ ປ ຢ ສ)

➤ Low consonants: kh,ng,s,y,th,n,ph,f,m,l,w,h (ຄ ງ ຊ ມ ຫ ນ ພ ພ ມ ນ ອ ຮ)

2. Tones sound



Sound systems

VoicelessUnaspirated	k	ʈ	s	d	p	f						
VoiceAspirated	th											
Voiced	ŋ	ɟ	n	m	t	ʈ	b	j	l	w	h	z
StopConsonants	k	kh	ŋ	ʈ	d	t	ʈ	b	p	ph	f	
NonStopConsonants	s	ɟ	n	f	m	j	l	r	w	h	z	
Nasal	ŋ	ɟ	n	m								
Fricative	s	f	w	h	z	h						
Trill	r											
Lateral	l											
Approximant	j	l										

CloseVowels	i	ii	v	w	u	uu						
MidVowels	q	qq	e	ee	o	oo						
OpenVowels	a	aa	x	xx	@	@@						
FrontVowels	i	ii	e	ee	x	xx	ia	iia				
CentralVowels	v	w	q	qq	a	aa	va	wa				
BackVowels	u	uu	o	oo	a	aa	ua	uua				
Diphthongs	ai	eo	eo:	ua	uua	ia	iia	o	oo	@	@va	wa
ShortVowels	a	i	v	u	q	e	x	o	@	ua	ia	va
LongVowels	aa	ii	w	uu	qq	ee	xx	oo	@	uua	iia	wa

Lao Syllable structure

Lao syllable was designed as "**CV, CVC, CVV,**
and CVVC "

- C: Main or nuclear Consonants
- V: vowels
- C: Consonantal or final consonants

L → R **k a a n p a t i b a d**
c v c c v c v c v c
□ □ □ □

(ການປະຕິບັດ)

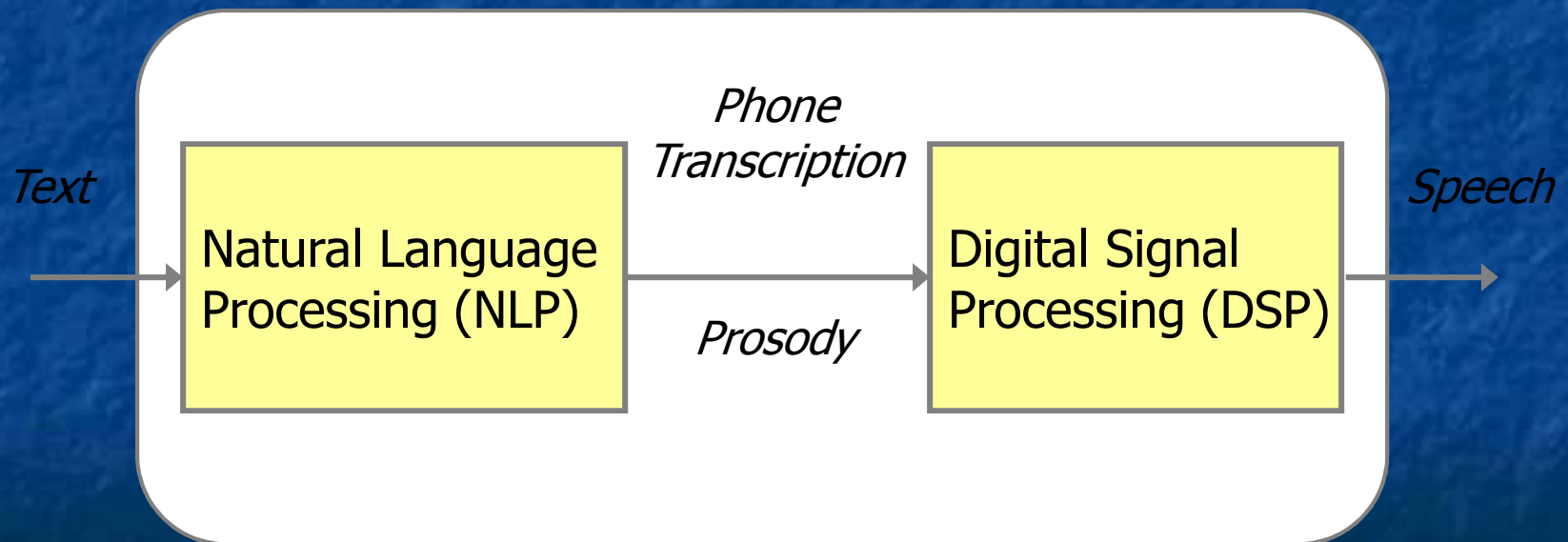
Lao Syllable breaking

ຄວາມປອດໄພພ້ອມດ້ວຍໂຄງຮ່າງການຈັດຕັ້ງດ້ານການແພດເຊິ່ງໂຄງການດັ່ງກ່າວ
ແມ່ນໄດ້ເລີ່ມກະກຽມແຕ່ເດືອນ ເມສາ 2004 ເປັນຕົ້ນມາ ແລະ ຮອດປະຈຸບັນ

/ຄວາມ/ປອດ/ໄພ/ພ້ອມ/ດ້ວຍ/ໂຄງ/ຮ່າງ/ການ/ຈັດ/ຕັ້ງ/ດ້ານ/ການ/ແພດ/ເຊິ່ງ/ໂຄງ/ການ/ດັ່ງ/ກ່າວ/
/ແມ່ນ/ໄດ້/ເລີ່ມ/ກະ/ກຽມ/ແຕ່/ເດືອນ/ /ເມ/ສາ/ 2004 /ເປັນ/ຕົ້ນ/ມາ/ /ແລະ/ /ຮອດ/ປະ/ຈຸ/ບັນ/

Lao TTS development

Have 2 main modules: Natural Language Processing or NLP Module and Digital signal processing or DSP modules



Natural Language Processing

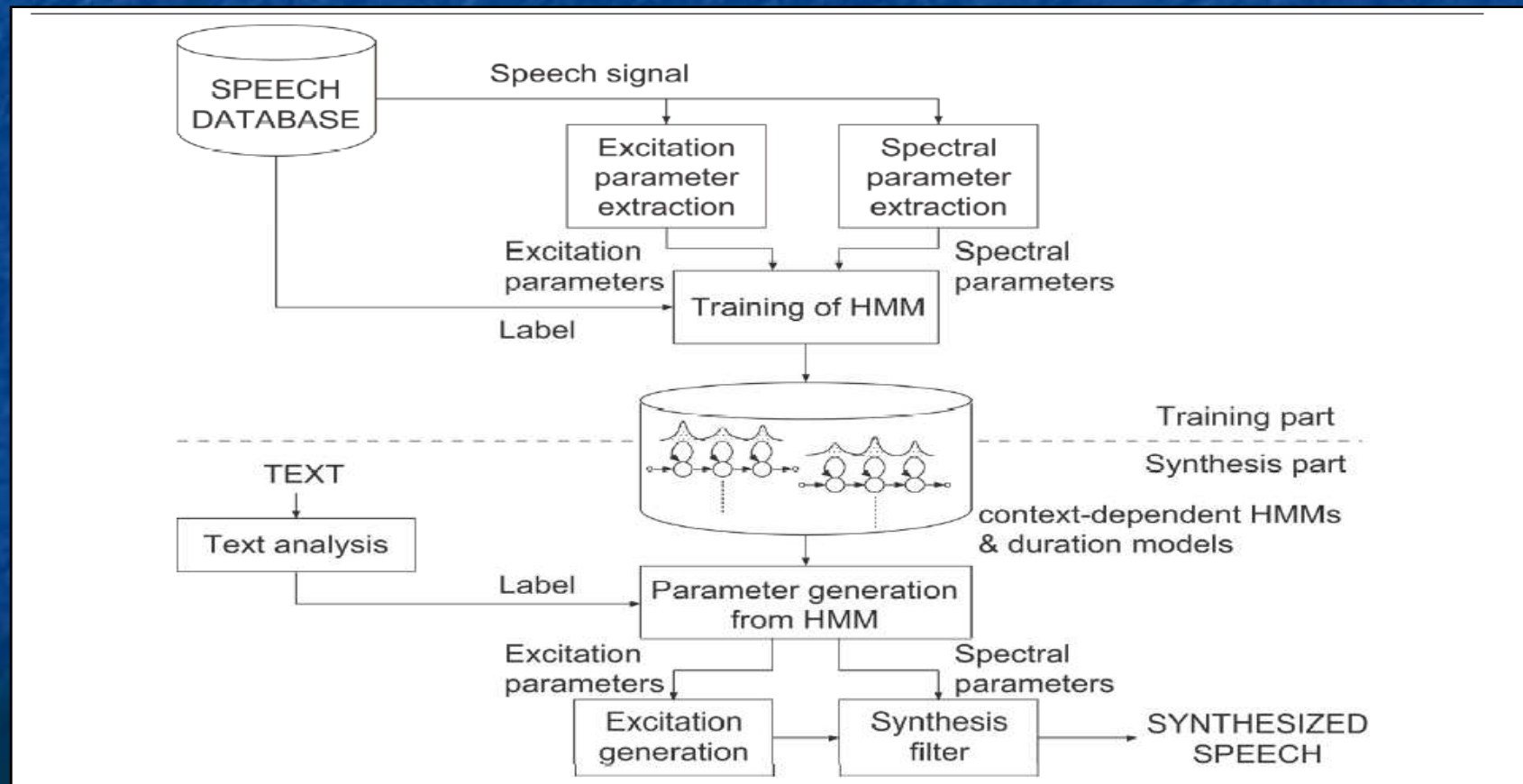
- ▶ Text analysis
 - Implemented using Lao text corpus (5 MB)
 - Sentences end marker by space and sentence long (11,159 sentences)
 - Syllable breaking based on Lao syllabification techniques
- Grapheme-to-phoneme (G2P) was implemented using Finite state Machines (FSMs) Toolkit

Natural Language Processing

- ▶ Speech corpus
 - 1,619 sentences were selected for recording
 - Including 60 phoneme and 5 tones
 - By female speaker
 - Time used: 15 hours
 - Sentence cutting by Manual
- ▶ Prosody generation
 - Using HTS toolkit to generate speech parameter Mel-Cestrum (MCEP), duration and Log fundamental frequency (Log F0) were extracted from each utterance in the speech corpus

Digital Signal Processing (DSP)

HMM-Based for speech synthesizer and now under Labeling files preparation and being training



HTS Labeling files preparation

- mono.dic : list all lao syllables with phones and tones in speech database
- word.mlf : list all lao syllable with sentence marker in speech database
- mono.unit: list all phones with tone in speech database
- mono.list : list of all phonemes in speech database.
- questions_qstLao001.hed : list of all context and properties format for tree-based context clustering.

mono.dic

```
1 !ENTER sil
2 !ENTER sp
3 !EXIT sil
4 !EXIT sp
5 (ມີ) m2 ii2 z^2
6 (ຫຼົງ) ng2 uua2 z^2
7 (ກວ່າ) kw1 aa1 z^1
8 (ໂຕ) t0 oo0 z^0
9 (ຄວາຍ) khw2 aa2 y^2
10 (ກວ່າ) kw1 aa1 z^1
11 (ໂຕ) t0 oo0 z^0
12 (ແບ້) b2 xx2 z^2
13 (ໂຕ) t0 oo0 z^0
14 (ຫມູ) m2 uu2 z^2
15 (ໂຕ) t0 oo0 z^0
16 ( ) $$ $$ $$
17 (ແລະ) l1 e1 z^1
18 ( ) $$ $$ $$
19 (ສັດ) s3 a3 d^3
20 (ປີກ) p0 ii0 k^0
```

word.mlf

```
1 #IMLF#
2 "*/output880.lab"
3 !ENTER
4 (ມີ)
5 (ຫຼົງ)
6 (ກວ່າ)
7 (ໂຕ)
8 (ຄວາຍ)
9 (ກວ່າ)
10 (ໂຕ)
11 (ແບ້)
12 (ໂຕ)
13 (ຫມູ)
14 (ໂຕ)
15 ( )
16 (ແລະ)
17 ( )
18 (ສັດ)
19 (ປີກ)
20 (ຫລາຍ)
```

questions_qstLao001.hed

```
QS LL-Consonants { "k_*","kh_*","ng_*","c_*","s_*","y_*","d_*","t_*","th_*","n_*","b_*","p_*","ph_*"}
QS LL-InitialConsonants { "k_*","kh_*","ng_*","c_*","s_*","y_*","d_*","t_*","th_*","n_*","b_*","p_*"}
QS LL-FinalConsonants { "k^_*","ng^_*","d^_*","b^_*","m^_*","y^_*","n^_*","w^_*"}
QS LL-SingleConsonants { "k_*","kh_*","ng_*","c_*","s_*","y_*","d_*","t_*","th_*","n_*","b_*","p_*"}
QS LL-VoicelessUnaspirated { "k_*","c_*","s_*","d_*","p_*","f_*" }
QS LL-VoiceAspirated { "th_*"}
QS LL-Voiced { "ng_*","y_*","n_*","m_*","t_*","th_*","b_*","j_*","l_*","w_*","h_*","z_*" }
QS LL-StopConsonants { "k_*","kh_*","ng_*","c_*","d_*","t_*","th_*","b_*","p_*","ph_*","f_*"}
QS LL-NonStopConsonants { "s_*","y_*","n_*","f_*","m_*","j_*","l_*","r_*","w_*","h_*","z_*" }
QS LL-Nasal { "m_*","n_*","ng_*","y_*" }
QS LL-Fricative { "f_*","s_*","w_*","h_*","z_*"}
QS LL-Trill { "r_*" }
QS LL-Lateral { "l_*" }
QS LL-Approximant { "l_*","j_*" }
```

Thank you for your attention

Khop cai lai lai !