AKADEMIA GÓRNICZO-HUTNICZA
IM. STANISŁAWA STASZICA W KRAKOWIE

Time durations of phonemes in the Polish language

Bartosz Ziółko, Mariusz Ziółko

Wydział Elektrotechniki, Automatyki, Informatyki i Elektroniki
Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie

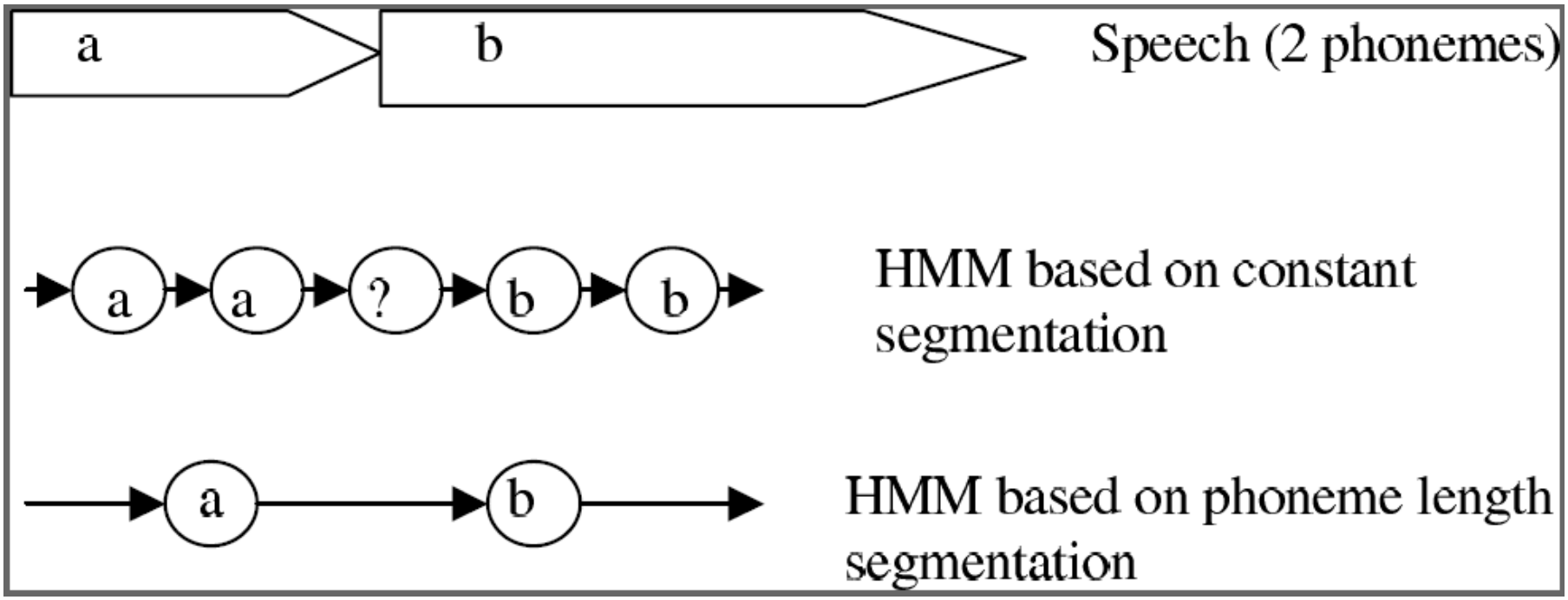
Signal Processing Group (www.dsp.agh.edu.pl)

LTC, Poznań, November 2009

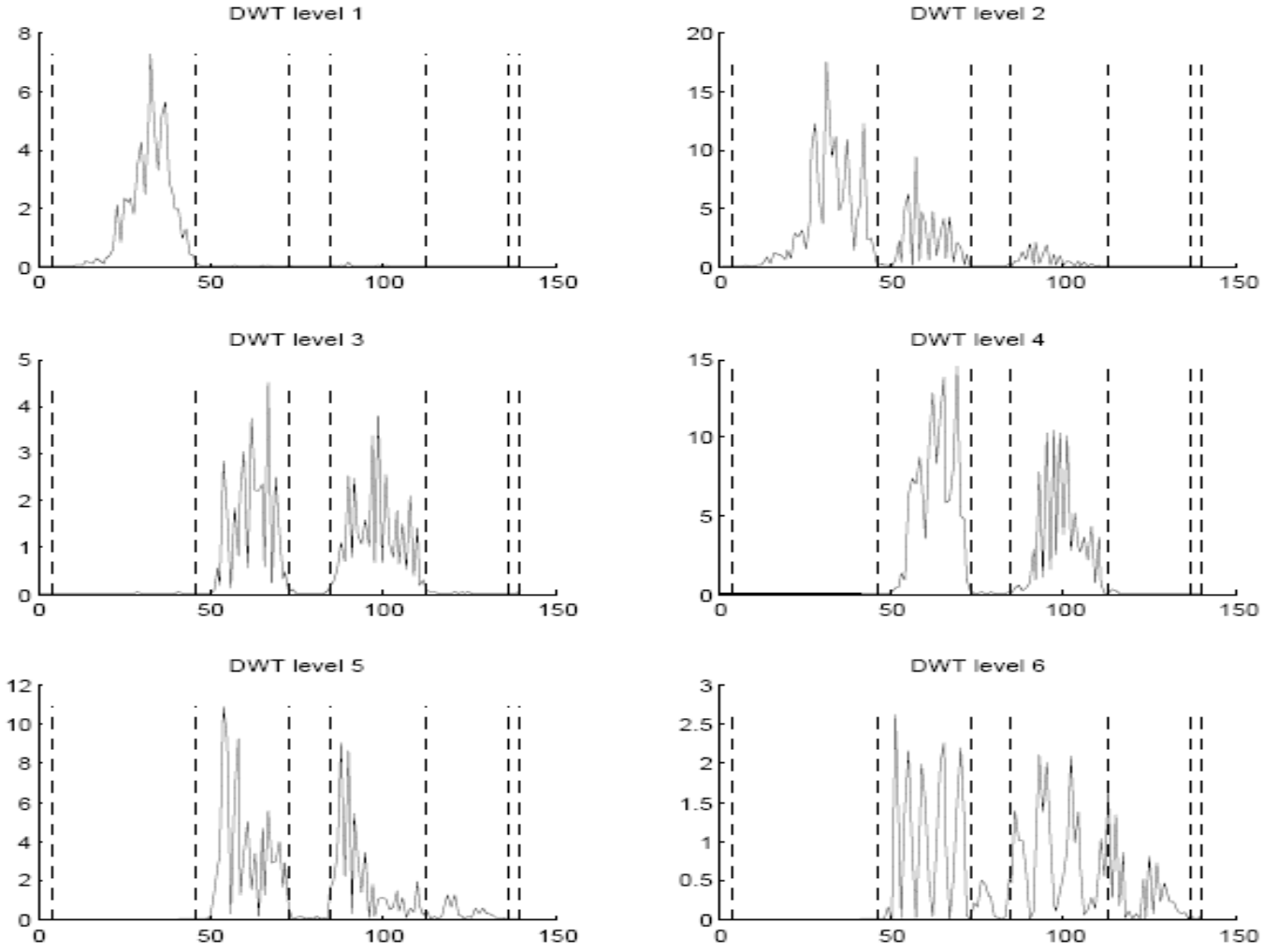
State-of-art

- B.Wierzchowska, Fonetyka i fonologia języka polskiego (Eng. Fonetics and phonology of Polish), Zakład Narodowy im. Ossolińskich.
- W. Jassem, Podstawy fonetyki akustycznej (Eng. Rudiments of acoustic phonetics), Państwowe Wydawnictwo Naukowe, 1973.
- Duration of phonemes is changeable and depends on speech ratio, type of utterance, localisation in a syllable and accents. What is quite constant is a ratio between durations of different phonemes.

Constant vs. Phoneme length segmentation



„Siedem” [Eng. Seven]



Experimental Data

Grocholewski CORPORA

The part of the database, which we used, contains 365 utterances (33 single letters, 10 digits, 200 names, 8 simple computer commands and 114 short sentences), each spoken by 28 adult males, giving 10220 utterances in total.

MLF - Master Label File

”*/ao1m1ada.lab”
0 50000 sil
100000 1350000 a
1400000 1900000 d
1950000 3100000 a
3150000 4150000 m
4200000 4350000 sil

1 unit = 100 ns

Statistics Collection

We summed all differences between starting and end times for all types of phonemes separately. The quantities of all types of phonemes in the corpus were also saved. Then the average phoneme duration was calculated, as the sum of durations divided by the number of phoneme occurrences. We calculated also standard deviation to evaluate how useful and trustworthy the data are.

Results (1)

CORPORA	SAMPA	av. duration [ms]	standard dev	example	transcr.
e_	e j~	174	58	gęś	ge~s'
a_	o w~	166	52	ciąża	ts'ow~Za
sz	S	152	59	szyk	SIk
s	s	132	46	syk	sIk
si	s'	130	45	świt	s'vit
c	ts	128	41	cyk	tsIk
a	a	127	48	pat	pat
ci	ts'	125	42	ćma	ts'ma
cz	tS	124	40	czyn	tSIn
f	f	122	64	fan	fan
zi	z'	115	33	źle	z'le
e	e	111	48	test	test
z	z	107	34	zbir	zbir
rz	Z	106	31	żyto	ZIto
drz	dz'	103	36	dźwig	dz'vik
o	o	103	35	pot	pot
h	x	100	45	hymn	xImn
dz	dz	100	35	dzwoń	dzvon'
u	u	99	42	puk	puk

Results (2)

t	t	98	52	test	test
dzi	dZ	98	27	dżem	dZem
k	k	94	45	kit	kitk
i	i	93	38	PIT	pit
p	p	93	41	pik	pik
n	n	91	41	nasz	naS
b	b	88	27	bit	bit
y	I	88	43	typ	tIp
m	m	86	34	mysz	mIS
d	d	83	29	dym	dIm
g	g	83	28	gen	gen
w	v	82	32	wilk	vilk
j	j	81	34	jak	jak
l_	w	79	33	łyk	wIk
ni	n’	76	33	koń	kon’
r	r	73	30	ryk	rIk
l	l	72	31	luk	luk
N	N	72	25	pęk	peNk
sp		68	28		
sil		15	26		

Ę Ą

CORPORA transcriptions are based on SAMPA notation with 37 symbols. Letters ę and ą are phonetically transcribed as *e_* and *a_* in CORPORA. However, these letters should be actually represented by two phonemes each. *ę* should be *e j~* and *ą* should be *o w~* but we are not able to detect these extra boundaries precisely enough. This is why we decided to keep them toegether as they are in the corpus. This is why e and a are the longest in Tab. 1. They represent two phonemes each, actually.

The standard deviations are generally high. The ratio between average duration and standard deviation vary and is around 3 to 1. Phonemes a, f, e, x, u, t, k, p, n, I, j, w have relativelly high standard deviations. It is probably a result of different ways of pronouncing these phonemes by different people.

Conclusions

- Average values of Polish phoneme durations vary from 72 ms to 174 ms.
- Usage in speech modelling and in automatic speech recognition systems.
- Standard deviations are around one third of average values.

Thank you !!!