Prosodic Analysis of Pupuh Pucung using Mbrola Speech Synthesis Application

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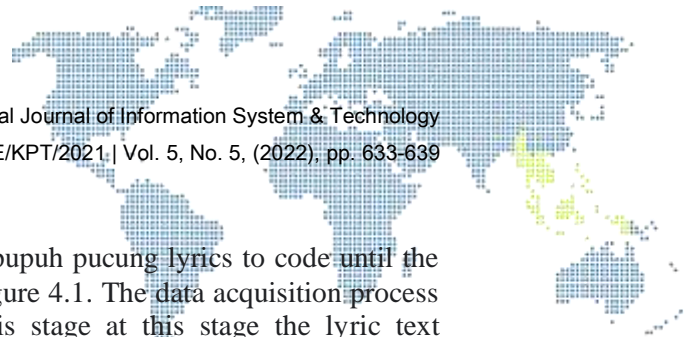*agung.indrawan@instiki.ac.id, eka.giri@instiki.ac.id*

Abstract

Pupuh Pucung is one part of the sekar alit which is part of the Balinese song. Sekar alit/pupuh has a rule in writing lyrics called padalingsa, which consists of guru wilangan, namely the number of syllables in each line, guru dingdong, which is the vowel in the last word of each line and guru gatra, which is the number of lines in one stanza. This study discusses how the text-to-speech application can help in developing pupuh pucung. Text to speech is an application that converts text into sound. In this research, an application design that can sing Pupuh Pucung's lyrics was developed with the concept of text to sing. This study uses the mbrola application as a text-to-speech converter. The analysis results, namely the frequency of the fundamental tone, aim to determine each phoneme's initial frequency in Pupuh Pucung. With the initial frequency, it will shorten the range of subsequent prosodic observations. The use of pupuh pucung's fundamental tone as a guide for the formation of prosody can be used as an initial guide in forming pupuh pucung's prosody.

Keywords: Prosodic Analysis, Pupuh Pucung, Pupuh Bali, Text to speech

1. Introduction

Pupuh pucung is a Dharma Gita or Balinese sound art. The Dharma Gita can be grouped into four types, namely Sekar Rare, Sekar Alit, Sekar Madia and Sekar Agung. Pupuh pucung is part of the Sekar Alit group. Sekar Alit is a song that contains a certain story or can also be in the form of advice that teaches goodness [1]. Sekar Alit is usually used in arja performances, which is one of the performing arts in Bali. Sekar Alit or Tembang Macepat is also often referred to as pupuh which in writing uses a rule called Padalingsa. The padalingsa rules in the sekar alit can make it easier to write the poems from the sekar alit [2]. The lyrics that have been written based on the rules of the padalingsa are sung with the tone and rhythm of the respective pupuh. The tone and rhythm of each canoe will also be different in some areas and will also be influenced by the singing habits of the singer. Until now, there are no really standard rules in singing pupuh.

To overcome the difficulties in learning to sing and compose pupuh lyrics, it is necessary to develop a system that can sing pupuh pucung with a fixed basic tone and rhythm with changes in the lyrics. Technological developments can help to overcome these difficulties. Text-to-speech technology or converting text into voice is one way to help overcome these difficulties [3]. This text-to-speech technology can change the lyric text that is made into sound in the form of singing [4]. Through this research, an analysis of the prosody resulting from the conversion of Balinese scales (titi nada) ventatonis (5 tones) will be carried out, namely: dang, ding, dong, deng, dung to the frequency of the chromatic scale with the same keyaringan one octave [5]. The use of Mbrola speech synthesis software is intended to facilitate the conversion of text-to-speech into Balinese scale conversion (point tone) [6].

2. Research Methodology

An overview of the design of the conversion of pupuh pucung lyrics to code until the Mbrola speech synthesis software can be seen in Figure 4.1. The data acquisition process is a processing process for user input text, at this stage at this stage the lyric text undergoes a validation process against Pupuh Pucung's Padalingsa rules and repairs lyric text [7]. The next process is the process of converting text to phonemes where in this process, the corrected lyrical text will be converted into the form of a code until the code is obtained from the database.
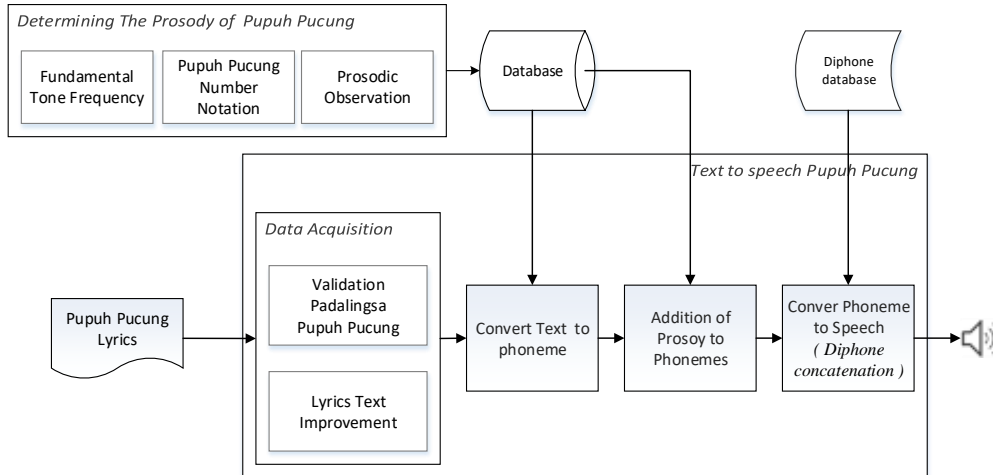

Figure 1. Research Design
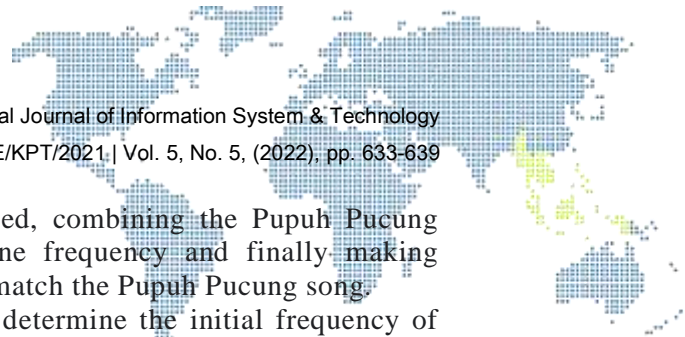
2.1. Convert Phoneme to Sampa Code's

Conversion phoneme to sampa code's is the process of converting phoneme to sampa code's mbrola. The process of converting phoneme to sampa code's form has been carried out [8]. Examples of Pupuh Pucung lyrics that have been corrected are converted to code until mbrola as shown in the following Table (1).

Table 1. Conversion Phenome to Sampa Code's

b	i	b	i		a	n	u						
b	I	b	I	_	V	n	U						

l	a	m	u	n		p	a	y	u		l	u	w	a	s		m	a	n	d	u	s
l	V	m	U	n	_	p	V	j	u	_	l	U	w	V	s	_	m	V	n	d	U	s

a	n	t	E	ng e		t	E	k	E	a	ng
V	n	t	@	N E	_	t	@	k	@	k	V	N

y	a	t	n	a	i	n		ng a		b	E		m	E	s	u	w	i
j	V	t	n	V	I	n	_	N V	b	@	_	m	@	s	U	w	I

t	i	y	u	k		p	u	n	t	u	l
t	I	j	U	k	_	p	U	n	t	U	l

b	a	w	a	ng		a	ng	g	o	n		p	a	s	i	k	E	p	a	n
b	V	w	V	N		V	N	g	Q	n		p	V	s	I	k	@	p	V	n

2.2. Pupuh Pucung's Prosodic Analysis

Pupuh Pucung's prosodic analysis is a process to find a series of prosodic sequences that match Pupuh Pucung's song [9]. The steps taken in this process are

determining the frequency of the basic tone used, combining the Pupuh Pucung number notation with the determined basic tone frequency and finally making observations and adjusting the prosodic value to match the Pupuh Pucung song.

The use of the basic tone frequency aims to determine the initial frequency of each phoneme in Pupuh Pucung [10]. With the initial frequency it will shorten the range of subsequent prosodic observations. The tone frequency used is the piano tone frequency with C equal to do. The frequency data for each tone can be seen in the following table.

Table 2. Basic Tone Frequency

Leteer Notation	Number Notation	Frequency
C	1	65.4064
D	2	73.4162
E	3	82.4069
F	4	87.3071
G	5	97.9989
A	6	110.000
B	7	123.471

Notation of pupuh pucung numbers with slendro barrel according to I Ketut Ramen in 1982 [1] can be described as follows.

Figure 2. Notation of Slendro Barrel Pucung Pupuh Numbers

The first syllable, "bi" has a notation of the number 2 (re). As in the previously described tone frequency, 2(re) has a frequency of 73.4162 Hz. This frequency is used as a prosody frequency where the Phenome /b/ and /i/ of the bi syllable are given an initial frequency value of 73.4162 Hz.

3. Results and Discussion
3.1. Prosody Frequency
At this stage, all the Phenome on the lyrics of the quail pupuh added frequency based on the Notation of The Number Pupuh Pucung Laras Slendro. Here is a Table (3) of the frequencies of each Phenome on the lyrics of the Pupuh Pucung.
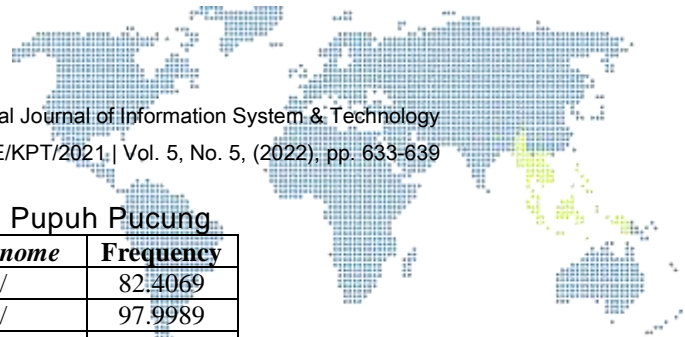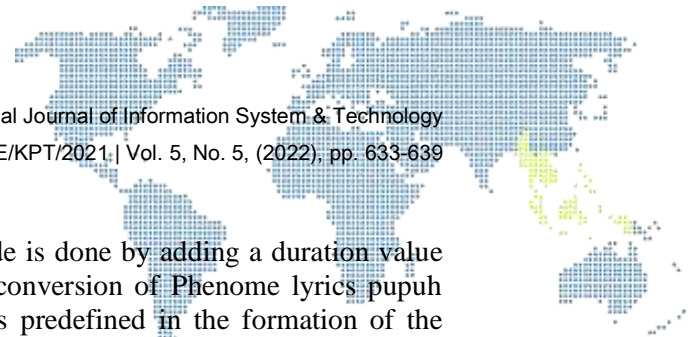
Table 3. Frequency of Lyrics Pupuh Pucung

Syllable	Number Notation	*Phenome*	Frequency
Bi	3	/b/, /i/	82.4069
bi	5	/b/, /i/	97.9989
_	-	-	-
a	3	/a/	82.4069
nu	2	/n/, /u/	73.4162
_	-		-
La	2	/l/, /a/	73.4162
mun	3	/m/, /u/, /n/	82.4069
_	-		-
pa	5	/p/, /a/	97.9989
yu	6	/y/, /u/	110.000
_	-		-
lu	5	/l/, /u/	97.9989
was	3	/w/, /a/, /s/	82.4069
_	-		-
man	1	/m/, /a/, /n/	65.4064
dus	3	/d/, /u/, /s/	82.4069
_	-		-
An	3	/a/, /n/	82.4069
te	5	/t/, /e/	97.9989
nge	3	/ng/, /e/	82.4069
_	-		-
te	2	/t/, /e/	73.4162
ke	1	/k/, /e/	65.4064
kang	6	/k/, /a/, /ng/	110.000
_	-		-
Yat	6	/y/, /a/, /t/	110.000
na	6	/n/, /a/	110.000
in	6	/i/, /n/	110.000
_	-		-
nga	2	/ng/, /a/	73.4162
be	1	/b/, /e/	65.4064
_	-		-
me	1	/m/, /e/	65.4064
su	6	/s/, /u/	110.000
wi	5	/w/, /i/	97.9989
_	-		-
Ti	5	/t/, /i/	97.9989
yuk	6	/y/, /u/, /k/	110.000
_	-		-
pun	1	/p/, /u/. /n/	65.4064
tul	2	/t/, /u/, /l/	73.4162
_	-		-
Ba	1	/b/, /a/	65.4064
wang	1	/w/, /a/, /ng/	65.4064
_	-		-
ang	6	/a/, /ng/	110.000
gon	6	/g/, /o/, /n/	110.000
_	-		-
pa	6	/p/, /a/	110.000
si	2	/s/, /i/	73.4162
ke	3	/k/, /e/	82.4069
pan	1	/p/, /a/, /n/	65.4064

3.2. Addition of Prosodi to the Sampa Code

The process of adding prosody to the sampa code is done by adding a duration value and pitch pattern to each code resulting from the conversion of Phenome lyrics pupuh quail. The duration value and pitch pattern used is predefined in the formation of the pedestal pupuh prosody. The merger between the code, duration, and pitch pattern is stored in a file with format.pho which is a format that the mbrola machine can read. Examples of the results of the formation of prosody additions from lyrics that have been converted into code form sampa, are as follows.

a) Line I

B - b 100 0 73 20 73 60 73 80 73 100 73
I - I 250 0 73 20 73 60 73 80 73 100 73
B - b 100 0 73 20 73 60 73 80 73 100 73
I - I 250 0 73 20 73 60 73 80 73 100 73
A - V 250 0 65 20 65 60 65 80 65 100 65
N - n 100 0 65 20 65 60 65 80 65 100 65
U - U 250 0 65 20 65 60 65 80 65 100 65
_ 200

b) Line II

L - l 100 0 73 20 73 60 73 80 73 100 73
A - V 250 0 73 20 73 60 73 80 73 100 73
M - m 100 0 73 20 73 60 73 80 73 100 73
U - U 250 0 73 20 73 60 73 80 73 100 73
N - n 250 0 73 20 73 60 73 80 73 100 73
P - p 100 0 73 20 73 60 73 80 73 100 73
A - V 250 0 73 20 73 60 73 80 73 100 73
Y - j 100 0 73 20 73 60 73 80 73 100 73
U - U 250 0 73 20 73 60 73 80 73 100 73
L - l 100 0 65 20 65 60 65 80 65 100 65
U - U 250 0 65 20 65 60 65 80 65 100 65
W - w 100 0 65 20 65 60 65 80 65 100 65
A - V 250 0 65 20 65 60 65 80 65 100 65
S - s 250 0 65 20 65 60 65 80 65 100 65
M - m 100 0 110 20 110 60 110 80 110 100 110
A - V 250 0 110 20 110 60 110 80 110 100 110
N - n 250 0 110 20 110 60 110 80 110 100 110
J - dZ 100 0 65 20 65 60 65 80 65 100 65
U - U 250 0 65 20 65 60 65 80 65 100 65
S - s 250 0 65 20 65 60 65 80 65 100 65
_ 200

c) Line III

A - V 250 0 110 20 110 60 110 80 110 100 110
N - n 250 0 110 20 110 60 110 80 110 100 110
T - t 100 0 73 20 73 60 73 80 73 100 73
E - @ 250 0 73 20 73 60 73 80 73 100 73
NG - N 100 0 110 20 110 60 110 80 110 100 110
E - @ 250 0 110 20 110 60 110 80 110 100 110
T - t 100 0 65 20 65 60 65 80 65 100 65
E - @ 250 0 65 20 65 60 65 80 65 100 65
K - k 100 0 110 20 110 60 110 80 110 100 110
E - @ 250 0 110 20 110 60 110 80 110 100 110
K - k 100 0 97 20 97 60 97 80 97 100 97
A - V 250 0 97 20 97 60 97 80 97 100 97
NG - N 250 0 97 20 97 60 97 80 97 100 97
_ 200

d) Line IV

Y - j 100 0 97 20 97 60 97 80 97 100 97
A - V 250 0 97 20 97 60 97 80 97 100 97

T - t 250 0 97 20 97 60 97 80 97 100 97
N - n 100 0 97 20 97 60 97 80 97 100 97
A - V 250 0 97 20 97 60 97 80 97 100 97
I - I 250 0 97 20 97 60 97 80 97 100 97
N - n 250 0 97 20 97 60 97 80 97 100 97
NG - N 100 0 65 20 65 60 65 80 65 100 65
A - V 250 0 65 20 65 60 65 80 65 100 65
B - b 100 0 110 20 110 60 110 80 110 100 110
E - @ 250 0 110 20 110 60 110 80 110 100 110
M - m 100 0 110 20 110 60 110 80 110 100 110
E - @ 250 0 110 20 110 60 110 80 110 100 110
S - s 100 0 110 20 110 60 110 80 110 100 110
U - U 250 0 110 20 110 60 110 80 110 100 110
W - w 100 0 82 20 82 60 82 80 82 100 82
I - I 250 0 82 20 82 60 82 80 82 100 82
_ 200

e) Line V
T - t 100 0 82 20 82 60 82 80 82 100 82
I - I 250 0 82 20 82 60 82 80 82 100 82
Y - j 100 0 110 20 110 60 110 80 110 100 110
U - U 250 0 110 20 110 60 110 80 110 100 110
K - k 250 0 110 20 110 60 110 80 110 100 110
P - p 100 0 65 20 65 60 65 80 65 100 65
U - U 250 0 65 20 65 60 65 80 65 100 65
N - n 250 0 65 20 65 60 65 80 65 100 65
T - t 100 0 65 20 65 60 65 80 65 100 65
U - U 250 0 65 20 65 60 65 80 65 100 65
L - l 250 0 65 20 65 60 65 80 65 100 65
_ 200

f) Line VI
B - b 100 0 110 20 110 60 110 80 110 100 110
A - V 250 0 110 20 110 60 110 80 110 100 110
W - w 100 0 110 20 110 60 110 80 110 100 110
A - V 250 0 110 20 110 60 110 80 110 100 110
NG - N 250 0 110 20 110 60 110 80 110 100 110
A - V 250 0 97 20 97 60 97 80 97 100 97
NG - N 250 0 97 20 97 60 97 80 97 100 97
G - g 100 0 97 20 97 60 97 80 97 100 97
E - @ 250 0 97 20 97 60 97 80 97 100 97
N - n 250 0 97 20 97 60 97 80 97 100 97
P - p 100 0 82 20 82 60 82 80 82 100 82
A - V 250 0 82 20 82 60 82 80 82 100 82
S - s 100 0 110 20 110 60 110 80 110 100 110
I - I 250 0 110 20 110 60 110 80 110 100 110
K - k 100 0 110 20 110 60 110 80 110 100 110
E - @ 250 0 110 20 110 60 110 80 110 100 110
P - p 100 0 110 20 110 60 110 80 110 100 110
A - V 250 0 110 20 110 60 110 80 110 100 110
N - n 250 0 110 20 110 60 110 80 110 100 110

4. Conclusion

Based on analysis, using the basic tone of the boil pupuh as a guideline for the formation of prosodi can be used as an initial guide in forming the prosodi pupuh quail. The prosodi results produced in this study still sound unnatural but already sound to have the basic tone of pupuh pucung

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