

ISOLATED MALAY SPEECH
RECOGNITION USING FUZZY LOGIC

NORMIZA BINTI MOHD YUSOF

BACHELOR OF COMPUTER SCIENCE
(COMPUTER SYSTEM & NETWORKING)

UNIVERSITI MALAYSIA PAHANG



SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Computer Science (Computer System and Networking).

(Supervisor's Signature)

Full Name : DR NOORHUZAIMI @ KARIMAH BINTI MOHD NOOR

Position : SENIOR LECTURER

Date : 11th JANUARY 2019



STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

(Student's Signature)

Full Name : NORMIZA BINTI MOHD YUSOF

ID Number : CA 15078

Date : 11th JANUARY 2019

ISOLATED MALAY SPEECH RECOGNITION USING FUZZY LOGIC

NORMIZA BINTI MOHD YUSOF

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Computer Science (Computer System & Networking)

Faculty of Computer System & Software Engineering

UNIVERSITI MALAYSIA PAHANG

JAN 2019

ACKNOWLEDGEMENTS

Firstly, I would like to thank to Allah S.W.T for giving me a good health and strength to finish the research. As the research is very important for me to evaluate my knowledge and skills during the process to complete my final year research project.

Next, I would thank to my lovely supervisor Dr Noorhuzaimi@Karimah binti Mohd Noor for giving me a chance to be one of her protege to finish my final year project. She is very good supervisor as she is the one of my greater guider, supporter and helper for me to finish my research project. Thank for the endless time, encouragement, opinions, suggestions and invaluable advice to complete my research.

Besides that, I would like to thank to my parent Mohd Yusof bin Halos and Uji Syariza binti Kadri that always give full support and guidance for me to finish my final year project. They always support me in my studies especially to finish and complete my greatest challenges which is final year project.

Lastly, I would like to extend my gratefulness to other person who directly or indirectly involved in my final year project.

ABSTRAK

Kecerdasan Buatan (AI) adalah salah satu kaedah yang digunakan oleh manusia untuk berkomunikasi diantara manusia dan komputer. Terdapat banyak aplikasi yang dihasilkan dengan menggunakan pendekatan AI seperti diagnosis perubatan, membuktikan teorem matematik dan kenderaan autonomi. Terdapat banyak kaedah dan pendekatan yang telah digunakan oleh penyelidik terdahulu untuk membangunkan sistem pengecaman pertuturan seperti neural network dan Hidden Markov Model. Matlamat penyelidikan ini adalah untuk membangunkan sistem pengecaman ucapan Bahasa Melayu yang terpendek menggunakan kaedah Fuzzy Logic. Kajian ini menumpukan kepada enam perkataan terpendek iaitu *empat (four)*, *lapan (eight)*, *rekod (record)*, *tidak (no)*, *tujuh (seven)* dan *tutup (close)*. Kajian ini juga menumpukan kepada perkembangan peraturan kabur diantara setiap perkataan. Proses penilaian dijalankan berdasarkan kadar ketepatan dan perbandingan diantara kaedah sebelumnya yang menggunakan Hidden Markov Model. Keputusan menunjukkan 75% kadar ketetapan pengenalan suara menggunakan kaedah Fuzzy Logic.

ABSTRACT

Artificial intelligence (AI) is one of the method that human use to communicate between human and computer. There are a lot of applications has been produces by AI approach such as medical diagnosis, proving mathematical theorems and autonomous vehicle. Many methods and approach has been used by researcher to develop speech recognition system such as neural network and Hidden Markov Model. This research aim is to develop a isolated Malay speech recognition using Fuzzy Logic method. This research is focused on six isolated words which is *empat* (*four*), *lapan* (*eight*), *rekod* (*record*), *tidak* (*no*), *tujuh* (*seven*), and *tutup* (*close*). This research is also focused on the development of fuzzy rules between each words. The evaluation process is measured based on the accuracy rate between the previous method using Hidden Markov Model. The result show that 75% speech recognition accuracy rate using fuzzy logic method.

TABLE OF CONTENT

DECLARATION	
TITLE PAGE	
ACKNOWLEDGEMENTS	ii
ABSTRAK	iii
ABSTRACT	iv
TABLE OF CONTENT	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
LIST OF SYMBOLS	x
LIST OF ABBREVIATIONS	xi
CHAPTER 1 INTRODUCTION	1
1.1 Introduction	1
1.2 Problem Statement	3
1.3 Objective	4
1.4 Project Scope	4
1.5 Thesis Organization	5
CHAPTER 2 LITERATURE REVIEW	7
2.1 Introduction	7
2.2 Speech Recognition Method	8
2.2.1 Neural Network Method	8
2.2.2 Mel Frequency Cepstral Coefficients (MFCC) & Vector Quantization Using Linde-Buzo Gray (VQLBG)	9

2.2.3	Dynamic Multi-Pipeline API Method	11
2.2.4	Hidden Markov Model	12
2.2.5	Neuro Fuzzy Approach	12
2.3	Methodology	16
2.4	Speech Recognition Process	16
2.5	Data Sets	17
2.6	Conclusion	17
 CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY		18
3.1	Introduction	18
3.2	Methodology	18
3.3	Literature Review	20
3.4	Features Determination	21
3.5	Fuzzy Values	26
3.6	Conceptual Model	27
3.7	Evaluation Process	29
3.8	Hardware and Software Requirements	30
3.9	Gantt Chart	31
3.10	Comclusion	31
 CHAPTER 4 SPEECH RECOGNITION IMPLEMENTATION		32
4.1	Introduction	32
4.2	Experiment Setup	33
4.2.1	Data Preparation	33
4.2.2	Rules Preparation	33
4.2.3	Develop Prototype	38

4.2.4	Google Cloud's Speech Recognition API	38
4.2.5	Python	40
4.2.6	Algorithm	41
4.3	Experiment Testing	44
4.4	Conclusion	44
CHAPTER 5 RESULTS AND DISCUSSION		45
5.1	Introduction	45
5.2	Performance Speech Recognition with Fuzzy Logic	45
5.3	Fuzzy Logic vs Hidden Markov Model	48
5.4	Conclusion	50
CHAPTER 6 CONCLUSION		51
6.1	Introduction	51
6.2	Research Constraints	52
6.3	Future Works	52
REFERENCES		53
APPENDIX A		54

LIST OF TABLES

Table 2.1	The summarization of comparison existing speech recognition application that has been produced by previous researcher	13
Table 3.1	The words that possible same with tujuh	23
Table 3.2	Rules for determine word <i>empat</i> (four) which are three rules that can be show word that used by user as word <i>empat</i>	26
Table 3.3	List of hardware and software	30
Table 4.1	Rules for empat	33
Table 4.2	Rules for lapan	34
Table 4.3	Rules for rekod	35
Table 4.4	Rules for tidak	35
Table 4.5	Rules for tujuh	36
Table 4.6	Rules for tutup	37
Table 5.1	The words that has comes out when the testing process is running	46

LIST OF FIGURES

Figure 2.1	Block diagram of Mel Frequency Cepstral Coefficients (MFCC)	10
Figure 3.1	Methodology Diagram	19
Figure 3.2	The example of phenomes in Standard Malay Sound System	22
Figure 3.3	Speech frequencies for tuju and tujuh	24
Figure 3.4	Speech frequencies for empat and tempat	24
Figure 3.5	Speech frequencies for lapan and papan	25
Figure 3.6	Speech frequencies for rekod and poskod	25
Figure 3.7	Speech frequencies for tidak and today	25
Figure 3.8	Speech frequencies for tutup and cukup	26
Figure 3.9	The conceptual model for speech recognition process	27
Figure 4.1	Coding used to support Google Cloud's Speech Recognition API	39
Figure 4.2	The packages in the Python that has been used in this research	40
Figure 4.3	The pseudocode for the speech recognition system	41
Figure 4.4	The prototype for the speech recognition system	43
Figure 5.1	The bar graph for speech recognition accuracy rate in percentage for each of the words	47
Figure 5.2	The bar graph for performance of speech recognition using Fuzzy Logic and Hidden Markov Model	48

LIST OF SYMBOLS

Va	Total number of success training
Vb	Total number of training

LIST OF ABBREVIATIONS

AI	Artificial Intelligence
ANFIS	Adaptive Neuro Fuzzy Inference System
ANN	Artificial Neural Networks
C	Consonant
CVCs	Consonant-Vowel-Consonants
DSP	Digital Signal Processing
DTW	Dynamic Time Warping
GUI	Graphical User Interface
HMM	Hidden Markov Model
MFCC	Mel Frequency Cepstral Coefficient
SAPI 5.3	Speech Application Programming Interface 5.3
STT	Speech to Text
VQLBG	Vector Qualification using Linde-Buzo-Gray

CHAPTER 1

INTRODUCTION

1.1 Introduction

Speech recognition is one of the methods that has been used to communicate between the human and the computer. As the technology becomes more advanced year by year, speech recognition systems have grown a lot to help humans do their daily activities easier. There are a lot of methods that have been used by previous researchers to upgrade and enhance the speech recognition system such as Hidden Markov Model (HMM) by Fadhilah Rosdi (2008), neural networks by Gulin Dede (2009) and Dynamic Multi-Pipeline API by Sirikongtham and Paireekreng (2017). All of these methods have their own average rate accuracy depends on the problem that they solved.

Malay language is a language that is used as a national language in Malaysia. This language also has been used in Singapore as one of the official languages in the country. Other countries that also use the Malay language are Indonesia, Brunei and southern Thailand but in different accents and dialects. Unlike English words, Malay words do not need lexical stress which means a non-tonal language. Malay language also has been used in English words such as *informasi* (information), *parkir* (parking) and *librari* (library).

In Malay language, there is 37 set of phoneme that are used as phonemic representation. Phoneme is the tiny unit in speech which the substitution of this will affect the meaning. In Malay language has 6 vowels, 27 consonants, 3 diphthongs and 1 for silence. The words have a combinations between vowels (V) and consonants (C). The vowels are divided into two which is vowel backness and vowel height. In each of the words, they have different structures of syllables. The example of structures of syllables is V, CV, VC CVC and many more. The syllables also consist of onset and rhyme but within the rhyme also have a peak and coda.

This research proposed of using fuzzy logic method to increase the performance of speech recognition system. Fuzzy logic is one of the method in Artificial Intelligence that has used widely by researcher to proof and analyse their data according to the rules and steps that they have created. However, Malay speech recognition is still new in our computer industry and technology. This is due to the limitation of finding a related work.

Different people produce different features of speech. Some of them can speak slow, fast, high pitch, low pitch and sometimes whispered. Speed of the speech also can be different for each of them. There are many reasons why the existing system and algorithm is not effective to be use because do not achieve human requirement. Compared to manual method such as written language, it may lead to some difficulties that can affect the recognition process. If the recognition process failed, so the recognition rate also low.

Besides, a lot of speech recognition system has been investigated by previous researcher. There still need a lot of improvement since every system that they implement in different language that have different syntactic and semantic knowledge.

1.2 Problem Statement

Some of the implementation of the system is based on the problem human faced in their daily life. Some of the speech recognition application has been applied in car system by Loh, Boey, and Hong (2017). Loh et al. (2017) has highlight the speech recognition system in the automotive field is implement to control the features in the cars such as controlling the multimedia system using command and output to support the user. The purpose they create this system is to communicate between the system and the person in car. This system also will manage some specific functions in the vehicle such as the command for open and close the door, switch on and off the headlamp and for the signal indicator in the vehicle.

Fadhilah Rosdi (2008), has found that word *empat* and *tutup* has the lowest recognition rate. This is because the word *tutup* is recognize as *tujuh* in the system because of the word structure quite similar to each other's. In Malay language, vowel sound plays an important role to determine the value of the features for each word. The combination of the vowel "u" in between the consonants in the word produces the same values. Therefore, the system recognises *tutup* as *tujuh* due to this problem.

Reem Sabah (2009), the system has been limited to digit 0-9 only. The system used to recognised isolated Malay digits from (0-9) by using ANFIS classifier. The digit is recorded in Malay language without considering any environment factors when recording the sample. They used very small data sets and cannot recognise the continuous speech. The proposed solution result's shows 85.24% average rate which is low and still need more improvement.

REFERENCES

- Fadhilah Rosdi, R. N. A. (2008). Isolated Malay Speech Recognition Using Hidden Markov Model. 5.
- Gulin Dede, M. H. S. (2009). Speech Recognition with Artificial Neural Networks. 6.
- Gustavo Boza-Quispe, J. M.-F., Jimmy Rosales-Huamani, Fabricio Puente-Mansilla. (2017). A Friendly Speech User Interface based on Google Cloud Platform to Access a Tourism Semantic Website.
- H. F. Ong, A. M. A. (2011). Malay Languages Speech Recogniser with Hybrid Hidden Markov Model and Artificial Neural Network (HMM/ANN). 6.
- Jozef, M. (May 2018). Voice Control of Smart Home by Using Google Cloud Speech-To-Text API. (Software Engineering Bachelor's Thesis), JAMK University of Applied Sciences, JAMK University of Applied Sciences.
- Loh, C. Y., Boey, K. L., & Hong, K. S. (2017, 10-12 March 2017). Speech recognition interactive system for vehicle. Paper presented at the 2017 IEEE 13th International Colloquium on Signal Processing & its Applications (CSPA).
- Md Salam, D. M., Sheikh Salleh. (2011). Malay Isolated Speech Recognition Using Neural Network: A work in Finding Number of Hidden Nodes and Learning Parameters. 8.
- Reem Sabah, R. N. A. (2009). Isolated Digit Speech Recognition in Malay Language using Neuro-Fuzzy Approach 5.
- Sirikongtham, P., & Paireekreng, W. (2017, 22-24 Nov. 2017). Improving speech recognition using dynamic multi-pipeline API. Paper presented at the 2017 15th International Conference on ICT and Knowledge Engineering (ICT&KE).