Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF MALAYSIAN SIGN LANGUAGE (MSL) TRANSLATOR USING DEEP LEARNING APPROACH

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Bachelor of Electronics Engineering Technology with Honours

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I declare that this project report entitled "Development of Malaysian Sign Language (MSL) Translator Using Deep Learning Approach" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology with Honours.

Signature :

Supervisor Name : Dr. Haslinah Binti Mohd Nasir

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DEDICATION

To my dear family,

To my loyal friends,

To my supervisor and mentors,

And to my dearest self.

ABSTRACT

Malaysian Sign Language (MSL) has been used as a means of communication in Malaysia between the deaf and the hearing people. Many people still could not take a grasp on what is being conveyed by the deaf which may cause misunderstanding. Thus, the aim of this project is to develop a MSL translator interface which able to detect the type of gestures when signing and a speech to text conversion. A deep learning approach is used focusing on the image classification that are known as “Hai”, “Tak”, “Terima Kasih” by utilizing TensorFlow and Mediapipe software where the model build will be trained using labeled images and identify its classes. This project has been develop succesfully of a MSL translator interface that can assist both the deaf and hearing people for a better two way communication in the future with the rate of confidence of more than 95 percent. In essence, it is to help in bridging the gap between the communication of the deaf and hearing people.

ABSTRAK

Bahasa Isyarat Malaysia (BIM) telah digunakan sebagai satu cara untuk komunikasi di Malaysia antara komuniti pekak dan yang mampu. Ramai orang yang masih lagi tidak dapat memahami apa yang cuba disampaikan oleh komuniti pekak yang boleh menyebabkan salah faham. Oleh itu, matlamat utama projek ini adalah untuk membina satu sistem penterjemah dimana ianya mampu untuk mengesan jenis pergerakan apabila sedang memberi isyarat tangan dan penukaran kata kepada ayat. Satu pendekatan pembelajaran dalam yang tertumpu kepada pengelasan imej yang dikenali sebagai "Hai", "Tak", "Terima Kasih" dengan memanfaatkan penggunaan perisian TensorFlow dan Mediapipe di mana binaan model akan di latih menggunakan label imej dan mengenalpasti pengelasan tersebut. Projek ini telah berjaya dibangunkan iaitu satu antara muka penterjemah BIM yang dapat membantu kedua-dua komuniti pekak dan mampu untuk komunikasi dua hala yang lebih baik pada masa yang akan datang dengan kadar keyakinan melebihi 95 peratus. Asasnya, ianya adalah untuk mengurangkan jurang komunikasi antara komuniti pekak dan mampu.

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LIST OF ABBREVIATIONS

MSL	-	Malaysian Sign Language
ASL	-	American Sign Language
API	-	Application Programming Interface
BSL	-	British Sign Language
BIM	-	Bahasa Isyarat Malaysia
MFD	-	Malaysian Federation of the Deaf
kNN	-	K-Nearest Neighbour
PCA	-	Principal Component Analysis
HMM-SVM	-	Hidden Markov Model – Support Vector Machine
SLR	-	Sign Language Recognition
IDE	-	Integrated Development Environment
LSTM	-	Long Short-Term Memory
NLP	-	Natural Language Processing

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Over 5% of the world's population, require rehabilitation to address their 'disabling' hearing loss [1]. Clear communication are keys to better outcomes. However, creating a responsible community wholly to better improve communication between all groups with a disability, especially the deaf, also plays an important role. In Malaysia, only a small number of people can converse in sign language known as the Malaysian Sign Language (MSL), which began in 1954 that started its course with the enrollment of seven students [2]. Miscommunication is a major issue in the deaf and the hearing people since it has been neglected as it is not seen as important and interactions with them are a little to none. The project is intended to aid in communication between deaf and hearing people by using a mobile application. By applying this project, sign language can be directly understood and learned the essence of the sign language itself. The sign language used is focused on MSL which originally had some similarity to that of its origin which is the American Sign Language (ASL) [3]. In order to achieve this, images of hand gestures are fed into the system to further train the system focusing on the MSL. The image can be patterned in the form of classes depending on the context.

1.2 Problem Statement

As the year progresses, communication medium has been fast-growing and accessible, but not so much for the deaf. Engaging with other people, attending interviews, finding employment, or even asking for help can be much work when it should be done much more effortless. The main issue is when the outside world especially hearing people have a hard time communicating with the deaf [4]. There are several ways to bridge this gap by referring to the internet and books, taking class on sign language, or possibly hiring a translator. All this method has one thing in common: taking time and money. There is no denying that referring to the internet or books can help, but translating a conversation correctly can be time-consuming, even through flipping book pages. Even worse for the internet, the information put up online could be misleading and inaccurate.

1.3 Project Objective

The main objective of this project is to develop a MSL translator interface that will assist in the communication between the deaf and hearing people. Specifically, the objectives are as follows;

a) To study the Malaysian Sign Language (MSL) and its structure.

b) To develop a machine learning artificial intelligence model to detect types of gestures of sign language.

c) To validate the functionality of developed MSL translator through a Computer Vision user interface.

1.4 Scope of Project

Figure 1.1 Scope of project

From the Figure 1.1, under the detection, the laptop's camera is used to detect the signing gesture. Followed by the process, the gesture detected will be processed by the TensorFlow and Mediapipe library for the image classification. Lastly, the translation is displayed through the laptop screen. Similar for the speech-to-text, the microphone from the laptop will detect the voice input from the user and send it to Google's server for processing and return it to the system for the program to display on the MSL translator interface.

Generally, the scope of this project are as follows:

a) Focuses on communication between the deaf and hearing people.
b) Involves image classification that is run through TensorFlow and Mediapipe
c) Using Computer Vision algorithm for the MSL translator user interface.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter explain the researches of literature related to this project. It contains of some work that already done by other researches or institutes. They have also described several concepts of this project in this chapter. This is because the understanding between theory and work will help much in preparing this project. Some of the past researches includes the usage of hardware and as the year progresses, the system are upgraded to better portability.

2.2 Deafness

In general, aging, genetics, exposure to loud noises for a long period of time are all the possible cause of having deafness [1]. Deafness occurs when a person could not understand of what is being said even the sound has been amplified [5]. Especially for children, as the hearing sensory of the ear could not function, it will also affect the development of talking and language skills [6]. How much noise interferes with speech perception depends on a variety of factors, including impairments in peripheral and central auditory function as well as general cognitive capacities such as awareness [7].

2.3 Sign Language

American Sign Language (ASL) is a fundamentally different language from English. It has its own rules for pronunciation, word creation, and word order, as well as all of the essential properties of language. Languages differ in how they signal distinct functions, such as asking a question rather than delivering a statement. For example, English speakers may pose a question by raising their voices and modifying word order; ASL users raise their eyebrows, broaden their eyes, and lean their bodies forward to ask a question. ASL is a complete, natural language with similar linguistic features to spoken languages but different grammar than English. Hand and face movements are used to express ASL [8].

Just like other languages, there are also other sign languages such as British Sign Language (BSL) and Malaysian Sign Language (MSL) just to name a few. BSL is a spatial and visual language that many beginners mistake for mime. The first crucial thing to understand is that BSL grammar differs significantly from that of everyday English. Despite the fact that both the United Kingdom and the United States of America speak English as their first language, British Sign Language differs from American Sign Language [2]. This indicates that, despite the fact that English is the primary language in various countries, the sign language used varies.

Supposed that ASL and BSL are similar to each other but they are in fact completely different which takes about 30% of similarities between the signage even both languages are of one the same. Compared to ASL, BSL uses two hand to sign while the former uses one [9]. As per below Figure 2.3, the difference between the two sign languages is the used of hand to sign.

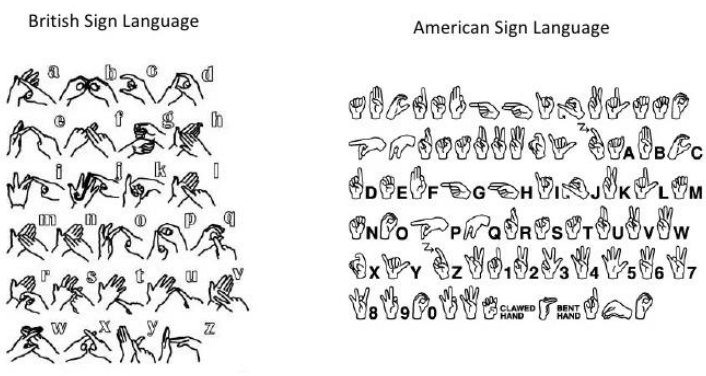

Figure 2.1 Differences between BSL and ASL

As for MSL, although it is based on American Sign Language (ASL), the two languages are considered separate. In turn, Bahasa Isyarat Malaysia (BIM) served as the foundation for Indonesian Sign Language. Malaysian deaf people use MSL, or Bahasa Isyarat Malaysia (BIM), for everyday communication. Despite the fact that MSL has been localised in specific regions or communities, most deaf persons can understand the standard MSL. As a result, the focus of this research is solely on the standard MSL specified by the Malaysian Federation of the Deaf (MFD), a competent body that monitors and maintains Malaysia's MSL [3].

2.3.1 Static and Dynamic Sign Language

In terms of static sign language recognition, studies have explored the use of deep learning techniques such as convolutional neural networks (CNNs) and long short-term memory (LSTM) networks to classify static sign language gestures from video data. A study by Buckley et al. (2021) used a deep CNN model to developed real-time web-camera based of British Sign Language (BSL) recognition system and achieved an accuracy of 89% [10]. Another study by Joshi et al. (2022) proposed an action recognition sign language certification platform by using LSTM for ASL learning platform and achieved an accuracy of more than 98% [11]. These methods have shown promising results, with some studies achieving high accuracy rates in gesture recognition.

Research on dynamic sign language recognition has also been conducted, with a focus on developing algorithms that can analyze the motion and dynamics of sign language gestures. Methods such as hidden Markov models (HMMs) have been used to model the temporal dynamics of sign language and improve recognition performance. A study by Lynn et al. (2022) proposed a HMM-based approach to recognize dynamic hand gesture and achieved an accuracy of 92.86% [12].

2.4 Related Past Research

Related past research has shown that the project related to the sign language has been evolving throughout the year from the usage of the hardware and to fully software based. It is clear that communication is a two-way process which in this case the sign language should not only help in healthy people understands, but also for the deaf to understand the conveyed information as well.

2.4.1 Sensory Glove-Based

One of the research is using portable sign language translator by using glove. The glove is integrated with a mobile phone application which uses both left and right hand. The device collects gesture posture with internal special sensors, realizes sign language posture using gloves, broadcasts sign language recognition results via mobile application, and allows non-deaf-mute individuals to accurately understand sign language [13].

Other research intends to integrate the glove with computer system using a technology of a flex sensor. The technology works by having the signer wear a sensor-based hand glove that is connected to a computer that automatically interprets the sign mode and translates it into the appropriate English alphabet or phrase. The sensor data for the signs are recorded by an Arduino and analyzed using the K-nearest neighbor (kNN) machine learning algorithm once the sign gestures have been taken using the glove [14].

Abdullah et. al develop a project where it improves the usefulness and mobility of Malaysian Sign Language (MSL) gestures by optimizing an inertial measurement unit (IMU) sensor-based technique. The optimization itself shows that arranging the sensors in specific location that has a complementary behavior to each other increases the accuracy by more than 98% [15].

2.4.2 Computer-Based

Apart from that, a computer visual-based using camera that acts as the device input has also taken the researches before to another stepping stone since that there are some of the micro-gestures that could not be detected by glove hence, the desired output could not be achieved. This method were designed with multiple attributes including authentication of user, recognition of the sign language, generation of the sign language, and services of remote communication. To be more specific, the system itself used PyQT user interface where once the user has logged into the system, option can be made to choose between sign language recognition and sign language generation. The former will capture the hand-movement of the user where the output is English letters along with number from zero until nine that focuses on the ASL and Arabic numerical gestures. Whereas for the latter, detecting the user's voice or text and converting it to English, then again, converting the identified sign language pictures into a video display for the user [16].

Promila Haque et al. created a two-handed Bangla Sign Language Recognition system that recognises 26 different sign motions. The system is divided into three phases: data formation, training, and classification. It makes no use of instrumented wiring devices such as "data gloves" or supplementary hardware and markers. The proposed system can be used by anyone because it does not require any additional components. The system used were Principal Component Analysis (PCA) and K-Nearest Neighbors as their classification algorithm [17].

2.4.3 Smartphone-Based

Smartphone is undeniably an important medium for communication as it is more portable then a computer. Hence, the technology of the sign language recognition has migrated into a better mobility to carry everywhere. According to a research paper by Wang et al. (2018), speech to sign language using animation model were developed for Android phone that focuses on the Chinese Language. It is designed as a support to answer calls. In addition, it improves the interrogative expression of the system by using interrogative pronoun checking and an HMM-SVM model [18].

Another research involved a real-time sign language translation from several Indian languages and English with the use of authentication. The system called 'Sign Translator' that will detect speech as input where it will match the voice with the string and the suitable image connected with the string. Thus, it is then translated to Sign Language where healthy people will be able to convey their thoughts and translated into sign language where deaf individuals will be able to grasp the output and easily understand in their comfortable sign language [19].

"Hand Gesture Recognition System For Translating Indian Sign Language Into Text And Speech" were intended to use sensor-based system that is integrated to an android phone that works as a display. It caters specifically to the Indian Sign Language which converts to English Language and Malayalam Language in the form of text and speech. The gesture will be displayed on the Android phone if it is genuine, otherwise it will be captured again. Arduino UNO is the microcontroller used where on the other hand, HC 05 bluetooth module were utisilized to communicate wirelessly between the microcontroller and the Android phone [20].

Ku et al. makes use of an adaptive ensemble framework to effectively translate sign language from smartphone footage. For efficient execution on smartphones, the framework