UNIVERSITI TEKNOLOGI MARA
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ICECoT 2021

International Conference on Emerging Computational Technologies

"Future Trends of Emerging Computational Technologies in the 21st Century"
"Strategizing IR4.0 in Conquering Covid-19 and Beyond"

In Partnership With

Vol. 1, 2021
International Conference on Emerging Computational Technologies

UNIVERSITI TEKNOLOGI MARA | Cawangan Melaka

INTERNATIONAL CONFERENCE ON EMERGING COMPUTATIONAL TECHNOLOGIES (ICECoT 2021)

24 - 25 August 2021

978-967-15337©ICECoT2021

First Edition 2021

Published by:

Universiti Teknologi MARA Melaka Kampus Jasin

978-967-15337©ICECoT2021

Preface

This e-book describes the research papers presented at the International Conference on Emerging Computational Technologies (ICECoT 2021), organised by Faculty of Computer and Mathematical Sciences (FSKM), UiTM Cawangan Melaka. The main discussions of the conference is on the technological advances that help shape the skills that are required to cope with the Fourth Industrial Revolution (IR 4.0). Considering that this is our first attempt at organising a conference, we are therefore greatly honoured that the Universitas Negeri Semarang (UNNES), Indonesia, Mahasarakham University (MSU), Thailand and University of Hail (UoH), Saudi Arabia have all agreed to become our partners by contributing several reseach papers as well as providing reviewers to assess the quality of the papers.

Out of the numerous research works that had been submitted and reviewed, the Editorial Board have selected 22 papers to be published in the e-book. The discussions of these papers pertain to the use of technologies within the broad spectrum of Computer Science, Computer Networking, Multimedia, Information Systems Engineering, Mathematical Sciences and Educational Technology. It is hoped that the research findings that are shared in this e-book can benefit those who are interested in the various areas of computational technologies; such as graduate students, researchers, academicians and the industrial players, to name a few.

As the Project Manager, I would like to thank all of the committee members from the bottom of my heart for their tireless efforts in ensuring the success of ICECoT 2021. Without their continual support and excellent teamwork, this conference would not have come to fruition. In fact, holding this major event has been a good learning experience for us all, and I sincerely believe that our future conferences will become more outstanding if the same spirit is maintained.

Dr. Noor Aishikin Adam
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Assistive Technology for Speech Disability Patients via Gesture Recognition

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***Abstract*—Non-verbal communication via gesture recognition helps to minimize the problem faced by people with language or speech disability. Speech disability or disorder may be caused by weakened facial muscles because of neurological or other degenerative disorders. These impairments may either be temporary or permanent; but do cause difficulties in conveying the patients' needs and thoughts to the people around them especially their caretakers. This project aims at developing assistive technology for speech disorder patients via gesture recognition using Internet of Things (IoT). Basic phrases in interpreted using a set of predefined gestures so that the patients may communicate their needs or a situation of emergency to the caretakers. Gesture sensors are used to detect the hand signals and notification is sent via mobile phones to alert the caretakers.**

Keywords—assistive technology, gesture sensors, Internet of Things (IoT), language disorder, speech disorder

I. INTRODUCTION

Currently, over a billion people including children are estimated to be living with disability. Disability refers to the physical or mental condition that limits a person's movements, senses or activity. There are different types of partial disabilities and one of them is language disorder. Communicating for people with speech impairment may be difficult if they are not capable to effectively send information. Their speech may be jumbled, fragmented, or impossible to understand. People with language disorder especially stroke patients who cannot move around have difficulty expressing themselves as they have limited ability to speak and walk which may cause failure to perform functional activities [1-2]. In addition, people with stroke have high fall risks, and fall related injuries that can significantly affect their mobility [3]. The situation might become worst if there is an emergency that requires immediate action but the disabled person could not reach for help during that time.

Recent developments in the Internet of Things (IoT) may alleviate the problems faced by patients of speech impairment by offering assistive technology to lower the barriers that they encounter in their daily lives such as communication. Even with disabilities, people can move their bodies to communicate in ways that other people can understand. There are many ways of communication and one suitable method for people with speech impairments is by using hand gestures. Deploying sensors technology that uses gesture has multiple benefits.

This project aims to assist partially disabled persons who have trouble to speak and move by developing a system for communication using gesture sensors. A gesture sensor is an interactive sensor that can detect simple hand movements such as upward, downward, swipe to the left or right, and also clockwise and anti-clockwise rotation. The advantages include accuracy, low cost, high performance and processing of data in real time. Each hand movement can be set to a specific task that a partially disabled person needs such as "to move", "to eat", or to signal that there is an emergency. Whenever a person gives the hand signal, the system will directly send a notification to the person in charge or a caretaker to alert them. This project uses Arduino Uno as the microcontroller to read the input which comes from the APDS-9960 gesture sensor and to send the data to the mobile application. The caretaker will receive a notification his or her mobile phone alerting about the patient's current need.

II. ASSISTIVE TECHNOLOGY FOR COMMUNICATION

A. Hand Gesture

Nonverbal communication consists of actions, gestures, and other physical appearance aspects which can be a powerful means of transmitting messages. The most common way used by people who have language disorder is by using hand gestures. Gestures are considered as a natural way of communication between humans, as it is a physical movements of hands, arms or body that conveys meaningful data [4-5]. A series of hand gestures can make up a whole language, as in sign languages. As for people with partial disability, the use of sign language is not necessary as their disabilities are not permanent, and it takes a lot of time to learn sign language. According to [6], gestures may be static, requiring less computational complexity or dynamics which are more complex but suitable for real-time environments. However, a simple hand signal would be enough for partially disabled people to express themselves. The hand signal that will be used in this project are swipe to the left, right, upward, downward, clockwise rotation and counter-clockwise rotation. Each signal would represent different needs that are usually required by the disabled people.

Signals are one type of nonverbal communication in which physical acts are used to communicate important messages and one of them is hand gesture. According to [7], the hand is a natural and powerful means of communication that conveys information very effectively. Hand gestures are widely used on different types of application [8]. As this project focuses on partially disabled people who have language disorder, simple hand signals are used with the help

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of technology to clarify their intentions. Three classifications of research on hand gestures are vision based, glove based and the one that will be implemented in this project is swipe gesture based. The table shows different methods that require the usage hand gesture. Table I shows the methods of hand gesture that has been used previously in related work.

TABLE I. HAND GESTURE METHODS

Method	Description
Vision Based	• Requires a camera, to capture the sign or hand gesture made such as sign language, uses image processing technique • Normally used for Human Computer Interaction (HCI)
Glove Based	• Requires user to wear a hand glove with sensors to detect hand sign • Using Flex sensors or copper plates
Swipe Based	• Require user to swipe hand over sensor the device in a certain direction • Usually involve the use of mobile application to interpret hand signal

For a long time, gestures were seen as an interaction technique that can provide more natural, imaginative, and intuitive communication methods with computers. Vision based gesture recognition uses the image processing technique where it requires a camera to capture the hand sign. According to [6], the two main groups representing vision based hand gestures are 3D model based methods and appearance based methods. The 3D model based representation of the hand gesture describes a 3D spatial definition of the human hand for display, with the temporal dimension being handled by automation. Meanwhile, the appearance based representation method are 2D static model based and motion based methods.

The smart glove is an associated device that identifies the hand and finger movements on an individual basis and sends these movements to the board in a variety of analog and digital pins. Glove based hand gesture recognition is divided into two types which are copper plate based glove and flex sensor device. Flex sensor is also called as resistive sensor. As a transducer, flex sensor is used because it transforms physical energy into electrical energy [5]. As the flex sensor bend, its resistance is changed to analog voltage. The sensors will help to recognize specific hand gestures and interpret them to text and any speech to express what a person desire.

Swiping is a common gesture that enables users to perform specific task on their device. A swipe gesture is when user moves his hand across the screen or over a device in a specific horizontal or vertical direction. User interfaces with in-air gesture controls could further reduce the gulf of user-to-digital information's execution [7-9]. This can also reduce issues such as fat finger or occlusion caused by restricted space in the touch. The swipe based method will be implemented in this project as it is the most suitable gesture recognition for people with partial disability. It is easy to use and does not require a person to learn sign language to interact with other people compare to glove based method.

B. Sensor Technology

Sensors today play a significant role in technical development for various social demands. Traditionally, sensors were functionally simple devices which convert physical variables into electrical signals. The main purpose of using sensor technology in the instruction system is to ease the communication between partially disabled people with other person. A device with sensor technology will act as intermediary in the communication process to effectively send information from the user to the intended audience.

In the world of human-machine interfaces, touchless gestures are the new boundary. Any machines such as computer, microcontroller or robot can be controlled only by swiping hand over the sensor. Table II shows some of the supported gestures and Fig. 1 shows the APDS-9960 Gesture Sensor that is used in this project. The device can detect gestures accurately because of its advanced gesture detection. Besides, the sensor has been used in various mobile phones including Samsung's Galaxy S5. It also can be used for Ambient Light, RGB Sensing, Proximity Sensing, and Gesture Detection as it is a multi-purpose sensor. Besides, the sensor has been used in many mobile phones including Samsung's Galaxy S5.

TABLE II. SWIPE BASED SUPPORTED GESTURES

Gesture	Description
Up	A swipe upwards beginning at the bottom to the top of the board including outside sensor range
Down	A swipe downwards beginning at the top to the bottom of the board including outside the sensor range
Left	A swipe from the right side of the board to the left and out of range of the sensor
Right	A swipe from the left to right side of the board, out of range of the sensor
Near	Hand begins well above sensor, glides closer towards it, hovers for a minimum of one second, and then glides out of the sensor's range
Far	The object begins at the vicinity of the sensor, hovers for at least 1 second, and then moves up well beyond the sensor's range

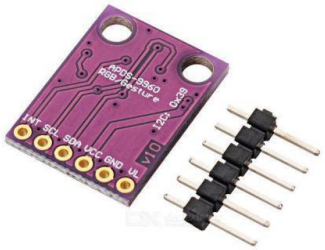

Fig. 1. APDS-9960 Gesture Sensor

III. METHODOLOGY

A. Sensor System Module

The gesture sensor enables the user to only use simple hand signals such as swipe upwards, downwards, left and right to send a message. In any situation where the disabled people want to ask for help, they can just swipe over the sensor device. Besides, after sensor can capture the hand signals, the message will be displayed on the serial monitor of Arduino IDE. The disabled person can make sure the correct message he wants to convey is being displayed at the screen. Fig. 2 displays the sensor module architecture.

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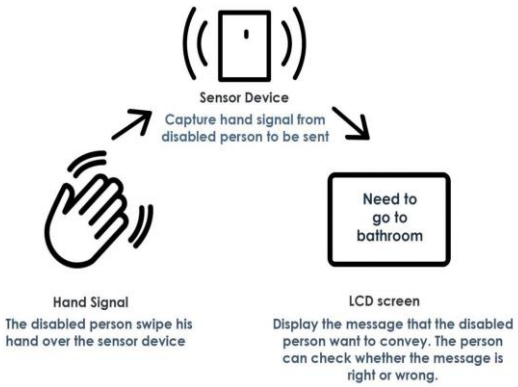

Fig. 2. Sensor system module architecture

B. Mobile Application Module

The mobile application module architecture shows the relationship between sensor device with the application. This is displayed in Fig. 3. The main reason why a mobile application is used in this project is because it is fast and could provide users non-intrusive and immediate notifications. Users will receive push notifications on the devices regardless of whether the user opens the app or not. In addition, a mobile application reduces the cost of SMS messages. In this project, the application will be used to display messages received from the sensor system module. It helps to notify the person in charge or caregivers of the disabled people. Fig. 4 displays the data flow diagram for the mobile application module.

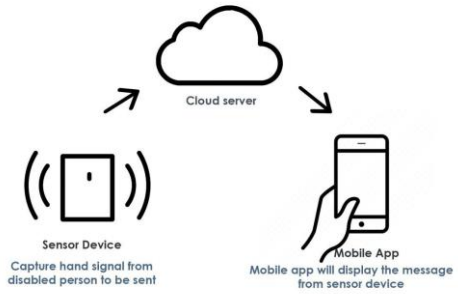

Fig. 3. Mobile application module architecture

The mobile application module was developed using the Ubidots platform as it is an IoT platform that helps users to test and scale up their IoT project for development. It is a user-friendly, customizable Application Enablement Platform that provides users with data in real time and sensor input visualization using a protected cloud. The platform supports most options for hardware and connectivity protocols. The MQTT protocols is used as the lightweight solution for porting the data from the sensor to the Ubidots platform. In this manner, data flows as and when needed only saving battery life and network bandwidth. Fig. 5 shows the widgets available in Ubidots.

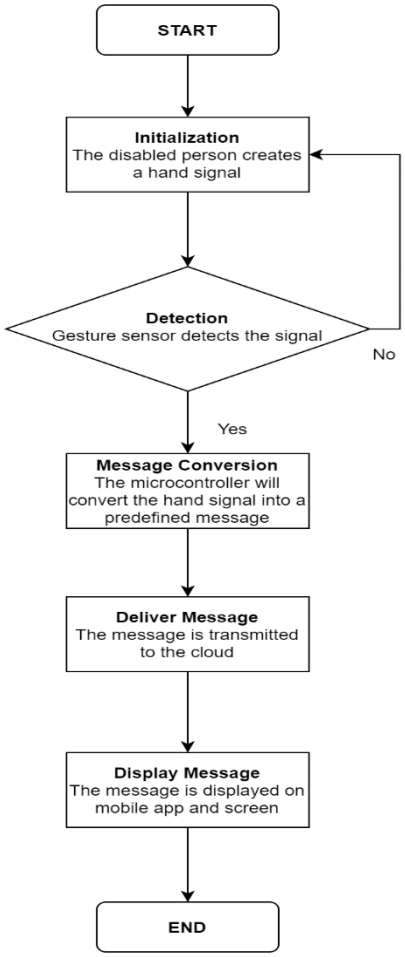

Fig. 4. Mobile application module data flow

Fig. 5. Ubidots widgets

C. Circuit Design

The circuit design diagram in Fig. 6. shows the connectivity of the microcontroller and the gesture sensor. The microcontroller being used is ESP32. The ESP32 is a low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth.

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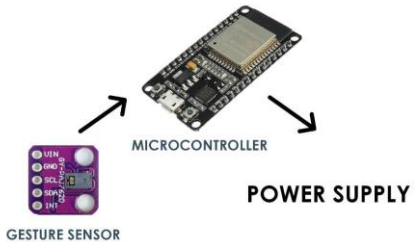

Fig. 6. Circuit design

The gesture recognition function used in the project are move up, move down, move left, move right, move forward and move backward. To test the sensor's functionality, Arduino IDE is used to write the programs and upload them to the device. As the sensor detects hand gestures, the monitor displays the outputs. Fig. 7 shows the outputs as the gesture sensor detects the hand movement.

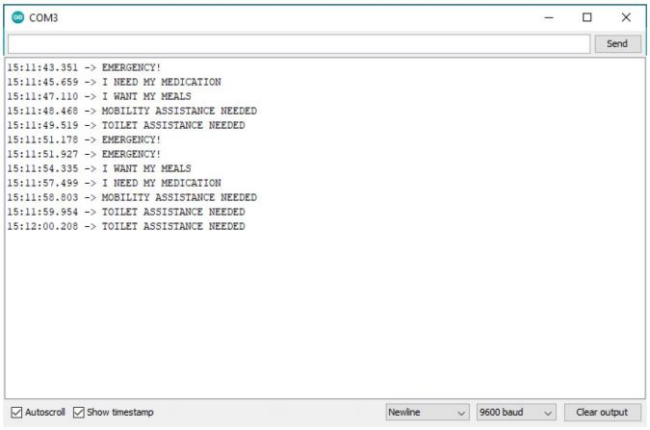

Fig. 7. Serial monitor displaying the output of the APDS-9960 gesture sensor

IV. Accuracy Testing

To test the accuracy of the sensor system, five people have been asked to test their hand movement over the sensor in specific directions. They have to swipe over the sensor three times for each direction to see whether the sensor could detect and display the correct message representing the hand movements. The result from the test are as shown in Table III until VII.

TABLE III. Swipe Up Detection

Tester	1st Swipe	2nd Swipe	3rd Swipe
1	√	√	√
2	X	√	√
3	√	X	√
4	√	√	√
5	√	√	√

TABLE IV. Swipe Down Detection

Tester	1st Swipe	2nd Swipe	3rd Swipe
1	√	√	√
2	√	√	√
3	√	√	√
4	X	√	√
5	√	√	√

TABLE V. Swipe Left Detection

Tester	1st Swipe	2nd Swipe	3rd Swipe
1	√	√	√
2	√	√	√
3	√	√	√
4	√	√	√
5	√	√	√

TABLE VI. Swipe Right Detection

Tester	1st Swipe	2nd Swipe	3rd Swipe
1	√	√	√
2	√	√	√
3	√	√	√
4	√	√	√
5	√	√	√

TABLE VII. Forward And Backward Detection

Tester	1st Swipe	2nd Swipe	3rd Swipe
1	√	X	√
2	√	X	√
3	√	√	√
4	√	√	√
5	√	√	√

V. Conclusion

This project focuses on developing an assistive technology for people with language or speech disability, especially those who are also immobile. Their disabilities prevent them from doing basic daily routines such as going to the toilet, taking meals and/or medications. The integration of simple gesture sensor such as the APDS-9660 into the ESP32 microcontroller along with readily available multipurpose platforms such as Ubidots help quickly generate a ready to use mobile application for the disabled and their caregivers. For this project, 6 different hand movements have been set. Each hand movements or hand gestures represent a specific need that can be set or change according to the needs of the disabled people. Whenever the user swipe or move his hand over the gesture sensor device, the sensor will detect and display the message that represents the hand signal on the dashboard of the mobile application.

Acknowledgment

We would like to thank the Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Melaka, Jasin Campus for the opportunity and support in carrying out this project.

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