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Verbal Communication Using Finger Motion (FiMo) Device for Patients with Difficulty in Speech and Mobility

(JHS-RIM-T-DO1)

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ABSTRACT:

Throughout the entire healthcare process, communication between the patient and the healthcare professional is vital. By having a clear communication with the patient, the healthcare professionals can provide care to the patients more easily. The device aims to assist the healthcare professionals on understanding the needs of the patients with difficulty in mobility and speech, by generating a sound dialogue based on the motion of the patient's fingers. The capabilities of the device were tested and evaluated by seven IT Experts. Functional Suitability, Performance Efficiency, Usability, Maintainability, and Satisfaction were evaluated by the experts. This study used ADDIE Developmental Design in developing the device to allow further enhancements on the device. The overall score of the evaluation is 3.46, which means that the evaluators agree that the device is accurate, efficient, and can be used by patients with difficulty in mobility and speech.

INTRODUCTION:

Communication in a healthcare facility is of high essential especially between the patient and the healthcare professional. Throughout the entire hospital process, from patient ingress to patient discharge, healthcare providers must communicate well to provide comprehensive care to their patients. Without effective means of communication, serious errors may happen risking the lives of the patients (University of Texas at Arlington, 2016).

According to a study about *Communication in Nursing Practice*, good communication between patients and caregivers have numerous benefits. One of its most important benefits is that it contributes greatly to the ability to provide care. It also makes the patients feel like they are receiving the immediate attention of the healthcare providers and will make them more satisfied of the care that they receive (Kourkouta, L., 2014).

A caregiver who has good way of communication with the patient can get a lot of information to accurately help the patient (Brown, D., 2016). However, if the patient is having difficulty with mobility and speech, it would be a challenge to gather information and to assist the patient.

Communication is of two types, Verbal Communication and Non-verbal Communication. Verbal communication is an auditory communication using words. It is

usually face-to-face or written with the use of language as a mean of communication. It is effective in terms of delivering the clear and fast manner. However, in case of a situation wherein verbal communication is not possible, non-verbal communication could be used. Non-verbal communication is a process of communication without the use of words. It is effective in terms of showing emotions so the message could be easily interpreted (Bajracharya, S., 2018). Non-verbal communication is commonly used by people with disabilities affecting their speech, and despite the absence of verbal communication, non-verbal could still be interpreted since they have *sign-language*.

Therefore, to address the issue, the researchers plan to create a device that makes the communication with a patient with difficulties in speech easier. The device is utilized to make a dialogue based on the individual's finger motion. The researchers are planning to develop the device to make the communication with a patient that has difficulty in speaking much easier, and this device could also potentially help in assisting bedridden patients who have difficulty in speaking.

The device will use sensors to scan the individual's finger motion. By using the sensors, the device will detect the movement of the finger and will measure how and where it moved to determine the dialogue. Afterwards, the device will generate a dialogue based on the movement of the finger of the individual.

The researchers aim to develop a device that can generate a dialogue by using the mobility of the finger of the individual. The researchers aim to address the following problems:

1. Is the device effective in terms of:

a) Functional Suitability?

b) Performance Efficiency?

c) Usability?

d) Maintainability?

e) Satisfaction?

2. What are the factors that will affect the efficiency of the device?

Significance of the Study

The results of the study will be of great benefit to the following:

Medical Facilities: The device that will be produced could help in making the communication between patients and guardians/nurses/doctors easier, which could lighten the workload of a medical facility and also ease the assistance of the medical facility.

Healthcare Professionals: The device that will be produced in this study could potentially help the healthcare professional to respond to the bedridden patient's needs, and it could also ease the difficulty in understanding the patient and what the patient really needs.

Immediate family of the patient: Similar with the healthcare professionals, the device that will be produced in this study could potentially ease the communication between the patient and its relatives. This way, they could respond immediately to the needs of the patient.

Patients with difficulty in mobility and speech: The device that will be produced in this study will be of great help to the patients that has difficulty in speaking. It would be easier to understand what the patient really needs, and the patient will not have difficulty in telling it. It could also potentially help in communicating if innovated in the future.

Future Researches: The data of this study will be useful for future researches. Researchers could potentially make the device in this study more efficient, more accurate, and possibly more advanced. Other researchers could also innovate this for it to be more usable by other people with difficulties in speaking.

Scope and Limitations

This study will focus on the development of the device that could potentially ease the difficulty of communication between the patient and the person in charge of taking care of the patient. This study will prioritize the making of an accurate and efficient device so it could be utilized in the future. The device can be potentially used in the future by patients with difficulty in mobility and speech that are having a hard time to speak but can move their fingers.

The device in development is only a prototype, so it can only hold a limited number of dialogues. The device may also experience difficulties regarding its durability, since the device is still under development. The necessary dialogues were assessed by the researchers based on commonality. The researchers selected the dialogues with basis on what are the common responses and dialogues that are needed in healthcare facilities.

The researchers will only focus on producing the prototype and will not get any further ahead, since future researchers that has more knowledge and experience can innovate the device and improve it to lessen the limitations that the current researchers have encountered.

MATERIALS AND METHODS

Research Design

A developmental type of research was conducted, which aims to develop a device that has two parts, the gloves for the input and the speaker for the output. This device aims to ease the communication between a patient that has difficulty in speech and a caregiver. The device will use a sensor to scan the finger's motion of the patient to determine the dialogue that will be produced in the speaker. The researchers utilized the ADDIE (Analysis, Design, Development, Implementation and Evaluation) Instructional Design in order to determine the step-by-step process in making the device. This grants support in tracking the progress of the research. With the use of the said design, further enhancements on the device can be done after multiple evaluations.

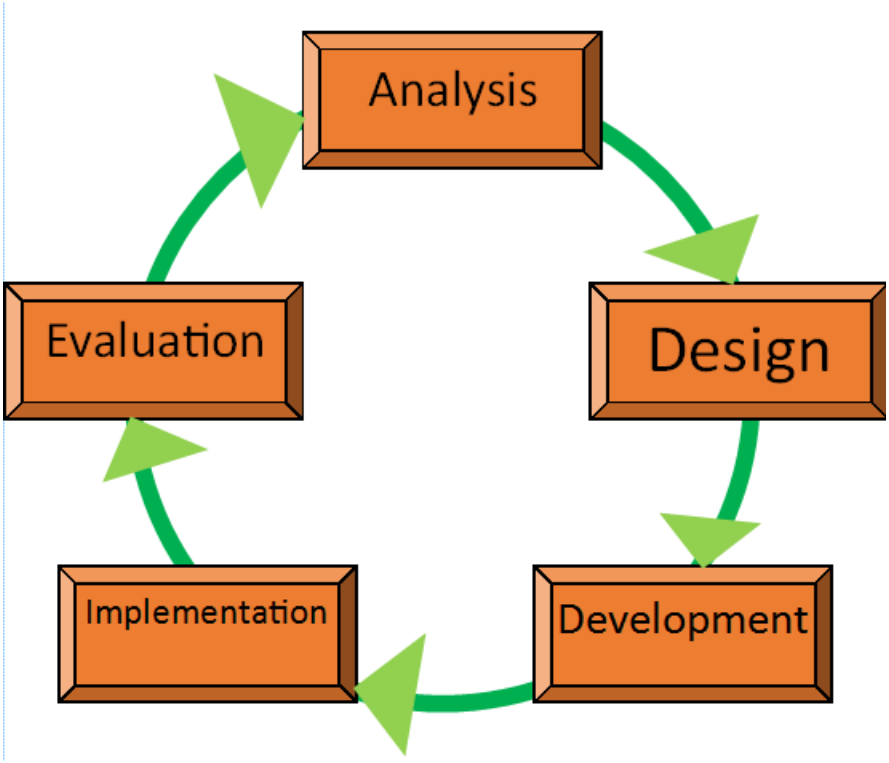

Figure 1. ADDIE Model

Analysis

The essence of communication for the healthcare professionals to respond to the patient's needs was analyzed based on the dialogues that the patient needs. The researchers also analyzed the necessary dialogues or outputs to be included in the device by determining what are the patients' needs in a healthcare facility.

Design and Development

Materials:

a. Micro Controller Unit (MCU) Arduino Mega ATMega2560

- This processor will serve as the main processor of the device. The gathered data by the sensors will be processed by the Arduino Mega and will select an output to play on the speaker based on the data gathered.

b. Flex Sensor

- This will serve as one of the sensors of the device. This sensor will identify and measure the amount of bending or deflection that the finger will make.

c. Accelerometer

- This will serve as one of the sensors of the device. This sensor will measure the finger's acceleration.

d. Force Sensor

- This will serve as the initializer of the device.

e. SD Card Reader

- This will serve as the main storage of the device. The dialogues that will be played is stored in this Module.

f. Speakers

- This will be the output of the device. The speaker will let out a dialogue set by the Micro Controller Units.

Design:

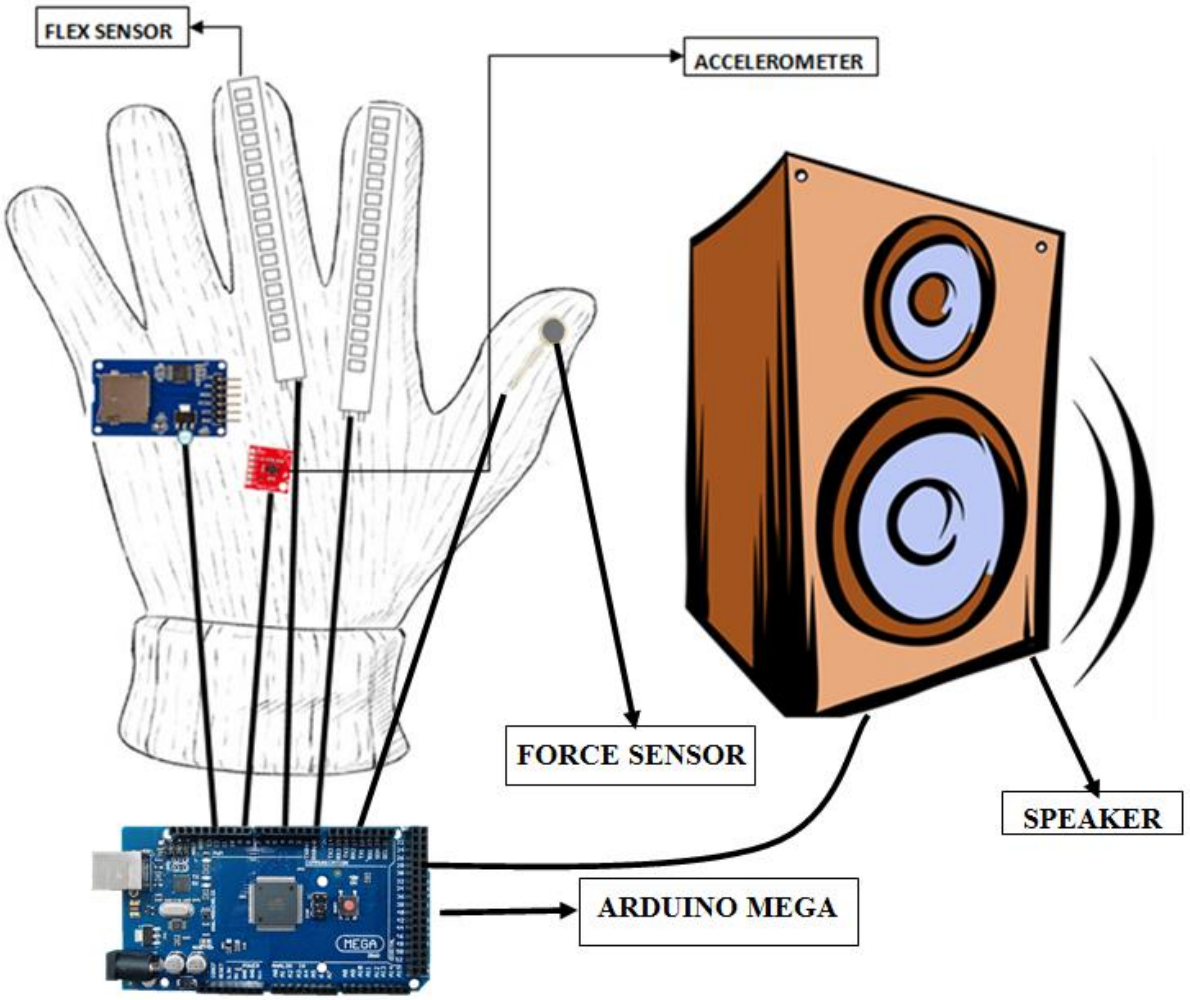

FIGURE 2. DESIGN OF THE DEVICE

The device has two parts, the Input and the Output. For the Input part, its main function is to measure the movement of the finger using the sensors, and it will be processed by the Arduino Uno. For the Output part, the Arduino Uno will play a sound file that is stored on the SD Card Module based on the information and values that it processed.

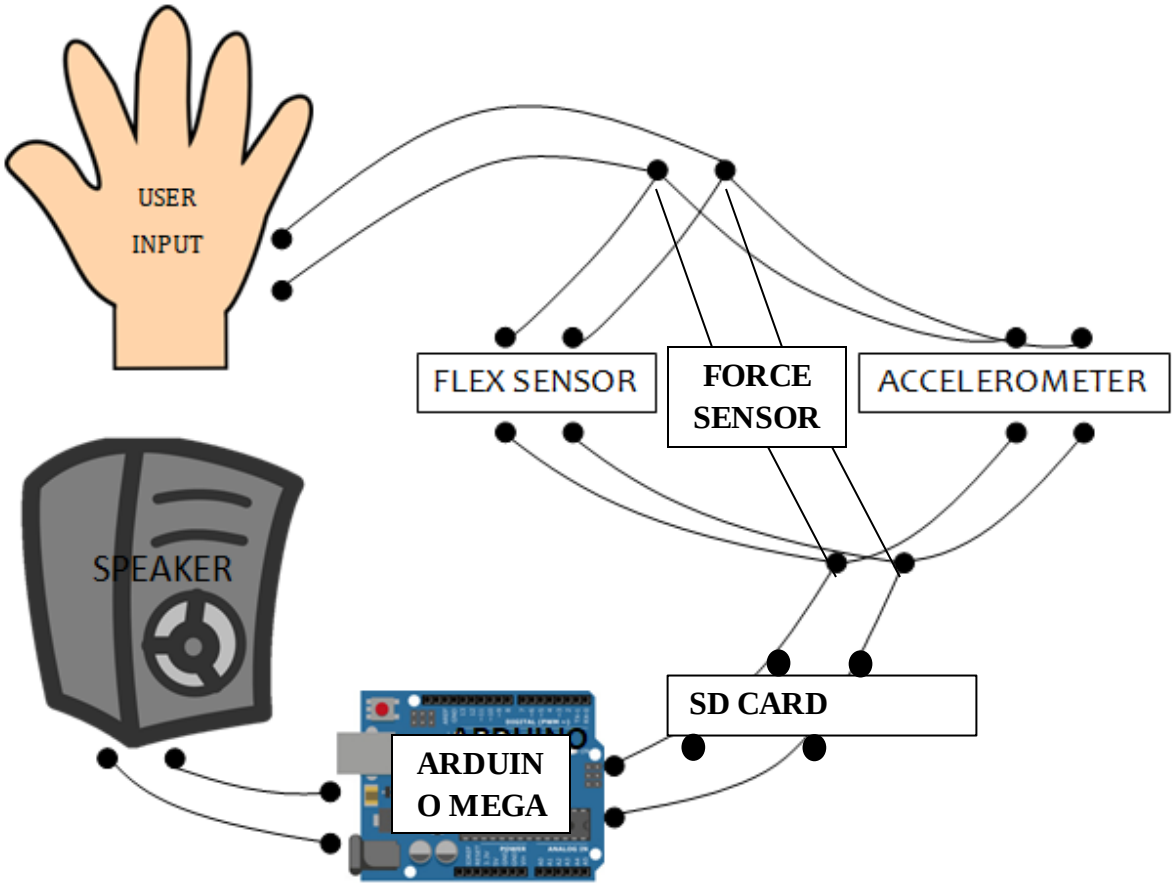

FIGURE 3. BLOCK DIAGRAM OF THE DEVICE

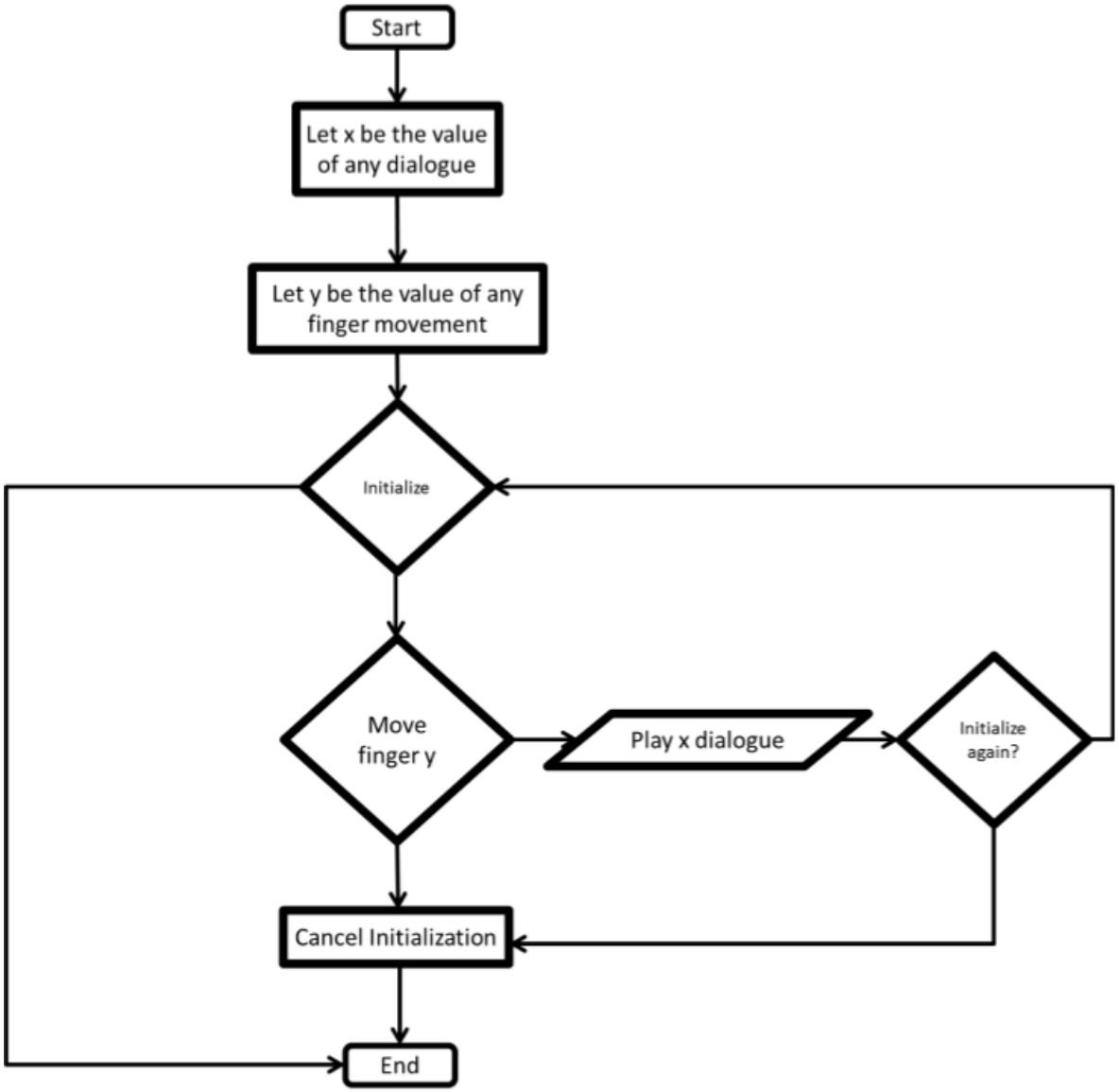

FIGURE 4. FLOWCHART OF THE DEVICE'S FUNCTION

Implementation

Upon accomplishing the task of developing the device, the researchers implemented the device to seven I.T. Experts for them to evaluate it. The researchers then explained how the device works, and what the purpose of the device is.

The I.T. Experts and then tried the device, and test the accuracy and capabilities of the device.

Evaluation

The I.T. Experts evaluated the device. After testing the presented device, they evaluated the functionality, accuracy, reliability and significance of the device by answering an evaluation sheet that was given by the researchers.

The evaluation sheet uses 4-point *Likert Scale* questions for the data to be interpreted and analyzed easily, and for the Evaluators to have a basis on their evaluations. The researchers utilized 4-point *Likert Scale* instead of the 5-point in order to get specific responses from the evaluators.

The questions of the evaluation sheet were based on *ISO 25010* or Software Product Quality, which focuses on what qualities a device or a software product should have.

RESULTS AND DISCUSSION

The study is about Verbal Communication Using Finger Motion for Patients with Difficulty in Speech and Mobility. Upon conducting the evaluation for the device, the following were acquired:

TABLE 1. Evaluation on the Functional Suitability of the device

Functional Suitability	MEAN	SD
The device covers all the specified tasks and user objectives.	3.14	0.37
The device provides the correct information with the needed degree of accuracy.	3.71	0.49
The device assists in accomplishment of specified tasks and objectives.	3.57	0.53
Overall	3.47	

TABLE 1 shows the mean of the evaluation of the IT Experts regarding the device's *Functional Suitability*. The *Functional Suitability* of the device is its ability to provide functions that meet stated and implied needs when used under specified conditions. The overall rating of the device's Functional Stability is 3.47, meaning the device is capable of providing functions when used under specified circumstances.

TABLE 2. Evaluation on the Performance Efficiency of the device

Performance Efficiency	MEAN	SD
The device is responsive to the inputs.	3.29	0.49
The essential dialogues were covered by the device's capacity.	2.86	0.79
Overall	3.1	

TABLE 2 shows the mean of the evaluation of the IT Experts regarding the device's *Performance Efficiency*. The *Performance Efficiency* of the device is its performance relative to the resources used under stated conditions. The overall rating of the device's Performance Efficiency is 3.1, implying the device has a good performance when being used. The device's capacity got a mean of 2.86, which implies that the device needs to have more capacity to cover more of the patients' needs.

TABLE 3. Evaluation on the Usability of the device

Usability	MEAN	SD

The device's functions are easy to learn and understand.	3.57	0.53
The device's functions are easy to operate and utilize.	3.71	0.49
The device's function is not prone to errors in output.	2.86	0.38
The device can be effectively used by people that have problems in mobility and speech.	3.43	0.53
Overall	3.39	

TABLE 3 shows the mean of the evaluation of the IT Experts regarding the device's *Usability*. The *Usability* of the device is the extent to which a device can be used. The overall rating of the device's Usability is 3.39, meaning that the device can be accessible to patients with difficulty in mobility and speech.

TABLE 4. Evaluation on the Maintainability of the device

Maintainability	MEAN	SD
The device can be further improved, and is capable of modifications.	4	0
Further evaluations can be performed to determine whether specific criteria have been met.	3.86	0.38
The device can be further analyzed to diagnose its defects.	4	0
Overall	3.95	

TABLE 4 shows the mean of the evaluation of the IT Experts regarding the device's *Maintainability*. The *Maintainability* of the device is its extent of how much the device can be modified to improve, connect or adapt the device to changes in environments and in requirements. The overall rating of the device's Maintainability is 3.95, which means there are a lot of improvements that could be applied into this study, and there are modifications that can assist in the future.

TABLE 5. Evaluation on the user's Satisfaction of the device

Satisfaction	MEAN	SD
The device is reliable in accommodating people with difficulty in mobility and speech.	3.57	0.53
The device's function is capable to achieve specified goals.	3.29	0.49
Overall	3.43	

TABLE 5 shows the mean of the evaluation of the IT Experts regarding the device's *Satisfaction*. The *Satisfaction* of the device is its capability to satisfy the needs of the target market. The overall rating of the device's satisfaction is 3.43, which implies that the device can satisfy the needs of patient with difficulty in mobility and speech. It also implies that it is reliable on providing assistance to the patients.

Overall, the rating of the device is 3.46. That implies that the device is good in terms of its Functional Suitability, Performance Efficiency, Usability, Maintainability, and Satisfaction.

CONCLUSION

After conducting the study, it shows that the gloves is accurate in its input and output, and it can also cover the essential dialogues to be used in a healthcare facility. The device was able to generate dialogues such as "Yes" or "No" based on the movement of the gloves. Based on the findings, it can be concluded that the device is capable of detecting motion and convert these to dialogues that can be very useful to the patients and the healthcare professionals.

RECOMMENDATION

For future researches, it is recommended that a more advanced and more compact processor will be used so that: a) The device will not be bulky; b) The device will have more capacity and c) The device can have more functionality since the processor is more advanced. It is also recommended that the future researchers will add more dialogues and create translations to the dialogues, so that the healthcare professionals will understand the patients with difficulty in mobility and speech better. The use of Bluetooth module is also suggested, so that the device will not be constrained by the wires. The device can also be further innovated so that the device can have more functions, and it can also help other people that has problems in speech, like mute people. Lastly, the device can also be configured by the future researchers so that the efficiency of the device can be improved.

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APPENDICES:

Appendix A: Documentation

The evaluators of the researcher's device

Appendix B: The Schematic Diagram of the device

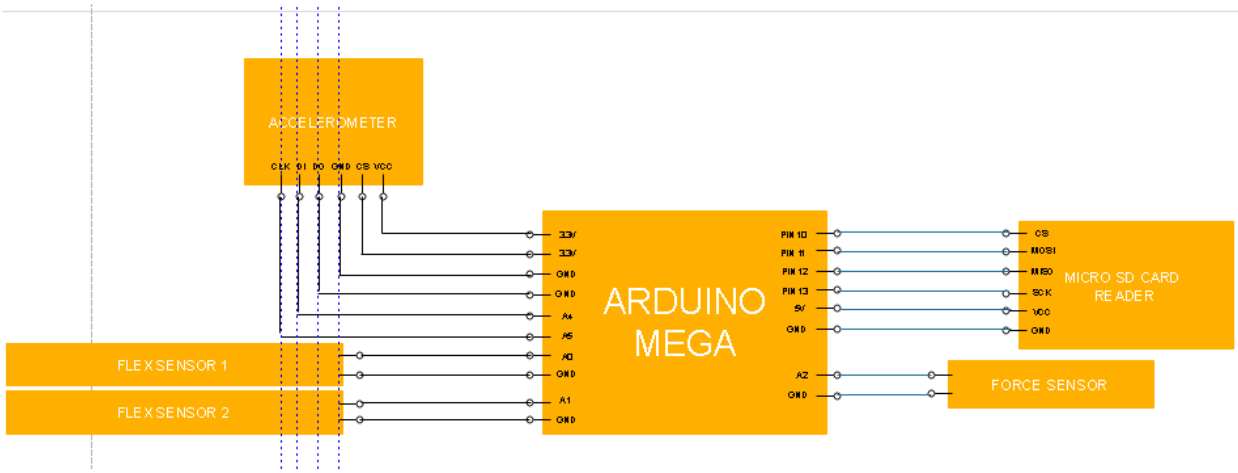

FIGURE 5. SCHEMATIC DIAGRAM OF THE DEVICE

Appendix C: Functionality of the Device

TABLE 6. List of Dialogues and Corresponding Commands

	Index Finger is Flexed	**Applied force to Thumb**
Hand is in Normal Position	"Water Please"	"I am hungry"
Hand is Facing the Side	"Yes"	"No"
Hand is Lying Down	"I need to go to the bathroom"	"I am not feeling well"

Appendix D: Evaluation Sheet

Device Evaluation Form: Finger Motion-based Gloves

This form collects opinions and observations from I.T. experts who have pilot tested the device.

Name of Evaluator:	Contact Number (Optional) :		
Gender:	Age:	Handspan:	Date:
Department/Institution:			

1- Strongly Disagree 2- Disagree 3- Agree 4- Strongly Agree

During the Pilot Test of the Device:	**1**	**2**	**3**	**4**
Functional Suitability				
The device covers all the specified tasks and user objectives.			IIIIII	I
The device provides the correct information with the needed degree of accuracy.			II	IIIII
The device assists in accomplishment of specified tasks and objectives.			III	IIII
Performance Efficiency				
The device is responsive to the inputs.			IIIII	II
The essential dialogues were covered by the device's capacity.		I	II	IIII
Usability				
The device's functions are easy to learn and understand.			III	IIII
The device's functions are easy to operate and utilize.			II	IIIII
The device's function is not prone to errors in output.		I	IIIIII	
The device can be effectively used by people that have problems in mobility and speech.			IIII	III
Maintainability				
The device can be further improved, and is capable of modifications.				IIIIIII
Further evaluations can be performed to determine whether specific criteria have been met.			I	IIIIII
The device can be further analyzed to diagnose its defects.				IIIIIII
Satisfaction				
The device is reliable in accommodating people with difficulty in mobility and speech.			III	IIII
The device's function is capable to achieve specified goals.			IIIII	II

Appendix E: Raw Data

TABLE 7. Data Gathered from the IT Experts

Respondent	A	B	C	D	E	F	G
Question 1	3	4	3	3	3	3	3
Question 2	4	4	4	4	3	4	3
Question 3	3	4	3	3	4	4	4
Question 4	4	3	4	3	3	3	3
Question 5	4	4	4	2	4	3	3
Question 6	4	4	4	3	4	3	3
Question 7	4	3	4	4	4	4	3
Question 8	3	3	3	3	3	3	2
Question 9	3	4	4	4	3	3	3
Question 10	4	4	4	4	4	4	4
Question 11	4	4	4	3	4	4	4
Question 12	4	4	4	4	4	4	4
Question 13	3	4	4	4	3	4	3
Question 14	3	4	3	4	3	3	3

TABLE 8. Tally of the Scores from the IT Experts

During the Pilot Test of the Device:	1	2	3	4
Functional Suitability				
The device covers all the specified tasks and user objectives.			IIIIII	I
The device provides the correct information with the needed degree of accuracy.			II	IIIII
The device assists in accomplishment of specified tasks and objectives.			III	IIII
Performance Efficiency				
The device is responsive to the inputs.			IIIII	II
The essential dialogues were covered by the device's capacity.		I	II	IIII
Usability				
The device's functions are easy to learn and understand.			III	IIII
The device's functions are easy to operate and utilize.			II	IIIII
The device's function is not prone to errors in output.		I	IIIIII	
The device can be effectively used by people that have problems in mobility and speech.			IIII	III
Maintainability				
The device can be further improved, and is capable of modifications.				IIIIIII
Further evaluations can be performed to determine whether specific criteria have been met.			I	IIIIII
The device can be further analyzed to diagnose its defects.				IIIIIII
Satisfaction				
The device is reliable in accommodating people with difficulty in mobility and speech.			III	IIII
The device's function is capable to achieve specified goals.			IIIII	II