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DIGITAL ONE-HAND SIGN TRANSLATOR

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ABSTRACT
This study was conducted to bridge the communication gap. The objective of the study was to develop and design a system that creates a two-way communication; Impaired user to Non- Impaired, and Non-impaired to Impaired with the help of these three aspects, Single Handed Communication, Gesture Recognition, and Two-way Communication. The first test of the system was, the Accuracy Test (from impaired to non- impaired translator). The evaluation was classified as non-complex with an overall percentage of 86% which that means the system has a positive result with ten (10) trials. The second test was Acceptance Test (from non- impaired to the impaired translator). Based on the evaluation results, the study concluded that the system will help the person with or without hearing disability both sides can communicate in a technological way.
KEYWORDS: *One-hand Sign Translator, two-way communication, the impaired user to Non- Impaired*

I. INTRODUCTION

Human beings have a natural ability to see, listen and interact with their external environment. Unfortunately, there are some people who are differently able and do not have the ability to use their senses to the best extent possible. Such people depend on other means of communication like sign language, a popular communication channel built solely on gestures. It is the kind of language that is directly associated with people who have a problem with hearing. Its history traces back to the 17th century when Juan Pablo Bonnet created the first sign language dictionary that also contained the first sign language alphabet. This led to its creation, schools and the development of its different kinds around the globe. The most popular form of sign language is the American Sign Language (ASL) a complete, complex language that employs hand signs, moving the hands combined with facial expressions and postures of the body. This is used as the primary language of many North Americans as their one of several communication options used by those hearing impaired persons at present, there are more than 200 types of sign language around the world. The development is as natural and continuous as a spoken language, which progresses through interactions Sonia M. Pascua et al., (2017) [2]. But unless you're hard of hearing, or have hearing-impaired friends or relatives, you probably won't understand sign language, which is frustrating for those who rely on it to communicate Michael Irving, (2017) [1] that's why it is necessary to have an advanced gesture recognition or sign language detection system to bridge this communication gap.

Hence this study was design based on American Sign Language (ASL) as common general language use in the Philippines and as a second use language that can be a very useful medium in communicating to impair of hearing and speaking community and also to bridge the gap between deaf and dumb community and normal masses with the use of two different sensor (flex sensor and gy88 sensor) that emulates the position of the one hand movement or gesture and transform to data then translate into text or audio.

Objectives of the Study

This study aims to:

1. To design a system that creates two-way communication between a:
   a. Hearing impaired user to non-impaired through the one-hand sign language that recognizes gestures and converts it to text or audio,
   b. The non-impaired user manually inputs the message to hearing impaired and converted into sign language through image display.
2. To evaluate the accuracy of the system.

Synthesis of the Study

This study, gestures recognition was used to create a system which understands human gestures and uses them to control various devices. It's necessary to build a robust and reliable system. This used one-hand sign language only because it's much simpler compared to the dual sign language. It has a higher ambiguous static gesture which makes the recognition a challenging task. And lastly, this study also acquired the two-way communication for a better understanding between the hearing-impaired and non-impaired person.

II. METHODOLOGY

Application Development

In developing an application, a PC-Based prototype was developed to demonstrate the main purpose of this study. Also, the study used C# language in developing the application.

Hardware Development

In hardware, this study used sensor connected to Arduino as a microcontroller of the software. This was developed using Arduino Language as a base language.

Architecture

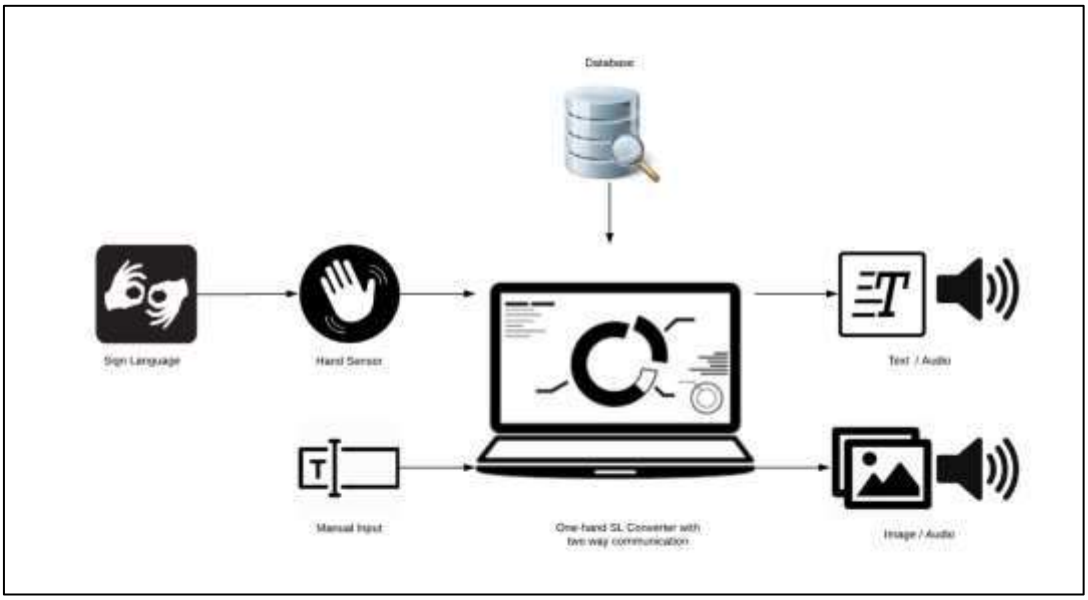


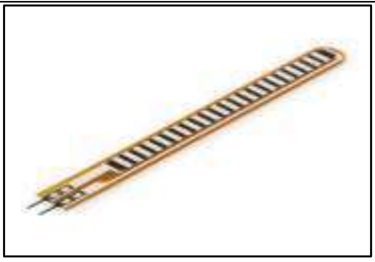
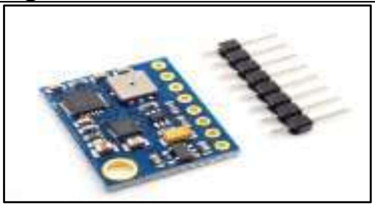
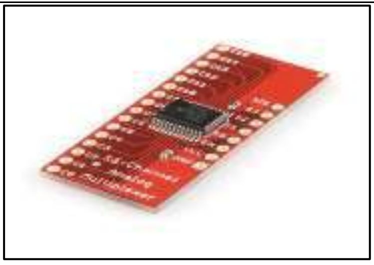
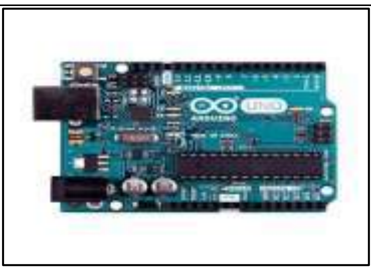
Figure 2.Digital One Hand Sign Architecture from Hearing Impaired person to Non- impaired and from Non- impaired to Impaired

Process

The architecture in Figure 2 shows how both user Non- impaired and Impaired send and process their message to the receiver. First, impaired to non- impaired. The glove with the sensor is used by an impaired person to communicate with the non-impaired. By simply forming the sign language with their hand using the glove with the sensor it will track the hand sign gestures then interpret the message through the SL converter and convert it into text or audio. Second the non-impaired to impaired. Non-impaired manually inputs a series of the message then process to SL converter and paired to its equivalent words/characters in the database for sign language than displayed the message through image display.

Hardware Aspects

The following components were used in developing the project.

Hardware	Description
 **Figure 3.** Flex Bend Sensor	This sensor on each finger that detects bending in one direction. Basically, resistors that change value based on how much they are flexed. The resistance of the flex sensor increases as the body of the component bends.
 **Figure 4.**Gy-88	This sensor is a motion tracking module. The mounting holes make it possible to provide a highly accurate and stable sensor data.
 **Figure 5.**Multiplexer	This is an analog pin extender for Arduino. This allows the user to connect up to 16 sensors to his system using only 5 pins. A Multiplexer is a device that allows one of several analogs or digital input signals which are to be selected and transmits the input into a single medium.
 **Figure 6.**Arduino Uno 3	This board is able to read inputs and turn them into an output or a microcontroller board. It has an extensive support community, which makes it a very easy way to get started working with embedded electronics.

Hardware Design

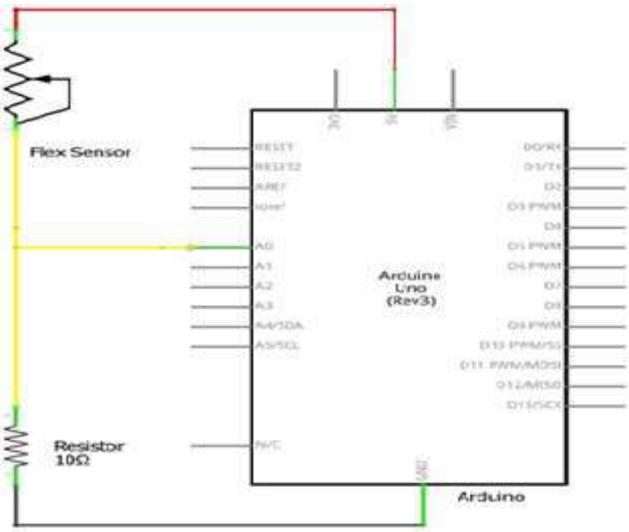


Figure 7.Schematic Diagram of Flex Sensor

Figure 7 shows the Schematic Diagram of Flex Sensor. Composed of Arduino, Flex Sensor, and Resistor. Flex Sensor is connected to 5v via red wire for its power, the black wire connected to ground to clear out a static discharge voltage, the yellow wire connected to Analog pin A0 for its input and 10k resistor for its control flow .

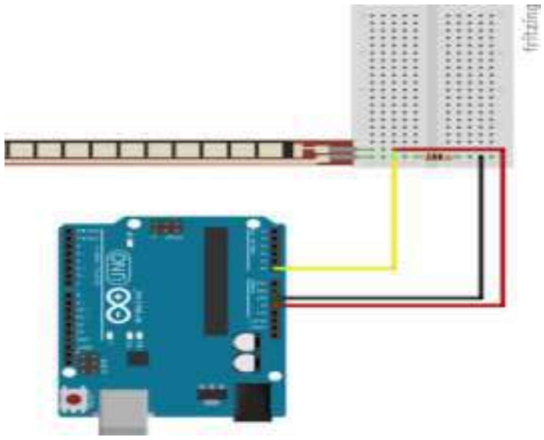


Figure 8. The perspective of Flex Sensor

Table 1.Specification for Schematic Diagram and Perspective of Flex Sensor

Type	Function	Detail
Red Wire	Power	5v to
Black Wire	Ground	GND
Yellow Wire	Input	Connected to A0
Resistor	Control Flow	10k

Table 1 shows the specification for schematic and perspective of Flex Sensor. To power up the Flex sensor, it is connected to the 5v via a red wire. The black wire connected to ground is used to dissipate a static discharge voltage. To incorporate the Flex sensor into the hardware is by using it in a voltage divider where the 10k resistor on the ground side means as the flex sensor's resistance increases the voltage on the yellow wire connected to the Analog pin A0 decreases.

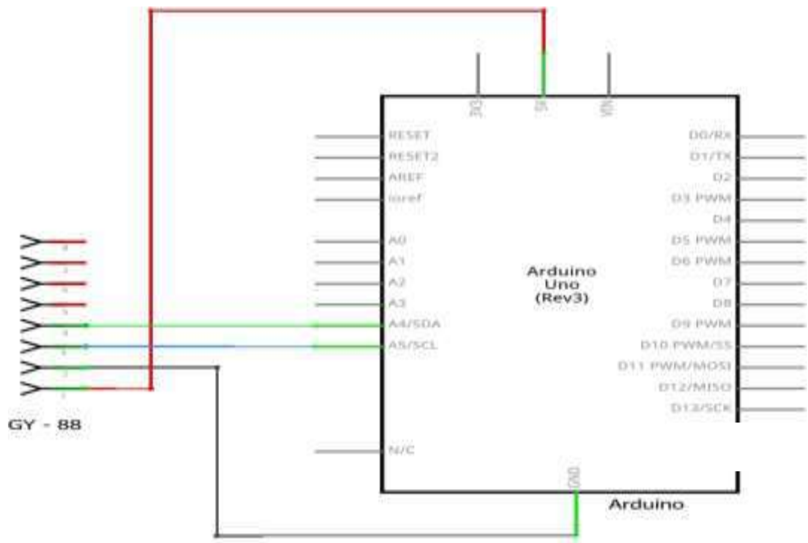


Figure 9.Schematic Diagram of GY-88 Sensor

Figure 9 shows the Schematic Diagram of GY-88 Sensor. Composed of Arduino and GY-88. Gy-88 is connected to 5v via red wire for its power, the black wire connected to ground to clear out a static discharge voltage, SCL (Clock Line) connected to Analog pin A5 via green wire for its input, and ADL (Data line) connected to Analog pin A4 via blue wire for its inputs.

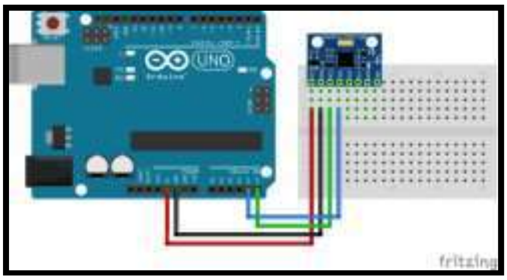


Figure 10.The perspective of GY-88 Sensors

Table 2. Specification for Schematic Diagram and Perspective of Gy-88 Sensor

Type	Function	Detail
Red Wire	Power	5v
Black Wire	Ground	GND
Green Wire	Input	SCL Connected to A5
Blue Wire	Input	SDA Connected to A4

Table 2 shows the specification for schematic and perspective of Gy-88. To power up the GY-88 sensor, it is connected to the 5v via a red wire. The black wire connected to ground is used to dissipate a static discharge voltage. To incorporate the GY-88 sensor into the hardware is by connecting to I2C Bus called SCL(Clock line) and SDA (Data line), SCL pin via a green wire into the Analog pin A5. It is used to synchronize all the data transfer into the hardware and the SDA pin via a blue wire into the Analog pin A4 is used to transfer the data into the hardware.

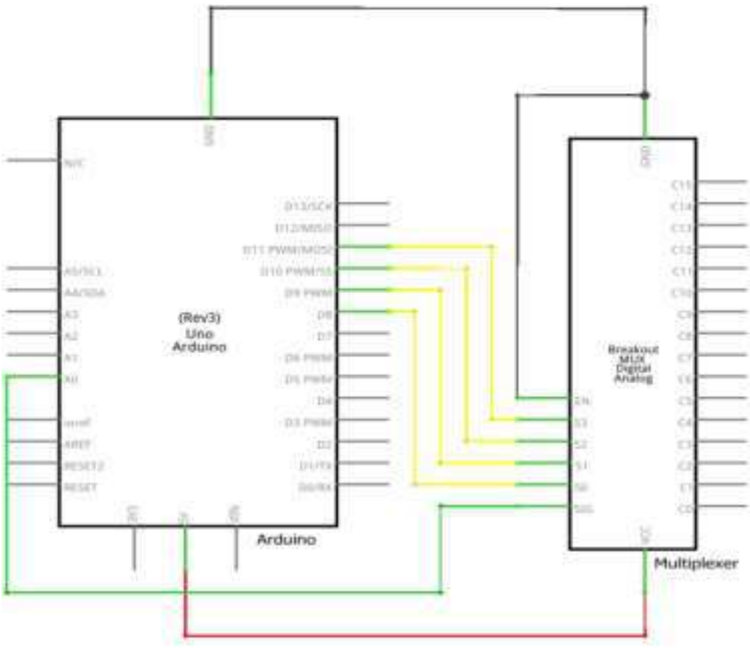


Figure 11.Schematic Diagram of Multiplexer

Figure 11 shows the perspective of Multiplexer. To power up the Multiplexer it is connected to the 5v via red wire, the black wire connected to ground is used to clear out a static discharge voltage, SIG pin connected to Analog pin A0 is used to connect to any of the 16 Channel of the multiplexer, 4 yellow wire Digital output pins S0,S1,S2, and S3 connected to the respective digital input pin D8, D9, D10 and D11 it used as Address input, and the EN pin connected to the GND via black wire is used to enable and disable SIG pin.

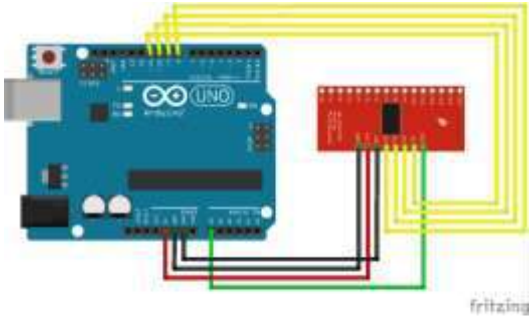


Figure 12.Perspective of Multiplexer

Figure 12 shows the perspective of Multiplexer. To power up the Multiplexer it is connected to the 5v via red wire, the black wire connected to ground is used to clear out a static discharge voltage, SIG pin connected to Analog pin A0 is used to connect to any of the 16 Channel of the multiplexer, 4 yellow wire Digital output pins S0,S1,S2, and S3 connected to the respective digital input pin D8, D9, D10 and D11 it used as Address input, and the EN pin connected to the GND via black wire is used to enable and disable SIG pin

Table 3.Specification for Schematic and Perspective of Multiplexer

Type	Function	Detail
Red Wire	Power	5v
Black Wire	Ground	GND
Black Wire	Ground	EN
Green Wire	Input	SIG connected to A0
Yellow Wire	Input	S0 Connected to D8
Yellow Wire	Input	S1 Connected to D9
Yellow Wire	Input	S2 Connected to D10
Yellow Wire	Input	S3 Connected to D11

Table 3 shows the specification for schematic and perspective of Multiplexer. To power up the Multiplexer it is connected to the 5v via a red wire, the black wire connected to ground is used to dissipate a static discharge voltage and the incorporation of the Multiplexer in to the hardware enables expansion of the input and outputs of the hardware, the SIG pin connected to Analog pin A0 is used to connect to any of the 16 Channel of the multiplexer, 4 yellow wire Digital output pins S0,S1,S2 and S3 connected to the respective digital input pin D8, D9, D10 and D11 it used as Address input / Control pin of the 16 Channel and the EN pin connected to the GND via black wire is used to enable(low) and disable(high) SIG pin to get back the value.

Software Prototype

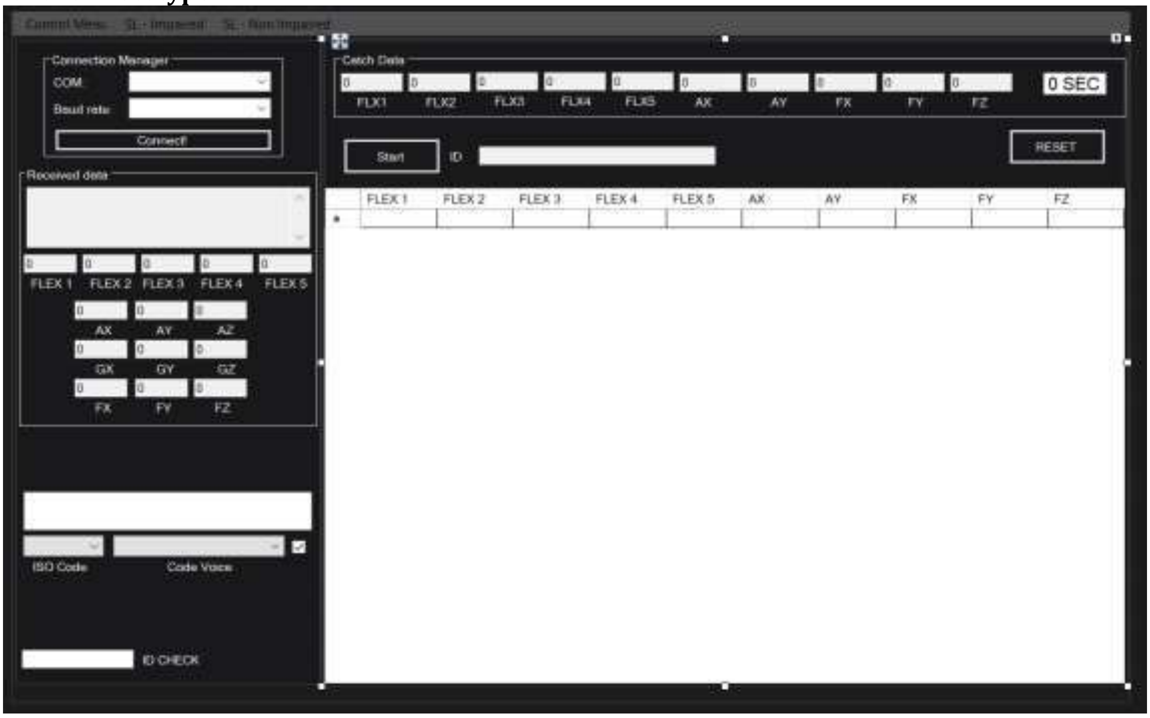


Figure 15.Graphical User Interface

This is the Graphical User Interface (GUI) that will be used in communication using an external device based on how the user interacts with it. The data is passed between the device and the application via an external sensor which records the position of the hands of the user forming hand signs then translate it to a text to be understood in the side of an able person.

Research Design

This study was conducted using a quantitative approach. A simple Accuracy Test with 10 (ten) times test case

Instrument and Data Gathering

This study surveyed people from Eastern Samar Philippines. For impaired to non- impaired Accuracy Test was used with ten (10) times test case. For non- impaired to impaired, Acceptance Test was used, and subjects were polled through a questionnaire related to the topic being discussed in this study using an IBM Computer System Usability Scale questions.

Data Analysis

Percentage, frequency and the weighted mean was used to analyze the tabulated evaluation results.

III. RESULTS AND DISCUSSIONS

Screenshot

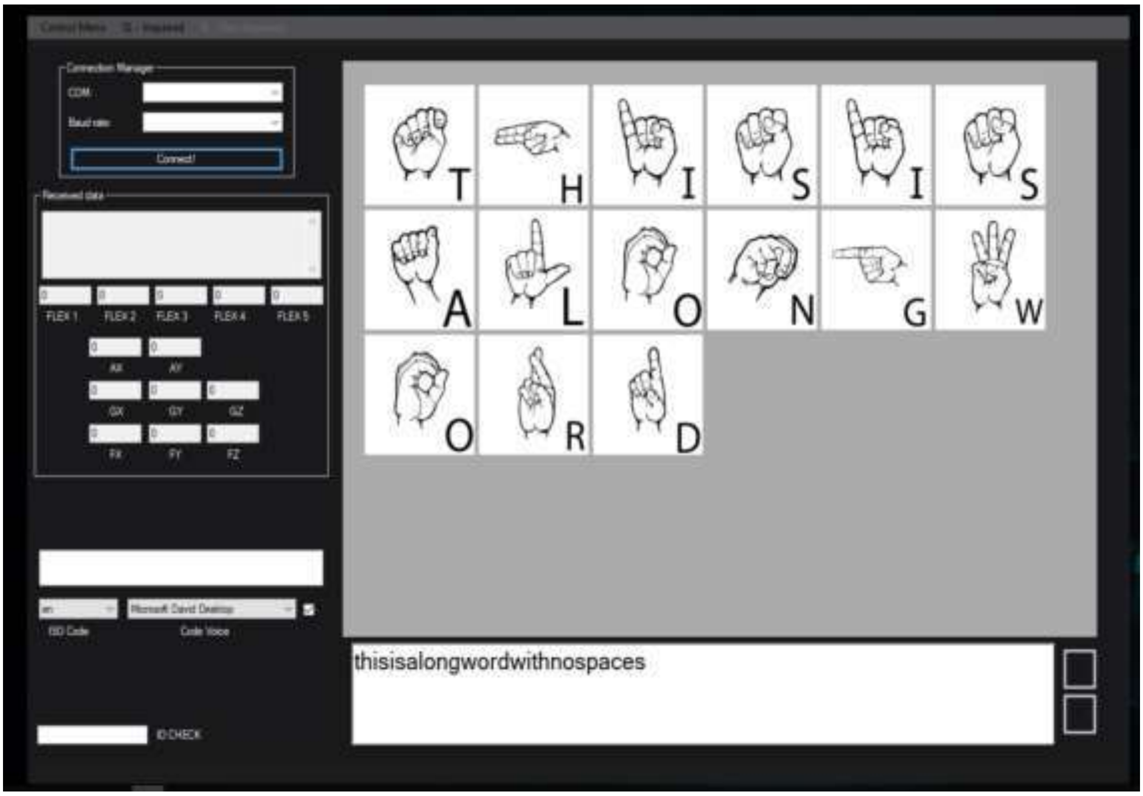


Figure 17.Non- impaired to impaired communication

Figure 17 shows the screenshot of the system where a non-impaired person inputs a series message then convert it into sign language through image display.

Table 5.Accuracy Test Result of the One-hand Sign Language of Numbers 1-10

Numbers Converted into Text or Audio	Number of Test Case		Percentage of Numbers Converted	Category
	Fail	Success		
1	0	10	100%	Non complex
2	0	10	100%	Non complex
3	0	10	100%	Non complex
4	0	10	100%	Non complex
5	0	10	100%	Non complex
6	0	10	100%	Non complex
7	0	10	100%	Non complex
8	0	10	100%	Non complex
9	0	10	100%	Non complex
10	0	10	100%	Non complex
Total percentage			100%	Non Complex

Table 5 shows the accuracy test result of the One-hand Sign Language (Numbers) using gloves that translates or converts into text or audio. The test results of all numbers classified as non-complex and 100% successfully converted into text or audio. The results show that the system can be implemented to the corresponding users that will benefit the system.

Table 6.Accuracy Test Result of the One-hand Sign Language of English Alphabet

Letters Converted into Text or Audio	Number of Test Case (10)		Percentage of Numbers Converted	Category
	Fail	**Success**		
A	0	10	100%	Non complex
B	0	10	100%	Non complex
C	0	10	100%	Non complex
D	0	10	100%	Non complex
E	0	10	100%	Non complex
F	0	10	100%	Non complex
G	0	10	100%	Non complex
H	0	10	100%	Non complex
I	0	10	100%	Non complex
J	4	6	60%	Very complex
K	0	10	100%	Non Complex
L	0	10	100%	Non complex
M	0	10	100%	Non complex
N	0	10	100%	Non complex
O	0	10	100%	Non complex
P	0	10	100%	Non complex
Q	0	10	100%	Non complex
R	6	4	40%	Very Complex
S	3	7	70%	Complex
T	3	7	70%	Complex
U	5	5	50%	Very Complex
V	5	5	50%	Very complex
W	0	10	100%	Non complex
X	3	7	70%	Complex
Y	3	7	70%	Complex
Z	5	5	50%	Very complex
Total Percentage			**86%**	**Non Complex**

Table 6 shows the accuracy test result of the One-hand Sign Language (Alphabet) using gloves that translate them into text or audio. Results are categorized as Non-complex for passing the 10 times test case, Complex for almost passing and Failed for not passing due to its complex function (finger flexure and rapid movement). The test results letters A-Z interpreted as non-complex with a total percentage of 86%.

Table 7.Overall Accuracy Test Result

Convert Into Text or Audio	Overall Percentage	Category
Numbers	100%	Non Complex
Alphabet	86%	Non Complex
Total Percentage	**93%**	**Non Complex**

Table 7 shows the overall accuracy test result with a total of 93% non-complex. This means that the system was able to meet the passing percentage of Accuracy test (80%). Furthermore, this also means that the system overall functionality as develops system that is ready for implementation**.**

Acceptance Test

An acceptance test confirms that a story is complete by matching a user action scenario with the desired outcome. Acceptance testing is also called beta testing, application testing, and end-user testing.

Table 8.Overall Weighted Mean and Interpretation for Acceptance testing

Questions	Weighted Mean	Adjectival Interpretation
1. Overall, I'm satisfied with how easy it is to use this system.	4.6	Highly Acceptable
2. It was simple to use this system	4.4	Highly Acceptable
3. I can effectively complete my work quickly using this system.	3.6	Acceptable
4. I am able to efficiently complete my work using this system.	3.7	Acceptable
5. I am able to effectively complete my work using this system.	3.9	Acceptable
6. I feel comfortable using this system.	4.2	Highly Acceptable
7. It was easy to learn this system.	4.5	Highly Acceptable
8. I believe, I became productive quickly using this system.	4.0	Highly Acceptable
9. The system gives error messages that clearly tell me how to fix problems.	4.0	Highly Acceptable
10. Whenever I make a mistake using the system, I can recover easily and quickly.	4.0	Highly Acceptable
11. The information provided with this system is clear	4.0	Highly Acceptable
12. It is easy to find the information I needed.	4.0	Highly Acceptable
13. The information provided for the system is clear and easy to understand.	4.4	Highly Acceptable
14. The information is effective in helping me complete the tasks and scenarios.	4.0	Highly Acceptable
15. The organization of information on the system screens is clear.	4.2	Highly Acceptable
16. The interface of this system is pleasant.	4.2	Highly Acceptable
17. I like using the interface of this system.	4.3	Highly Acceptable
18. This system has all the functions and capabilities I expect to have.	3.9	Acceptable
19. Overall, I am satisfied with this system.	3.9	Acceptable
Overall Weighted Mean	**4.0**	**Highly Acceptable**

Table 8 shows the results of the conducted Acceptance Testing at Eastern Samar State University with 15 respondents. The results are interpreted as Highly Acceptable with a Grand mean 4.0.

IV. CONCLUSION

Based on the objectives of this study, titled Digital One-hand Sign Translator, the study was able to achieve and meet its objectives. The system was able to translate the one-hand sign into text or audio. The study concluded that the objectives of this study were meet the standard of the users who will benefit from this study.

REFERENCES

1. *Irving, Micheal (2017). Smart Glove Translates Sign Language.*
2. *Pascua, Sonia (2017). Words in Vision: A Filipino Sign Language Thesaurus Management System Using Ren-py.*