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Implementation of Internet of Things in the Development of Sign Language Translator Gloves Using Flex Sensors

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ABSTRACT

This research focuses on the development of gloves utilising flex sensors that translate hand gestures into sign language. Designed specifically for a person with a disability to communicate with others who do not understand sign language. The prototype method is used in this research with the stages of user identification, code generation and implementation, prototype testing and evaluation. The test results show that the readability rate is between 20% to 90% using SIBI gestures, the readability rate is high in some specific gestures. Integrating gloves with flex sensors creates a communication tool that is comfortable, easy and efficient to use.

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INTRODUCTION

In an era with rapid technological development, IoT is one form of technology that connects the digital world with the physical world. IoT is becoming more highlighted because it is able to facilitate humans in carrying out their daily lives, not only helping humans who are physically well but also can help humans who are physically less (disability). The application of IoT is poured into the form of smart gloves using flex sensors that are enabled to read finger movements and convert them into letters and numbers to LEDs which will be read by people who do not understand the finger language used by people with disabilities.

In general, of all the components, the flex sensor is the main component that is very influential in making this smart glove, the flex sensor in the glove is specifically functioned to detect changes in the indentation on the surface it is attached to in this case is the finger on the glove. When this glove is used, the flex sensor will detect the motion of the indentation on the finger including changes in the angle and position of the finger, this is done in order to get the right results when translating.

The flex sensor also has a minimalist design that makes it comfortable to use, as it does not add excessive weight to the glove, which is also an important factor in terms of user comfort. Another rationale for using flex sensors is that they provide a fast and real - time

Page : 113-119
Doi. 10.54209/jurnalkomputer.v15i02.117

response making it possible to interpret movements and transmit them in a short time. Flex sensors are also easy to adjust to the size of the hand making them more flexible to use.

Overall, flex sensors are a good choice to be implemented into smart gloves, with various advantages such as accurate data movement, fast response and also flexibility when using it. Of course, this is also in accordance with the purpose of making this smart glove, which is to create a comfortable and effective communication tool for people with disabilities.

METHODS

This research focuses on the development of sign language translation gloves using Internet of Things (IoT) technology by utilising flex sensors. This glove is specifically designed to help interlocutors who cannot use sign language recognise hand gestures and body curves used in sign language communication. The research method is an important step in our endeavour to achieve the research objectives. In this research, we chose to use the Prototype method as the main approach. According to Novitasari (2020), the Prototype Method is one of the system life cycle methods based on the concept of a working model [1]. We apply this method in the product/system development stages to achieve our research objectives. In order for the prototype model of this glove to run according to the initial objectives that have been set, we define the work steps used in this research, namely:

1. **Identify User Needs**

   At this stage, further studies are conducted to detail the various needs that must be met by the user. This process involved analysing various very important aspects, such as the safety, comfort and efficiency of the Flex Sensor Sign Language Interpreting Glove. Through careful and in-depth analysis, we sought to holistically understand how the device would interact with the user, providing a safe, comfortable and efficient experience.

2. **Prototype Design**

   After determining any user requirements in the previous stage, we then started by conceptualising a glove model that would allow for efficient sensor placement. In this process, many different design factors were considered, such as user comfort, sensor accuracy, and easy integration with IoT components. We carefully thought about how the flex sensors would be placed inside the glove to ensure that they could accurately detect body movements and curves. This also involved thinking deeply about how the user would feel and interact with the glove.

3. **Implementation of Programme Code into System**

   The next step is to implement the programme code into the system. We installed the flex sensor and hardware components according to the design on the sign language translator glove. Next, using the Arduino IDE, we implemented the necessary programme code into the system.

4. **Prototype Testing**

   After the implementation of the programme code, we conducted intensive testing to ensure that the flex sensor works accurately in detecting the indentation on the fingers. We also tested the IoT integration function and the hardware responsible for interpreting the sensor data into the appropriate sign language and the data that has been generated by the flex sensor will be displayed through the LCD integrated with the IOT device.

5. **System Evaluation**

   Once the testing was complete, we evaluated the results. The evaluation results help us to understand the strengths and weaknesses of the solution. From here, we plan for further development, which may include design improvements, software optimisation or adding additional features. In the evaluation and development

Page : 113-119
Doi. 10.54209/jurnalkomputer.v15i02.117

process, we also involve the end users, i.e. sign language interpreters, to get valuable feedback in improving the sign language interpreter glove prototype.

Internet Of Things

According to Arafat (2016), the Internet of Things, also known by the abbreviation IoT, is a concept that aims to expand the benefits of continuously connected internet connectivity [2]. Internet of Things (IoT) is a concept that aims to expand the benefits of continuously connected internet connectivity. In other words, IoT allows physical devices or everyday objects to connect to the internet and interact automatically, opening up opportunities for increased efficiency, better decision making, and innovation in various sectors.

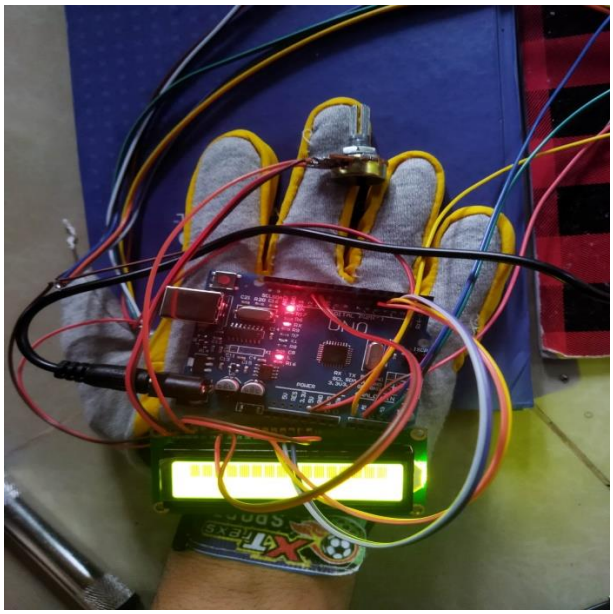
Arduino

As explained by Putri Natashia and Humdiana in their journal, Arduino is known as an "electronic board" which contains a microcontroller made by the Atmel company and various supporting devices that allow anyone to easily create various electronic projects [3]. Arduino therefore plays an important role in giving individuals access to create electronic solutions that suit a variety of needs and applications. With its open and supportive nature, Arduino facilitates exploration and innovation in the world of electronics.

Sensor Fleks

According to Affinannisa Tiara Nirwani (2018), a flex sensor is a sensor that has a change in resistance due to a change in the indentation on the sensor part, to detect a curvature. The principle works the same as a potensimeter. The flex sensor has 2 pin legs, with a thin elongated and flexible physical shape. This sensor has an output in the form of resistance. The two foot pins, if one pin is given a voltage of +5 V then the other pin as an output and a voltage of 0 Volts. The working principle of this flex sensor is similar to a variable resistor. The flex sensor provides resistance to the microcontroller through a voltage divider circuit. This resistance output will be given a voltage which will be read by the microcontroller [4].

RESULTS AND DISCUSSION



Picture 1. Sign Language Translator Gloves Prototype

Page : 113-119
Doi. 10.54209/jurnalkomputer.v15i02.117

The flex sensor on the glove works as a resistor that changes the resistance value according to the location of the indentation on the sensor and changes the value according to the bending angle. The circuit components of the flex sensor can be seen in table 1.

Table 1. Components of the Glove Set

Arduino Uno	LCD 16*2	Potensiometer 10K
GND	VSS, K	Terminal 1
+5V	VDD, A	Terminal 2
	VEE	Terminal 3
Pin D12	RS	
GND	RW	
Pin D11	E	
Pin D5	D4	
Pin D4	D5	
Pin D3	D6	
Pin D2	D7	

In the table 2, shows the explains of the various components connected to the arduino board, including arduino as the main brain in controlling the system includes controlling and processing data starting from flex sensors 1 to 5, each sensor functions to process each movement of the fingers and change it according to the SIBI rules. On the board there is also a 10K resistor which is used to split the voltage, there are also analog pins A0 to A4 which function to receive and read data from the connected device. There is also a GND connection that serves to measure the voltage and then the voltage is given to the device that requires the power source. Here are some components of the Arduino that are connected to the flex sensor:

Table 2. Components of the Arduino

Arduino	Fleks 1	Fleks 2	Fleks 3	Fleks 4	Fleks 5	Resistor 10K
A0	Terminal 1					Terminal 1
A1		Terminal 1				Terminal 1
A2			Terminal 1			Terminal 1
A3				Terminal 1		Terminal 1
A4					Terminal 1	Terminal 1
GND						Terminal 2
+5V	Terminal 2	Terminal 2	Terminal 2	Terminal 2	Terminal 2	

Table 3 shows the results of the finger configuration on the flex sensor. The finger movement configurations for assessing hand position in this study consist of non-bending, slight bending, bending (medium), and grasping (maximum) conditions defined as follows:

a. Non-bending = 0
b. Slight bending = 1
c. Medium = 2
d. Maximum = 3

Table 3. Finger Motion Configuration

SIBI Movement	Thumb	Index Finger	Middle Finger	Ring Finger	Little Finger	Hand Position
A	1	2	2	2	2	Upright
B	3	0	0	0	0	Upright
C	1	1	1	1	1	Sideways

Page : 113-119
Doi. 10.54209/jurnalkomputer.v15i02.117

D	2	0	2	2	2	Upright
E	3	2	2	2	2	Sideways
F	2	1	0	0	0	Upright
G	2	0	2	2	2	Sideways
H	2	0	0	2	2	Sideways
I	3	2	2	2	2	Upright
J	3	2	2	2	0	Sideways
K	3	0	0	2	2	Upright
L	0	0	2	2	2	Upright
M	3	2	2	2	2	Left Tilt
N	2	2	2	2	2	Left Tilt
O	1	1	1	1	1	Sideways
P	2	1	0	2	2	Sideways
Q	2	1	2	2	2	Sideways
R	3	1	1	2	2	Upright
S	3	2	2	2	2	Upright
T	3	1	2	2	2	Upright
U	3	0	0	1	2	Upright
V	2	0	0	1	2	Upright
W	3	0	0	0	2	Upright
X	3	1	0	0	0	Left Tilt
Y	0	2	2	2	0	Upright
Z	1	1	0	0	0	Left Tilt

Table 4 shows the results of testing the success of SIBI gesture classification with a test sample of 10 times.

Table 4. Finger Configuration Testing Results

SIBI Movement	Succeed	Failed	Readability Level (%)
A	7	3	70%
B	8	2	80%
C	5	5	50%
D	4	6	40%
E	6	4	60%
F	5	5	50%
G	5	5	50%
H	7	3	70%
I	9	1	90%
J	8	2	80%
K	3	7	30%
L	8	2	80%
M	5	5	50%
N	5	5	50%
O	9	1	90%
P	5	5	50%
Q	5	5	50%
R	4	6	40%

Page : 113-119
Doi. 10.54209/jurnalkomputer.v15i02.117

S	4	6	40%
T	2	7	20%
U	7	3	70%
V	7	3	70%
W	7	3	70%
X	4	6	40%
Y	9	1	90%
Z	1	9	10%

CONCLUSION

The research focuses on developing IoT (Internet of Things) based smart gloves by utilising flex sensors as the main key in communicating using these gloves. The conclusion of the research can be summarised into the following points, namely. The flex sensor is a key component of this research, where it is used to detect changes in the finger flex and then the flex data is converted into data that can be interpreted. Using the prototype method as the main approach in the research, this method includes several stages such as identifying user needs, designing prototype designs, creating and implementing code, testing programme code and evaluating it. The readability potential of this glove varies greatly between 20% - 90%, which has a huge potential to help people with disabilities communicate. The integration of IoT, flex sensors and gloves creates an easy-to-use, convenient and efficient communication tool to assist communication for people with disabilities.

Overall this research is a first step that can be developed more later in helping people with disabilities to be able to communicate more freely, further efforts can be made improvements such as design improvements, system and software optimisation, adding new features and of course increasing the effectiveness and accuracy of the percentage related to the level of readability of this smart glove. The conclusion is that integrating IoT, flex sensors and gloves can bring a big change to the way people with disabilities communicate, further development of these gloves will bring a better impact on the communication of people with disabilities.

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