

Design a Sign Language Translator Using Flexible Sensors

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In terms of communication skills, many of us have limitations and shortcomings or what we are more familiar with is speech impairment. Speaking is the ability to pronounce articulated sounds or words to express, express and convey thoughts, ideas and feelings. Communication skills can include many ways, including using verbal skills, namely verbally and non-verbally. In Indonesia, there are two sign languages used, namely Indonesian sign language (BISINDO) and Indonesian sign system (SIBI). BISINDO is a sign language that appears naturally in Indonesian culture and is practical for use in everyday life so that BISINDO has several variations in each region. The flex sensor has a thin and densely curved shape so that the flex sensor can be used as a motion detection and finger curve. Flex sensor application for human movement detection, patient monitoring. Therefore, hand-to-letter/text sign language translators using flexible sensors is a very important problem today. The method carried out is system design using tools and components used in research. This tool using the working principle in this system is to translate the sign language of alphabetic letters using flexible sensors. Design sign language translation of alphabetic letters using flexible sensors. The test to display the letters of the alphabet A-Z has a total minimum and maximum resistance at a flexible session of 1000 ohms with a voltage of 5V each. The result of this data is that there is no error in the play because the range value does not violate each other with other range values

Keywords: Hand-to-Alphabet, Flexible Sensors, sign languages, Communication skills



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1. INTRODUCTION

Speaking is the ability to pronounce articulated sounds or words to express, express and convey thoughts, ideas and feelings. Communication skills can include many ways, including using verbal skills, namely verbally and non-verbally. In terms of communication skills, many of us have limitations and shortcomings or what we are more familiar with is speech impairment. Because many of the speech impaired have difficulty communicating with the community, a tool is needed that helps translate sign language with text using finger curves [1]. In Indonesia, there are two sign languages used, namely Indonesian sign language (BISINDO) and Indonesian sign system (SIBI). BISINDO is a sign language that appears naturally in Indonesian culture and is practical for use in everyday life so that BISINDO has several variations in each region. Meanwhile, SIBI is a signal system recognized by the government and used in teaching at Special Schools for the Deaf (SLB/B). One of the differences is that BISINDO moves two hands to signal the alphabet, while SIBI only uses one hand [2] – [5]. However, the limited understanding of ordinary people towards sign language makes communication not well established. For ordinary people communicate with deaf and speech impaired. Therefore, a system or technology is needed that can translate sign language so that it can overcome these problems. One of the most commonly used technologies for the interaction of movement in the human and computer interfaces is data glove. Data glove can be utilized to help users to interact with the virtual world and serve as input in non-verbal communication [6].

The flex sensor has a thin and densely curved shape so that the flex sensor can be used as a motion detection and finger curve. Flex sensor application for human movement detection, patient monitoring. Glove data uses the principle of magnetic induction, designing glove data using five flex sensors mounted on the thumb, index, middle, ring and little fingers. Flex sensors are placed on proxima phalanges and middle phalanges [7]. The desired sensor performance is achieved by using a composite material that is formed by adding carbon nanoparticles to the Dragon skin as an elastomer. The strain sensor has stable piezoresistive characteristics and possesses sufficient characteristics to distinguish the differences between hand signs for full expressions of English alphabets without degrading the stretchability of the elastomer substrate. The wearable system is demonstrated with an assembly of the strain sensors, which achieves interpretation of the letters from the hand signs in real time [8]. The ASL, short for American Sign Language is the most widely used sign language across the globe with certain variations according to the country. In this work, we developed a wearable wireless gesture decoder module that can translate the fundamental set of ASL gestures into corresponding alphabets and words. Our project utilizes a glove that houses a series of flex sensors on the metacarpal and inter-phalangeal joints of the fingers to detect the bending of fingers, through piezoresistive effect. The

glove is outfitted with an accelerometer as well, that helps to detect the hand movements. Simple classification algorithms from machine learning are then applied to translate the gestures into alphabets or words. With the assistance of a bluetooth module, the data is sent wirelessly. The result is then displayed and heard on the android smartphone using an android application named “Dastaana”, which is an Urdu word for glove. Portability, compactness, cost-effectiveness and a user-friendly android application gives this system an edge [9]. In this paper, an accurate implementation of American Sign Language Translator is presented. It is a portable electronic hand glove to be used by any deaf/mute person to communicate effectively with the others who don't understand sign language. It provides the visual and audible output on an LCD and through a speaker respectively. This glove consists of five flex sensors that senses the variation in different signs, an accelerometer to distinguish between the static and dynamic signs, a contact sensor, Arduino Mega 2560 for processing of the data, VoiceBox shield, LCD and Speaker for the outputs. There exists a communication gap between the normal and the disabled people [10].

The sensory gloves provide data of the human hand shape or movement and translate it to text and speech. It comprises hardware and software for translating sensor data. It is wearable devices that can be put on human hands and convert hand's gestures into signs letter by letter and send the data into the firebase for further processing. The glove is equipped with flex sensors and an inertial measurement unit to recognize the movement by monitoring the finger orientation and hand motion in three-dimensional spaces that senses a person's gestures in the form of finger bend and hand fist tilt. The Hall sensor has been used to process and collect data for training and model development. The three different machine learning algorithms, i.e., support vector machine, Naïve Bayes, decision tree, have been used for analysis. It has been observed that the support vector machine has the highest accuracy, i.e., 90%. After Analyzing, the data has been sent to the speech converting function, and then audible results have been produced [11]. Communication is merely a means of transferring information from one place, person or group to another. Vocal Communication is the manner in which human being interact with others. Be that because it might, not every one of us isn't able to share our thoughts in verbally due to some physical disabilities. It is very difficult for Deaf and Mute people to convey their thoughts and ideas with normal people. Most of the people does not know sign language which make it difficult for silent people to communicate with others. Some devices are available that convert sign language to text and speech in English, but no device is available for any other language specifically Malayalam [12]. The problem is that SL is not understood by everyone, forming a communication gap between the mute and the able people. Multiple and systematic scholarly interventions that vary according to context have been implemented to overcome disability-related difficulties. Sign language recognition (SLR) systems based on sensory gloves are significant innovations that aim to procure data on the shape or movement of the human hand to bridge this communication gap, as the proposed system. The proposed model is a glove equipped with five flex sensors, interfacing with a control unit fixed on the arm, translating American Sign Language (ASL) and Arabic Sign Language (ArSL) to both text and speech, displayed on a simple Graphical User Interface (GUI). The proposed system aims to provide an affordable and user friendly SL translator system, working on the basis of Machine Learning (ML). However, it adapts to each person's hand instead of using a generic data set. The system achieved 95% recognition rate with static gestures and up to 88% with dynamic gestures [13].

This paper presents the design and construction of a cost-effective, portable sign language to speech translator. The system is designed to work with American Sign Language fingerspelling (which facilitates translation in any Latin alphabet-based language) and aims to translate a pangram into speech. The system consists of three subsystems, namely, gesture detection, gesture classification, and text-to-speech subsystems and relies on a power bank for its power supply. The gesture detection subsystem makes use of five flex sensors, each placed on the finger of a glove, as well as a three-axis accelerometer. Gesture classification is achieved through a supervised machine learning approach — five different algorithms are compared to determine the best configuration for this system. Overall, a support vector machine with a radial basis function kernel and a penalty parameter of 10.0 performs best in the context of this investigation. Using the best-case sensor configuration, and the best-performing machine learning classifier, the system achieves a practical repeatability of 85.51%. Text-to-speech translation of the classified gestures is performed using the eSpeak engine [14]. In this research, the objectives are to develop a sign language translation system in order to assist the hearing or speech impaired people to communicate with normal people, and also to test the accuracy of the system in interpreting the sign language. As a first step, the best method in gesture recognition was chosen after reviewing previous researches. The configuration of the data glove includes 10 tilt sensors to capture the finger flexion, an accelerometer for recognizing the motion of the hand, a microcontroller and Bluetooth module to send the interpreted information to a mobile phone. Firstly the performance of the tilt sensor was tested [15]. Therefore, hand-to-letter/text sign language translators using flexible sensors is a very important problem today. This problem is something that is very important and often discussed in the surrounding environment. With various problems that occur in the community.

2. METHOD

At this stage, system design is carried out using tools and components used in research. This tool using the working principle in this system is to translate the sign language of alphabetic letters using flexible sensors. The following is a hardware system design scheme.

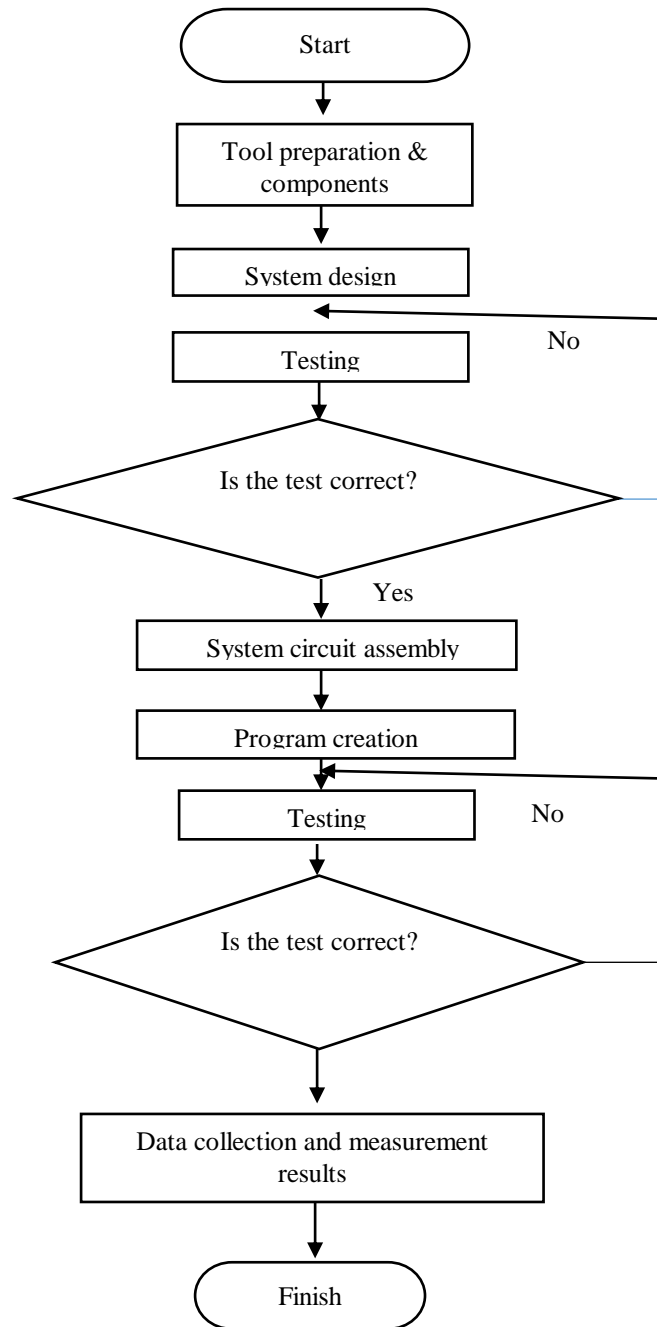


Figure 1. System Tightening Process Water Diagram

This process is by designing the system, then preparing tools and materials in the design process after that testing each tool and material used, if the test has been met or is correct, then proceed directly to the assembly process or making a series of systems and making programs. Then return to testing again in order to ensure the performance of the tool whether it has met, if so, the tool can already take data. This hardware manufacturing process is the main goal for designing and designing sign language translation gloves from letters of the alphabet using flexible sensors. Basically, the manufacture of this hardware to create a system that is able to help human performance in this case is as a design for translating sign language alphabets using flexible sensors and other equipment. The design of sign language translation uses several hardware or components that will be combined into a sign language translation system namely Flexible sensors, Gloves, Arduino Pro mini, OLED LCD, 56K Resistors and 9 volt Alkaline Batteries and MPU Gyro Sensors. The design of the whole set of sign

language translation is the combination of several sets of devices to create a sign language translation tool, as in figure 2 The hardware that has been designed will be realized in prototype form.

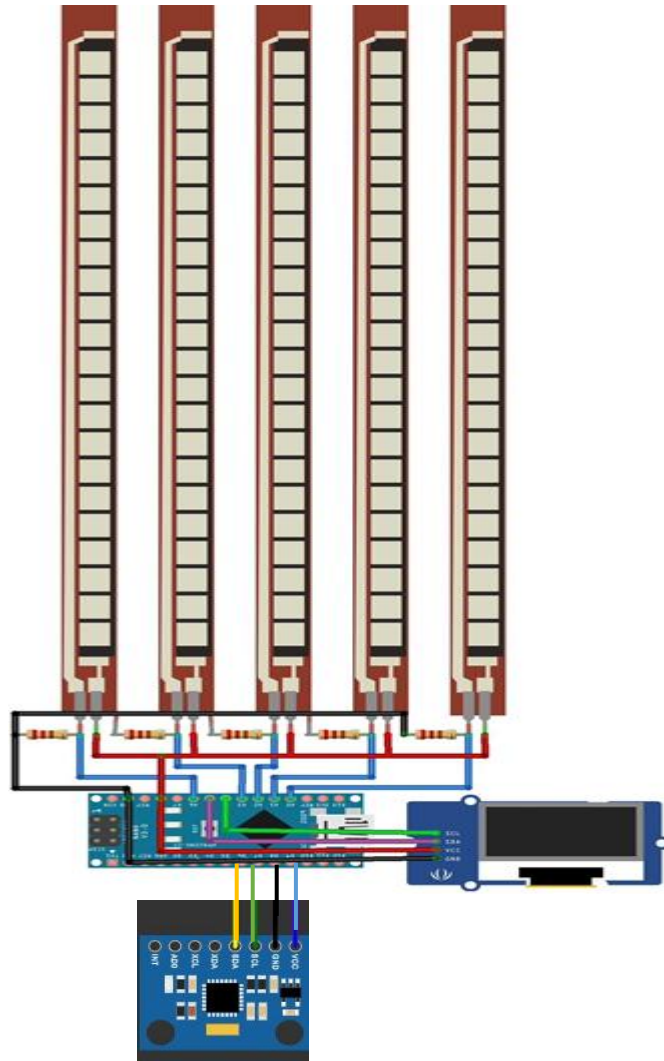


Figure 2. Whole circuit

In the design of this tool using several components, namely Flexible Sensors. This flexible sensor is connected from one leg of the 10K resistor with the VCC/5V pin of the Arduino, then another leg of the resistor is connected to one leg of the flex sensor from pins A0, A1, A2, A3, A4 to the GND pin of the Arduino. Then the Oled LCD and MPU 6050 gyro sensor are connected to the I2c pins, namely SDA and SCL Arduino Pro Mini. The flexible sensors used in this prototype are 5 (five) sensors placed on the little finger, ring finger, middle finger, index finger and thumb finger. Each sensor will obtain successive analog values on analog pins A0 to A4 arduino as shown in figure 3.



Figure 3. Flexible Sensor Layout

Oled LCD is a display screen made of semiconductors. This LCD functions as a light emitter made of organic layers. This Oled LCD is to facilitate schematics in communicating with the fingers of the hand can be seen in the following picture:

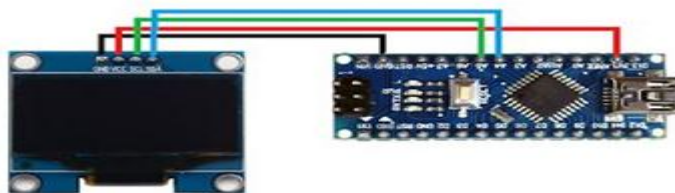


Figure 4. Oled LCD Layout/ Display

The sign language translation prototype is made according to pre-existing design concepts. The flexible sensor path is given gloves as a flexible sensor container that is adapted to the design concept of sign language translation prototypes, then the sensor container is glued, this is a process where gluing is carried out to the flexible sensor as a container for the control circuit of the sign language translation prototype and places the sensor paths in each knuckle. The use of Flexible Sensors in this final project is the principle of wearing glove media as the movement is based on movements on the fingers. In accordance with the number of alphabets in Indonesian, the form of finger movements has a movement of 26 letters of the alphabet that will display the results on the Display / LCD.

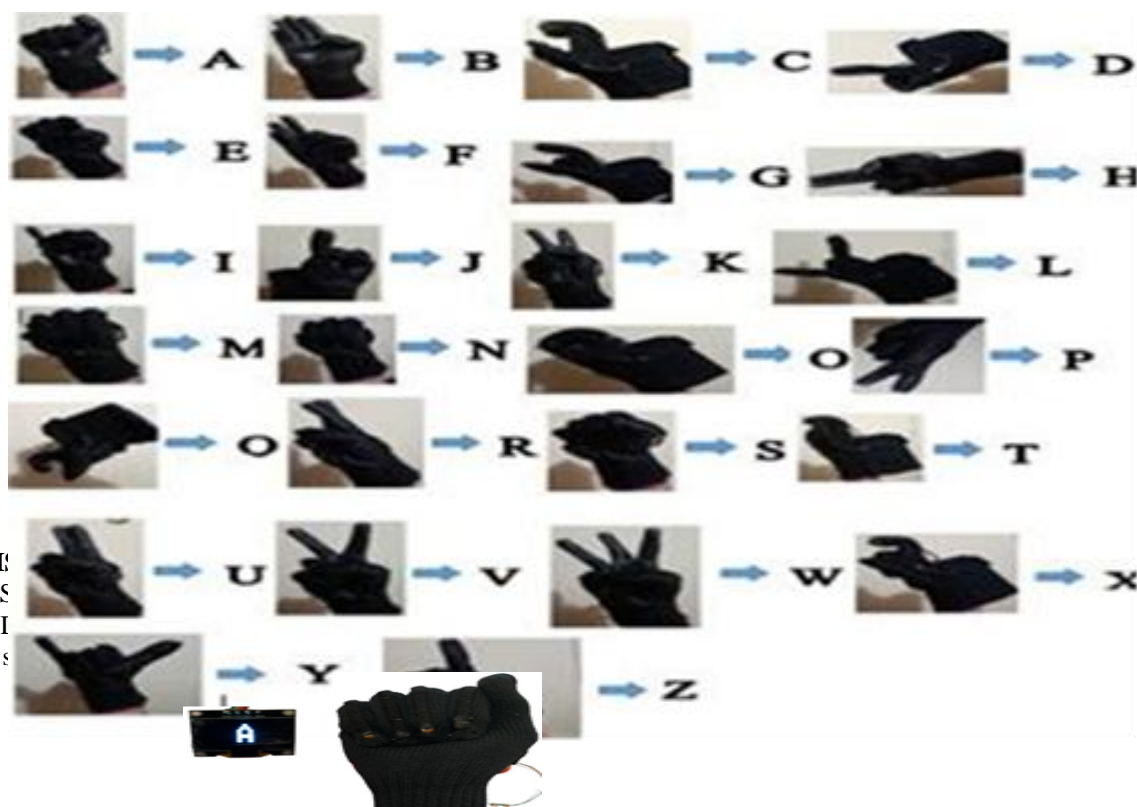


Figure 6. Display of the letter A and finger gestures

Based on the test result data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 850, the minimum adc value is 820, for sensor 2 the maximum value is 950 the minimum value is 900, for sensor 3 the maximum value is 925 the minimum value is 890, for sensor 4 the maximum value is 840 the minimum value is 830, for 5 sensors, the maximum value is 950, the minimum value is 900 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 1. Letter A Sensor Data Value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Min	820	900	890	830	900	A	NoI
Max	850	950	925	840	950		

2. Display the letter B Display

The following is sensor data that has been recorded, when the display shows the letter B



Figure 7. Display of the letter B and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 920, the minimum adc value is 879, for sensor 2 the maximum value is 850 the minimum value is 760, for sensor 3 the maximum value is 820 the minimum value is 780, for sensor 4 the maximum value is 800 the minimum value is 730, for 5 sensors, the maximum value is 875, the minimum value is 810 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters

Table 2. Sensor Data Value Letter B

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Min	879	760	780	730	810	A	Nol
Max	920	850	820	800	875		

3. Display the letter C Display

The following is sensor data that has been recorded, when the display shows the letter C



Figure 8. Display of the letter C and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 830, the minimum adc value is 865, for sensor 2 the maximum value is 885 the minimum value is 930, for sensor 3 the maximum value is 869 the minimum value is 890, for sensor 4 the maximum value is 920 the minimum value is 860, for 5 sensors, the maximum value is 920, the minimum value is 860 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters

Table 3. C Letter Data Value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Min	865	930	890	900	860	A	Nol
Max	830	885	869	760	920		

4. Display the letter D Display

The following is sensor data that has been recorded, when the display shows the letter D



Figure 9. Display of the letter D and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 879, the minimum adc value is 910, for sensor 2 the maximum value is 790 the minimum value is 840, for sensor 3 the maximum value is 880 the minimum value is 920, for sensor 4 the maximum value is 810 the minimum value is 800, for 5 sensors, the maximum value is 900, the minimum value is

959 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 4. D Letter Data Value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Min	910	840	920	800	959	D	Nol
Max	875	790	880	810	900		

5. Display the letter E Display

The following is sensor data that has been recorded, when the display shows the letter E



Figure 10. Display of the letter E and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 890, the minimum adc value is 920, for sensor 2 the maximum value is 890 the minimum value is 939, for sensor 3 the maximum value is 899 the minimum value is 920, for sensor 4 the maximum value is 900 the minimum value is 970, for 5 sensors, the maximum value is 945, the minimum value is 899 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 5. Letter E Data Value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Min	920	939	920	970	899	E	Noll
Max	890	890	899	900	945		

6. Display the letter F Display

The following is sensor data that has been recorded, when dsplay shows the letter F



Figure 11. Display of the letter F and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 865, the minimum adc value is 889, for sensor 2 the maximum value is 900 the minimum value is 920, for sensor 3 the maximum value is 800 the minimum value is 820, for sensor 4 the maximum value is 890 the minimum value is 900, for 5 sensors, the maximum value is 845, the minimum value is 880 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters

Table 6. F Letter Data Value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Min	889	920	820	900	880	F	Nol
Max	865	900	800	890	845		

7. Display the letter G Display

The following is sensor data that has been recorded, when the display shows the letter G



Figure 12. G Letter Display and Finger Gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 780, the minimum adc value is 882, for sensor 2 the maximum value is 790 the minimum value is 815, for sensor 3 the maximum value is 890 the minimum value is 929, for sensor 4 the maximum value is 800 the minimum value is 850, for 5 sensors, the maximum value is 925, the minimum value is 945 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters

Table 7 Data Values of the letter G

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Min	820	815	929	850	945	G	Nol
Max	780	790	890	800	925		

8. Display the letter H Display

The following is sensor data that has been recorded, when the display shows the letter H



Figure 13. Display of the letter H and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 860, the minimum adc value is 890, for sensor 2 the maximum value is 788 the minimum value is 820, for sensor 3 the maximum value is 790 the minimum value is 830, for sensor 4 the maximum value is 981, the minimum value is 899, for 5 sensors, the maximum value is 900, the minimum value is 945 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 8. H Letter Data Value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Min	890	820	830	899	945	H	Noll
Max	860	788	790	981	900		

9. Display the letter I Display

The following is sensor data that has been recorded, when the display shows the letter I



Figure 14. Display of the letter I and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 860, the minimum adc value is 910, for sensor 2 the maximum value is 880 the minimum value is 933, for sensor 3 the maximum value is 970 the minimum value is 890, for sensor 4 the maximum value is 810 the minimum value is 796, for 5 sensors, the maximum value is 850, the minimum value is 875 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 9 . Letter I Data Value

Value	Thumb	Forefinger	Middle	Ring	Little finger	Dsplay	Error
						I	

			finger	finger		Letters	
Min	910	933	890	796	875	I	Noll
Max	860	880	870	810	850		

10. Display the letter J Display

The following is sensor data that has been recorded, when the display shows the letter J

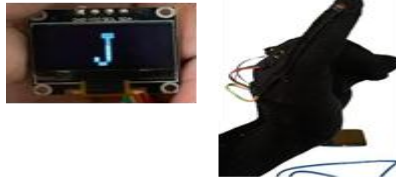


Figure 15. Display of the letter J and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 880, the minimum adc value is 910, for sensor 2 the maximum value is 880 the minimum value is 890, for sensor 3 the maximum value is 870 the minimum value is 890, for sensor 4 the maximum value is 840 the minimum value is 810, for 5 sensors, the maximum value is 850, the minimum value is 875 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 10. J Letter Data Value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Min	910	933	890	810	875	J	Noll
Max	880	880	870	840	850		

11. Display the letters K Display

The following is sensor data that has been recorded, when the display shows the letter K



Figure 16. K Letter Display and Finger Gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 790, the minimum adc value is 830, for sensor 2 the maximum value is 768 the minimum value is 790, for sensor 3 the maximum value is 780 the minimum value is 820, for sensor 4 the maximum value is 860 the minimum value is 890, for 5 sensors, the maximum value is 900, the minimum value is 935 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 11 Data Values of the letter K

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	830	790	820	890	935	K	Noll
Min	790	768	780	860	900		

12. Display the letter L Display

The following is sensor data that has been recorded, when the display shows the letter L



Figure 17. Display of the letter L and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 790, the minimum adc value is 850, for sensor 2 the maximum value is 775 the minimum value is 810, for sensor 3 the maximum value is 880 the minimum value is 920, for sensor 4 the maximum value is 885 the minimum value is 870, for 5 sensors, the maximum value is 990, the minimum value is 935 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters

Table 12. Data Values of the letter L

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	850	810	920	870	935	L	Nol
Min	790	775	880	865	890		

13 .Display the letter M Display

The following is sensor data that has been recorded, when the display shows the letter M



Figure 18. Display of the letter M and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 820, the minimum adc value is 870, for sensor 2 the maximum value is 892 the minimum value is 930, for sensor 3 the maximum value is 860 the minimum value is 899, for sensor 4 the maximum value is 830 the minimum value is 910, for 5 sensors, the maximum value is 880, the minimum value is 920 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters

Table 13. Data Values of the letter M

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	870	930	899	910	920	M	Nol
Min	820	892	860	830	880		

14. Display the letter N Display

The following is sensor data that has been recorded, when the display shows the letter N



Figure 19. Display of the letter n and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 800, the minimum adc value is 870, for sensor 2 the maximum value is 892 the minimum value is 830, for sensor 3 the maximum value is 860 the minimum value is 899, for sensor 4 the maximum value is 810 the minimum value is 830, for 5 sensors, the maximum value is 890, the minimum value is 835 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 14. N Letter Data Values

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	870	930	899	830	935	N	Nol
Min	800	892	860	810	890		

15. Display the letter O Display

The following is sensor data that has been recorded, when the display shows the letter O



Figure 20. Display of the letter O and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 850, the minimum adc value is 889, for sensor 2 the maximum value is 880 the minimum value is 930, for sensor 3 the maximum value is 880 the minimum value is 860, for sensor 4 the maximum value is 820 the minimum value is 860, for 5 sensors, the maximum value is 900, the minimum value is 950 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 15. Data Values of the Letter O

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	889	930	930	860	950	O	Nol
Min	850	880	880	820	900		

16. Display the letter P Display

The following is sensor data that has been recorded, when the display shows the letter P

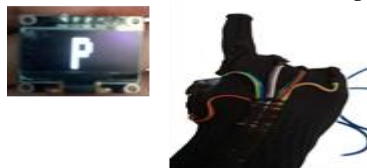


Figure 21. Display of the letter P and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 1035, the minimum adc value is 622, for sensor 2 the maximum value is 1010 the minimum value is 490, for sensor 3 the maximum value is 1050 the minimum value is 531, for sensor 4 the maximum value is 1030 the minimum value is 430, for 5 sensors, the maximum value is 950, the minimum value is 506 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 16. Data Values of Letter P

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	820	820	900	810	940	P	Noll
Min	780	770	870	830	900		

17. Display the letter Q Display

The following is sensor data that has been recorded, when the display shows the letter Q



Figure 22. Display of the letter Q and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 790, the minimum adc value is 825, for sensor 2 the maximum value is 770, the minimum value is 820 for the maximum 3 sensor value is 870, the minimum value is 890, for the sensor 4 the maximum value is 776, the minimum value is 790, for 5 sensors, the maximum value is 890, the minimum value is 930 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 17. Data Values of the letter Q

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	825	820	890	790	930	Q	Nol
Min	790	770	870	776	890		

18. Display the letter R Display

The following is sensor data that has been recorded, when the display shows the letter R



Figure 23. Display of the letter R and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 860, the minimum adc value is 889, for sensor 2 the maximum value is 770 the minimum value is 820, for sensor 3 the maximum value is 800 the minimum value is 840, for sensor 4 the maximum value is 850 the minimum value is 760, for 5 sensors, the maximum value is 900, the minimum value is 940 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 18. Data Values of Letter R

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	899	820	840	760	940	R	Nol
Min	860	770	800	850	900		

19. Display the letter S Display

The following is sensor data that has been recorded, when the display shows the letter S



Figure 24. Display of the letter S and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 800, the minimum adc value is 840, for sensor 2 the maximum value is 870 the minimum value is 900, for sensor 3 the maximum value is 900 the minimum value is 850, for sensor 4 the maximum value is 780 the minimum value is 820, for 5 sensors, the maximum value is 900, the minimum value is 940 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 19. Data Values of the letter S

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	840	900	850	820	940	S	Nol
Min	800	870	900	780	900		

20. Display the letter T Display

The following is sensor data that has been recorded, when the display shows the letter T



Figure 4.25 Display of the letter T and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 800, the minimum adc value is 840, for sensor 2 the maximum value is 870 the minimum value is 900, for sensor 3 the maximum value is 850 the minimum value is 899, for sensor 4 the maximum value is 820 the minimum value is 790, for 5 sensors, the maximum value is 900, the minimum value is 940 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 20. Data Values of the letter T

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	840	900	899	790	940	T	Nol
Min	800	870	850	820	900		

21. Display the letter U Display

The following is sensor data that has been recorded, when the display shows the letter U



Figure 26. U-letter display and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 860, the minimum adc value is 890, for sensor 2 the maximum value is 800 the minimum value is 820, for sensor 3 the maximum value is 800 the minimum value is 840, for sensor 4 the maximum value is 810 the minimum value is 870, for 5 sensors, the maximum value is 880, the minimum value is 940 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters

Table 21. Data Values of the letter U

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	890	820	840	870	940	U	Nol
Min	860	800	800	810	880		

22. Display the letter V Display

The following is sensor data that has been recorded, when the display shows the letter V



Figure 27. V Letter Display and Finger Gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 830, the minimum adc value is 880, for sensor 2 the maximum value is 780 the minimum value is 820, for sensor 3 the maximum value is 790 the minimum value is 820, for sensor 4 the maximum value is 800 the minimum value is 810, for 5 sensors, the maximum value is 900, the minimum value is

940 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 22. V Letter Data Values

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	880	820	820	810	940	V	NoI
Min	830	780	790	800	900		

23. Display the letter W Display

The following is sensor data that has been recorded, when the display shows the letter W



Figure 28. Display of the letter W and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 869, the minimum adc value is 895, for sensor 2 the maximum value is 770 the minimum value is 805, for sensor 3 the maximum value is 800 the minimum value is 839, for sensor 4 the maximum value is 910 the minimum value is 809, for 5 sensors, the maximum value is 900, the minimum value is 925 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters

Table 23. W Letter Data Values

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	895	805	839	809	925	W	NoI
Min	869	770	800	910	900		

24. Display the letter X Display

The following is sensor data that has been recorded, when the display shows the letter X



Figure 29. X Display and Finger Gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 860, the minimum adc value is 890, for sensor 2 the maximum value is 890 the minimum value is 920, for sensor 3 the maximum value is 880 the minimum value is 915, for sensor 4 the maximum value is 980 the minimum value is 960, for 5 sensors, the maximum value is 900, the minimum value is 940 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 24. Letter X Data Value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	890	920	915	960	940	X	NoI
Min	860	890	880	980	900		

25. Display the letter Y Display

The following is sensor data that has been recorded, when the display shows the letter Y



Figure 30. Y-letter display and finger gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 780, the minimum adc value is 820, for sensor 2 the maximum value is 890 the minimum value is 925, for sensor 3 the maximum value is 860 the minimum value is 890, for sensor 4 the maximum value is 815 the minimum value is 860, for 5 sensors, the maximum value is 859, the minimum value is 890 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 25. Y letter data value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	820	925	890	860	890	Y	Nol
Min	780	890	860	815	859		

26. Display the letter Z Display

The following is sensor data that has been recorded, when the display shows the letter Z



Figure 31. Z Letter Display and Finger Gestures

Based on the test data, it can be concluded that the sensor readings work well in the reading function, for sensor 1 the maximum adc value is 875, the minimum adc value is 910, for sensor 2 the maximum value is 790 the minimum value is 840, for sensor 3 the maximum value is 880 the minimum value is 920, for sensor 4 the maximum value is 960 the minimum value is 810, for 5 sensors, the maximum value is 900, the minimum value is 959 with a voltage of 5V each and a resistance of 1000 ohms. The result of this data is that there is no error on the display because the value of the range adc does not violate each other with the range adc of other letters.

Table 26. Letter Z Data Value

Value	Thumb	Forefinger	Middle finger	Ring finger	Little finger	Dsplay Letters	Error
Max	910	840	920	810	959	Z	Nol
Min	875	790	880	960	900		

Scheme Sign language translation design of alphabetic letters, the design of this tool utilizes a flex sensor to detect the curve of the fingers. Flex sensors have a change in resistance due to changes in indentation in the sensor part. This sensor has an output in the form of resistance. This sensor requires a voltage of +5V to work. This flex sensor is then connected to a voltage divider circuit. This resistance output will be given a voltage which will later be read by the microcontroller. The output of the flex sensor will be the input for the analog to digital converter (ADC) that is inside the microcontroller.

4. CONCLUSION

Design sign language translation of alphabetic letters using flexible sensors. The development of this tool can detect changes in glove movement reactions, adjustments to the contents of the program are needed, as well as accurate design size dimensions. Design and development of hardware so that component stickers do not require too much space. The test to display the letters of the alphabet A-Z has a total minimum and maximum resistance at a flexible session of 1000 ohms with a voltage of 5V each. The result of this data is that there is no error in the play because the range value does not violate each other with other range values

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