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Flex sensors and MPU6050 sensors responses on smart glove for sign language translation

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Abstract. Flex sensor is a transducer that measures the level of curvature of the sensor. One type of flex sensor is a resistive flex sensor. This type of sensor has output resistance value that proportionally to the level of flexibility of the sensor. The gyroscope and accelerometer sensor used in the research is the MPU6050 that has measurements on earth gravity. The glove was attached by the flex sensor and gyroscope sensors for sensing fingers and hand movement. This paper presented data on flex and MPU6050 sensor response. The microcontroller is used in the research was Arduino Nano controller to read flex sensors and MPU6050 sensors.

1. Introduction

Sign language has an important role for people with speech disorders. In Indonesia alone persons with disabilities at 18-30 years of age are 1.15% of the population, even in underfives with a disability of 0.26% [1]. Species of speech impaired at the age of 24-59 months in Indonesia in 2010 reached 0.14% and in 2013 reached 0.15% increase from the previous year [1]. In the data the person with speech impairment increases in the next year, it takes innovation to help our brother with those special needs. People with speech impaired use of sign language in daily communication. In figure 1, a simple gesture of American sign language. Each letter in the sign language system has its own gesture, the different finger density of the fingers of different fingers.

In the processing of sign language based electronic systems have many techniques and sensors are applied. Such as flex sensor, metal material, image processing [2]. Each technique has its own advantages and disadvantages. The use of gloves in an electronic system has practicality and convenience for its users [3]. Image processing techniques have high levels of computing and system complexity, while the use of flex sensors and applied to a lower level complexity glove, and easy to use for users [3].

Sensing gloves with flex sensors are of many applicative variants in assisting human tasks, the use of flex sensor gloves to drive DC motors designed to drive one wheelchair [4]. In addition, flex sensor gloves can be used on the robot arm control, even inserted accelerometer sensor to increase the sensation of hand movement, not only the finger curve that is read movement but also the slope of the wrist [5].

The research done by [6] shows data on the sensor response to each sign language gesture, which presented data from flex and accelero sensor in forming a gesture alphabet sign language. Data glove is can be applied in various aspects, such as virtual reality, robotics, tele electric, biomechanics.

Figure 1. Gesture of American sign language.

2. Overview of smart glove

To perform gesture readings on sign language with gloves the gloves require electronic sensor to perform the gesture reading of the sign language. The characteristics of the sign language gesture in figure 1 are the fingertip plays and the slopes on the hands.

There are two keywords: flexibility and slope. One sensor for flexibility reading is flex sensor. To measure the tilt can use accelerometer sensor and one of the series is MPU6050. In processing the sensor can use a microcontroller in this glove using Arduino as a sensor reader and sensor processor. The component material is packed and sewn into a glove with a flexible fabric and is designed to be easy to use, and can read gestures well.

3. Working and data smart glove

Gloves are made with sensors and electronics to perform the task of reading gesture sign language and can process the sensor output and converted into sign language in the form of text or sound to facilitate communion. With the data can then be made algorithm to make the sign language cues from gesture to the form of sound or text.

3.1 Smart glove hardware

The design of a hardware glove system using sensors and sensors MPU6050 with Arduino microcontroller for processing and a Personal computer to monitor the value of sensor output value. The block diagram of hardware groove of smart glove is shown in figure 2.

In accordance with figure 2 Arduino as sensor signal processor from sensor flex through ADC (Analog to Digital Converter) and MPU6050 gyroscope & accelerometer sensor through I2C (Inter-Integrated Circuit) line. In the flex sensor there is a circuit for dividing the voltage with a 10k ohm resistor according to figure 3.

The flex sensor is placed on top of each finger and the MPU6050 gyroscope & accelerometer sensor is placed on top of the hand, using a flexible Fabric both sensors closed and sewn over the fabric. While the Arduino placed on a cloth that can be worn on the wrist. In figure 4 detail the layout of the components of the smart glove.

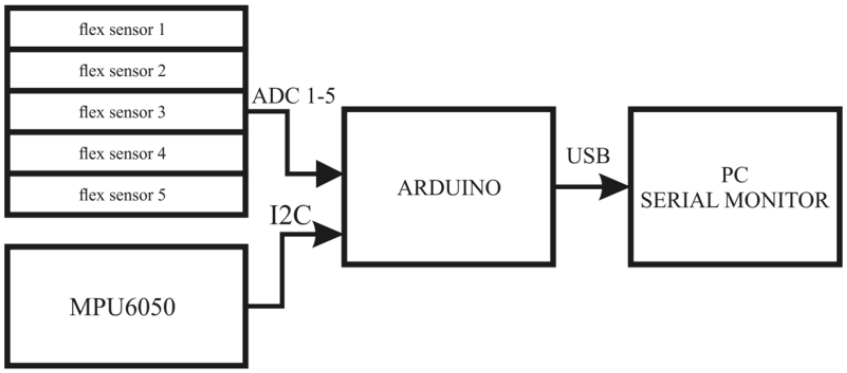

Figure 2. Diagram block of smart glove.

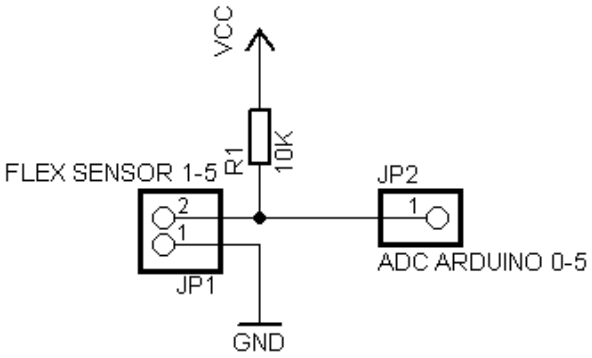

Figure 3. Flex sensor schematic.

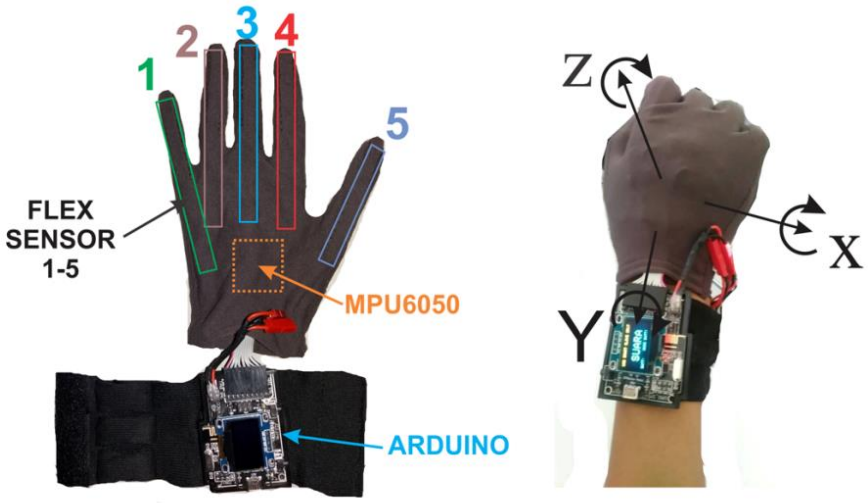

Figure 4. Attachment sensors on smart glove.

In figure 4, seen laying accelerometer sensor with 3 axis. In the above smart gloves on the picture 4 using a 4.5" sensors flex that is on the sensors 1-4 and on the sensors 5 flex sensor using size 2.2".

3.2 Response sensor data.

In sign language each finger letters form a certain pattern so that every pattern of gesture to form letter sign has its own character. In Figure 1 the gesture pattern of each letter has its own gesture. From A to Z has a different gesture. Due to the difference, that the sensor MPU6050 sensor and sensor output has different output values also on each gestures. Tested every sign language gesture from A to Z is taken 100 data on each gesture and data is taken at 1 second interval in each gesture data. The observed data are the ADC flex sensor 1-5 and the accelerometer value of MPU6050 axis x and y only and then take of mean on each gesture. Obtained data in table 1.

Table 1. flex and accelero sensors data.

Alphabet	Flex sensor 1	Flex sensor 2	Flex sensor 3	Flex sensor 4	Flex sensor 5	Acc X	Acc Y
A	754.58	747.51	744.64	719.41	858.10	-15,557.58	-1,840.04
B	511.52	510.90	508.09	511.18	903.05	-15,816.73	-672.97
C	582.22	628.07	614.12	623.98	884.06	-16,345.37	-214.06
D	636.70	660.67	647.79	539.22	879.64	-16,344.69	700.44
E	735.55	743.28	738.26	737.46	915.11	-16,111.43	1,526.06
F	513.90	516.21	516.24	690.08	902.97	-16,142.18	1,360.61
G	748.31	730.81	715.81	554.66	865.23	-5,215.11	-14,692.16
H	719.56	690.13	521.63	548.09	899.10	-7,971.96	-12,637.82
I	518.04	694.56	724.84	713.03	910.89	-14,670.14	2,956.93
J	517.34	693.31	719.17	714.79	902.89	-13,427.64	-8,908.12
K	733.44	692.25	541.05	515.78	861.43	-16,198.18	-1,150.46
L	747.43	728.96	709.44	526.73	883.46	-15,605.86	-643.03
M	740.67	696.80	713.58	719.70	863.32	-16,118.46	-2,071.88
N	746.54	737.91	721.14	704.46	845.14	-16,332.00	1,118.06
O	686.04	703.77	726.02	706.33	899.67	-16,210.18	1,050.26
P	730.39	685.46	600.62	537.13	858.93	-7,027.80	-2,663.96
Q	735.96	720.07	721.28	626.74	870.78	-6,910.79	-1,540.73
R	716.81	685.86	514.83	528.53	895.44	-15,701.58	487.88
S	733.17	728.11	753.30	747.41	907.92	-16,101.21	1,346.71
T	730.64	691.82	731.19	709.17	839.01	-16,238.75	-503.07
U	713.02	675.46	514.44	527.93	876.55	-16,302.91	-358.59
V	712.46	682.93	519.15	541.91	903.59	-16,202.99	-1,172.08
W	686.46	512.00	518.26	538.97	884.65	-16,290.91	387.68
X	749.36	732.85	754.41	639.26	910.17	-16,333.58	-552.81
Y	511.11	690.39	708.58	713.37	861.89	-15,940.85	-894.34
Z	728.59	721.08	726.21	569.25	897.17	-15,278.87	-296.89

3.3 Result

Obtained results in table 1, flex sensor response with unit bit of ADC Output. The results are taken from the flex sensor readings as they are attached to glove and form a specific curve at each gesture formation of sign language. The value is derived from the ADC conversion of the Arduino Nano with input according to figure 3 and the ADC value reference voltage in the Arduino is 5V. While the accelerometer value of x and y is the value of hand slope in implementing hand movement in formatting gesture. The

reading of that value with the figure 4. Figure 5 and figure 6 are graphs obtained from table 1 to clarify the difference in values on each gesture.

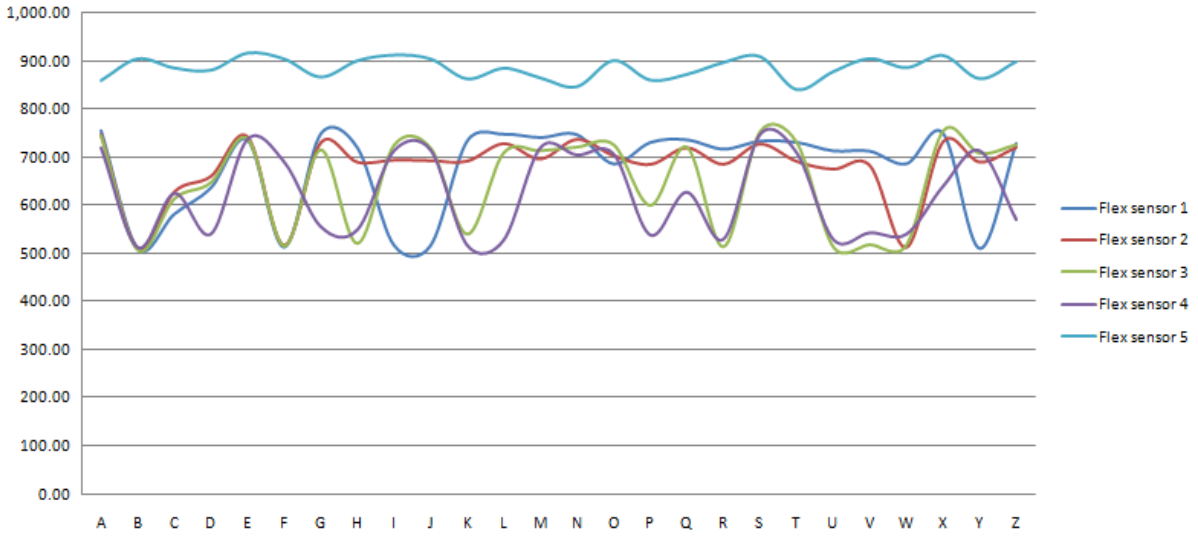

Figure 5. Flex sensors response for alphabet.

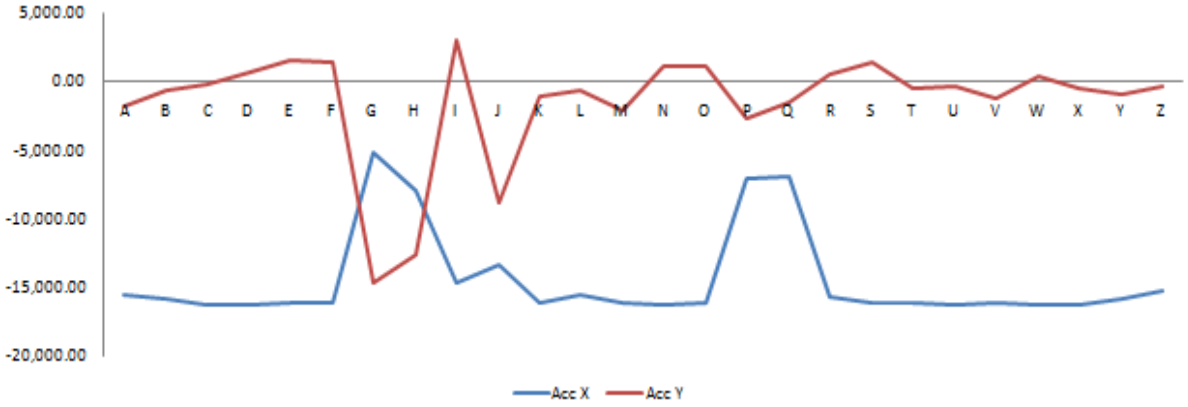

Figure 6. Accelerometer response for alphabet.

4. Conclusion

This paper has presented data flex and accelerometer sensor in forming gesture sign language. Flex sensor placed on each finger and MPU6050 placed on the hand. Then the sensor is read using the Arduino Nano controller, and is displayed on the PC using the serial path. Hand finger forms a certain curve and angle according to the gesture of sign language and the accelerometer's flex sensor reads each flex and slope and obtained data according to the paper presented.

Using additional accelerometer sensors can detect gestures that have a different slope than other gestures, such as the letters G, H, J, P and Q. The gesture accelerometer value has a significant difference value than the other letters

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