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ANALYSIS OF FLEX SENSOR OPERATION USING PROTEUS IN THE ARTHRITIS KNEE JOINT APPLICATION

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ABSTRACT

Arthritis is a condition in which inflammation occurs in joints, but it is frequently happened in the knee. Knee arthritis will make it difficult to perform simple tasks like walking or ascending stairs. This study aims to detect the bending of the leg and provide movement for patients in need by creating a sensing machine such as a flex sensor. A flex sensor is a device that detects when something bends. Plastic and carbon are two components that can be used to create this sensor. The carbon surface is arranged on a plastic strip which when the strip is turned aside then the sensor's resistance is adjusted. To test the hypothesis that a flex sensor could detect the bending of the leg and provide movement for patients, the simulation of the flex sensor is created by Proteus. The theory from the simulation circuit is based on the resistance on the flex sensor and the recorded output voltage. The results showed higher the resistance recorded, the lower for output voltage. These results suggest that using the correct Arduino board types to solve the practical problem in doing simulation. Due to the LCD could not give the demand of output voltage.

1.0 INTRODUCTION

Biomedical engineering is an application that applies the concept and knowledge of engineering that involves a health care system based on aspects of device which can help in design the solutions therefore, analyse the problems in biology and science. It also can lead to the improvement on the quality of human life and prevent from any diseases (J. Enderle 2012). Medical instrumentation can be defined as the application of biomedical engineering that is related with medical devices and instrument technologies that will be used in a hospital for health care purpose. Hence, doctors can diagnose the disease by measure, evaluate and analyse the biological systems of patients (Saltzman, W. M 2009). This engineering principles is important in medical instrumentation as it could a perform a testing using the measurement of biological signals such as ECG and EMG, and any other electrical signals generated in the human body so that it can read and do analysis for the body condition (Puente et al 2017). Doctors can give a better treatment as a preventive actions and at the same time combating the disease. Furthermore, it also important for engineers to ensure the devices has an optimal utilization by making sure the safety and health is protected and eliminate from any hazards happens (Miller, C. G 1998). In this research paper, it takes flex sensor as the one of application system to analyse the movement of knee bending. Arthritis knee joint has become a particularly common disease which gives difficulties in making everyday activities (Felson, D. T 2006). With the help of flex sensor, it can detect the bending of leg and provide movement for patients in need. Based on previous work, a system of multiple flex-sensors and microelectromechanical systems (MEMS) vibratory gyroscope been used as sensing mechanism in measuring knee joint angle. It is convenient system with the continuous monitoring in rehabilitation activities. A system of body joint angle measurement can provide the information about angle movement of body. Hence, the therapists and physicians will be able to monitor their effectiveness and improvement in leg movement . Therefore, this research article provides a details explanation with the system of flex sensors to detect the bending of leg.

2.0 METHODOLOGY

Based on Figure 1, shows that a block diagram of flex sensor system to detect the bend of knee. The simulation circuit is created using Proteus software and connect with Arduino Uno so that functions will be formed by giving an output voltage and variable resistor. This will help in creating a programme that the flex sensor can detect the bending of knee and the bending degree can be analyse with the reading voltage shows in LCD (Masdar et al 2013). There are two

conditions which are no bending occurred and bending occurred on flex sensor. Both data obtained will be record to see the effectiveness and conditions of knee in real time with the amount of bending occurred in flex sensor.

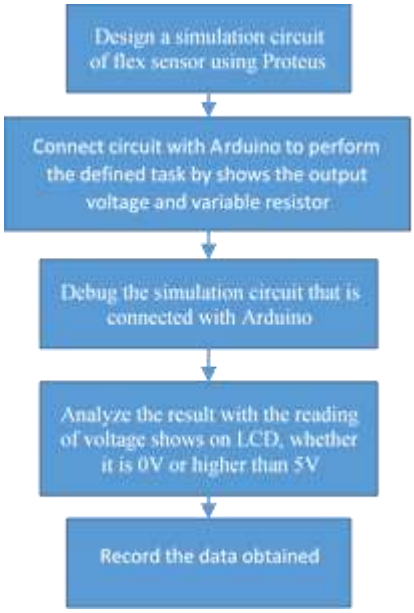

Figure 1. A block diagram of flex sensor system in detecting the bend of knee

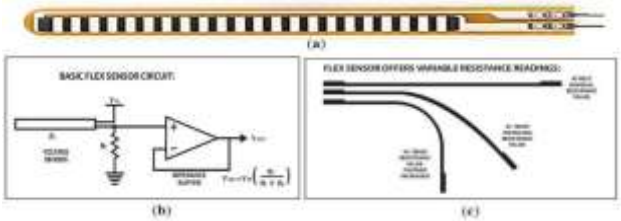

Figure 2. (a) Flex sensor component, (b) Basic flex sensor circuit, (c) Flex sensor variable resistance

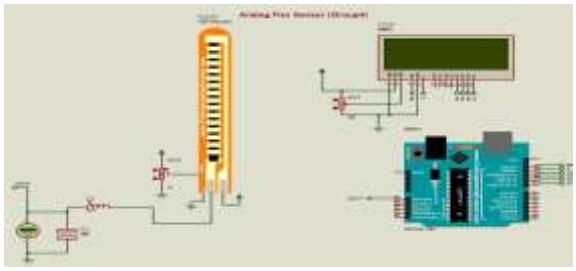

Figure 3. Simulation circuit diagram of Flex sensor in Proteus

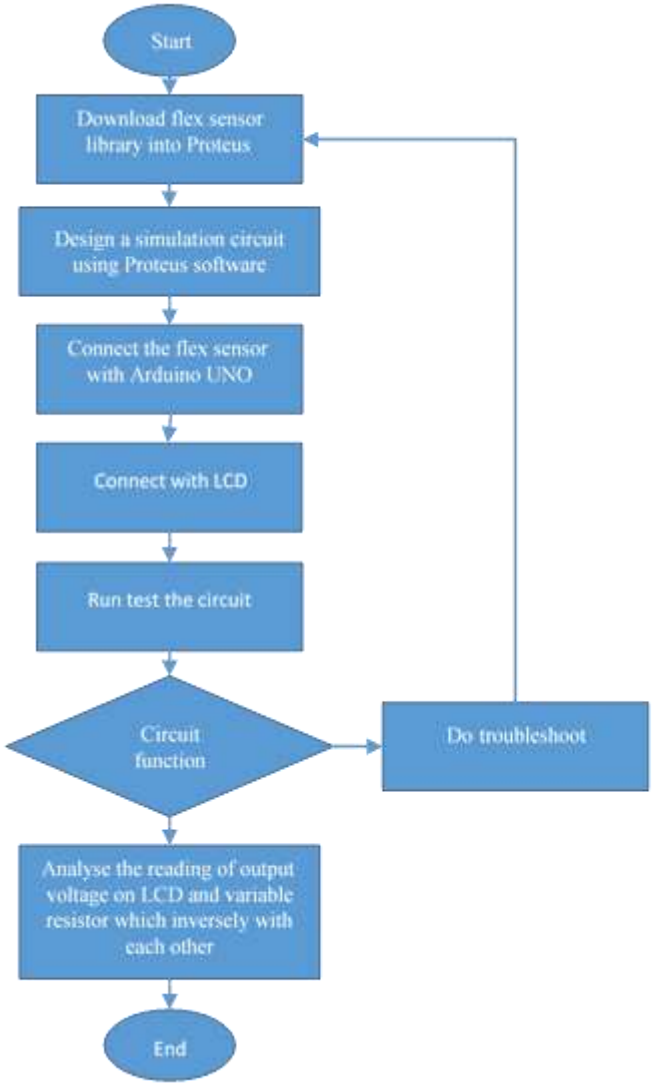

Figure 4. Flow chart for simulation circuit process of flex sensor using Proteus software

Based on Figure 4, it shows the flow chart for simulation circuit process of flex sensor using Proteus software. By designing the circuit of flex sensor that is connected with Arduino Uno it able to results to the output voltage and variable resistor which inversely with each other. However, if the circuit does not run well and the results are not accepted, troubleshoot must be taken to ensure the circuit can run smoothly (Davis, A. M. 2000).

This simulation circuit gives purpose in real time of rehabilitation activities that can monitor the patient's knee bending and condition that mostly suffers a disease such as arthritis knee joint. It is important to ensure all the data output is correct so that physicians and clinicians can help in improves the knee health and then patients will be able to do their daily activities easily.

In knee bending detection using flex sensor, it amplifies the movement of leg signals by senses and detects the input parameter under observation using flex sensor and convert it into a suitable electrical form. Then, it will give a form and display an output voltage on LCD and variable resistor to be analyze the conditions in bending knee. It has two conditions which are bending occurred and no bending occurred. When there is no knee bend the resistor is at 0% and voltage output will be 4.98V while when there is knee bend the resistance is 100% and the voltage output is 0.13V.

Table 1. Performance table in knee bending detection using flex sensor

The condition of flex sensor	The percentage variable resistor (%)	The output voltage (V)
Without any bending	0	4.98
With slightly bending	50	2.50
With the maximum bending	100	0.13

3.0 RESULTS AND DISCUSSION

3.1 Simulation of Circuit Design

Based on Figure 5, it shows that the whole circuit design of flex sensor with Arduino Uno by using Proteus 8 Professional software. The circuit design requires to connect the flex sensor with LC circuit due to the specification of flex sensor. Flex sensor comprises of four pins which are ground pin, output pin, voltage pin and test pin. Therefore, ground pin will be connected to the LC circuit through output voltage pin with variable resistor in order to obtain the conversion of peak value into the root mean square voltage (Vrms) value.

Next, the flex sensor is embedded with the Arduino Uno and display the voltage reading on LCD display 20x4 based on two conditions, 1) When there is no amount of bending on flex sensor, and 2) When there is bending on flex sensor. By referring to Figure 6, it shows the reading voltage when there is no amount of bending. The resistance is maximum, and the output voltage indicates as 4.98 V. From that, it can be noticed that the output voltage and variable resistor are inversely proportional from each other. Based on Figure 7, it shows the output voltage as 0.13 V when there is bending by means the resistance is reached to the maximum. It can be confirmed that the output voltage and variable resistor are inversely proportional from the voltmeter reading similar into output voltage on LCD display.

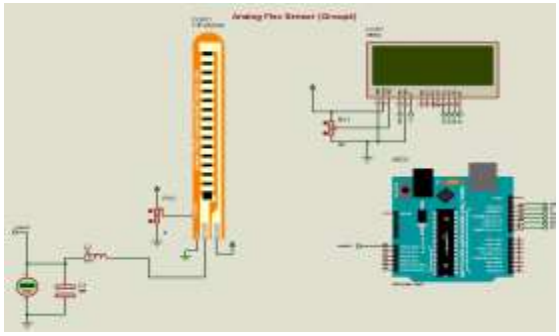

Figure 5. Circuit design of Flex sensor with Arduino Uno.

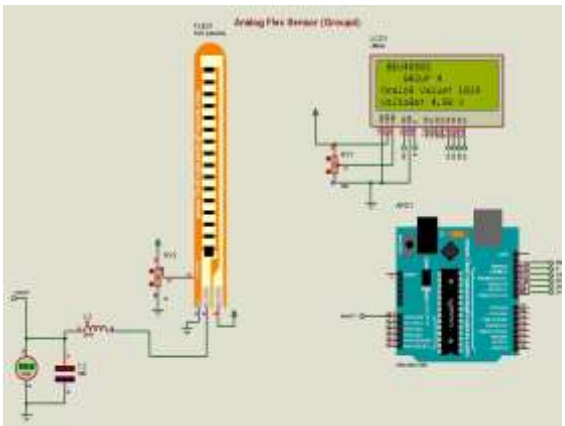

Figure 6. Simulation result with no resistance

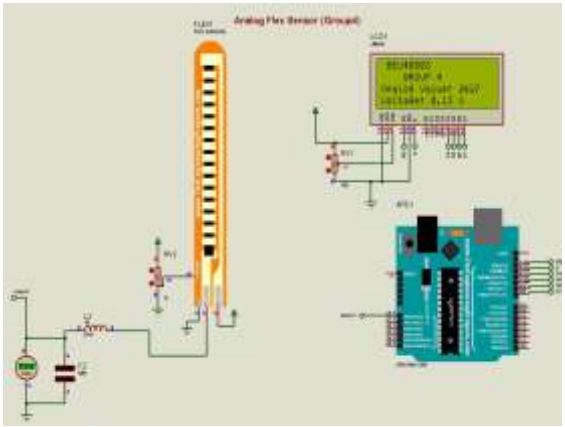

Figure 7. Simulation result with an existing resistance

3.2 Parameters of Result for Condition of Flex Sensor

From Table 2, it represents the result of input and output for flex sensor condition. The input parameter indicates the resistance on the flex sensor meanwhile the output voltage acts as an output parameter to prove whether the flex sensor is bending or instead.

Table 2. Result for Condition of Flex Sensor

Condition of flex sensor	Resistance(%)	Output voltage(V)
Without bending	No resistance (0%)	4.98V
With bending	Maximum(100%)	0.13V

3.3 Theory of Simulated Circuit

The theory from simulation circuit is based on the resistance on flex sensor and the recorded for output voltage. As the higher resistance recorded, the lower for output voltage. There is relation between the Ohm's law based on three physicals parameters which are current (I), voltage (V), and resistance (R). Ohm's law can be defined as the current flow through the resistance divided by voltage drop across R [7]. The Ohm's law equation as following:

$$V = IR \qquad (1)$$

where;
V is the voltage across
I is the current flow
R is the total resitance

Apart from that, Arduino Uno acts as a microcontroller to send the data from flex sensor and display the output voltage through LCD display 20x4. Arduino Uno has 14 digital input and output pins and contains 6 analog input that includes USB port, power jack, an ICSP header and also a button reset. The operating voltage for Arduino Uno board is 5V. Meanwhile, 20x4 LCD display can display 20 characters per line and consist of 4 lines.

3.4 Responded Parameters of Condition of Flex Sensor

Based on Table 3, it shows the 10 readings taken for every percentage in 10% from the given resistance value in order to obtain the output voltage. From the table 2, it can be seen that the higher of resistance on flex sensor leads the lower reading for output voltage.

Table 3. The 10 readings taken for Resistance Value associated with Output Parameters of Condition of Flex Sensor.

Resistance Value (%)	Output Voltage (V)
0	4.98
10	4.46
20	4.00
30	3.50
40	3.00
50	2.50
60	1.99
70	1.50
80	1.03
90	0.51
100	0.13

3.5 Graph of Resistance Value (%) Vs Output Voltage (V)

For Figure 8, the graph represents the resistance value along with the output voltage. From the graph, it can be observed that the resistance value is inversely proportional to the output voltage. As the maximum resistance reached, the output voltage will approach to 0V.

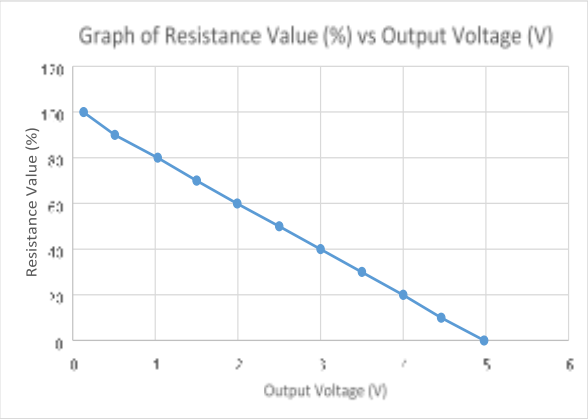

Figure 8. Graph of Resistance Value (%) vs Output Voltage (V)

4.0 CONCLUSION

As a conclusion, the practical problem in doing simulation is the LCD display could not give the demand of output voltage. However, the problem has been overcome by using the correct of Arduino board types.

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