Improvement of Automatic Signal Identification Device for Silat Body Protector

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Abstract—**This project is aim to improve the automatic signal identification device that used for Silat body protector. The new version of the device is developed using FlexiForce force sensor and Radio Frequency module as an interfacing device system. The results had shown that the developed device is successfully created and tested in which the detected voltage signal is able to transmit in a frequency of 433MHz.**

Keywords-flexiforce sensor; RF modules; interfacing circuit.

I. INTRODUCTION

Wireless remote controlled through Radio Frequency (RF) communication is widely used in robotics [1], electronics toys and automation systems [2]. Wireless network has become one of the hot topics nowadays [3] because the wireless so facilitate to human and it is so convenient to the human life. For example TV remote control. User just sit at the where he/she is and push the button to turning the channel.

In this development of identification of the device, wireless becomes preferable than interconnection of wires [4]. The RF modules are used for the wireless transmission. RF modules are the device that used the electromagnetic signal by encoding the information from the input device [1]. This device has two main components namely Transmitter Module and Receiver Module [1].

The data transfer between RF modules uses UART protocol. UART is a communication device that can interface a parallel-word system to serial communication network [5]. Just like other types of devices that use radio waves to communicate, wireless signal can passes through barriers such as a desk or thin wall. RF technology provides several advantages include; RF module requires low power and can run on batteries, RF module is inexpensive, and RF modules are light weight [1].

Also, the development of the identification device for silat body protector used the sensor as the medium between the forces that were applied during the match to the system device. The sensor that is used is the force sensor that senses the force or detailed is the force-to-resistance. Different types of force sensors have been used up to now in such contexts, differing by their technology:

1. Strain gauge sensors consist of a pattern of strain gauges mounted on a deformable structure. The force applied on the sensor induces strains in the structure which are evaluated by strain gauges.
2. Piezoelectric force sensors, such as the LIVM force sensor (Dytran Instruments Inc. CA, US), contain thin piezoelectric crystals generating analog voltage signals in response to applied dynamic forces.
3. Thin film piezoresistive force sensors such as the FSR (Interlink Electronics, Camarillo, CA, US) and the Flexi-force (Tekscan Inc., Boston, MA, US) sensors have their resistance varying with the applied force. They exhibit a lower accuracy than the other types, but their very small thickness allows a placement directly in contact with a human, for example for tactile sensing [7], [4].

Thin film piezoresistive sensors Flexi-force (Tekscan Inc., Boston, MA, US) have interesting properties, and their low cost enables to consider the integration of a large number of sensors for instance in a collision detection task. Furthermore, the Flexiforce sensors have been demonstrated to be insensitive to magnetic fields [8]

In this paper, it is aim to develop an interfacing system for silat scoring measurement. This involves the implementation of the RF modules and flexiforce as a sensor to the system. The rest of this paper is organizes as follows. Section II presents the propose method. Sections III shows experimental work. Result and discussion in section IV and finally, conclusion is in section V.

II. METHODOLOGY

A. Hardware Development

The block diagram of the automatic identification device system is shown in Figure 1. As shown, the system consists of FlexiForce sensor circuit and RF modules.

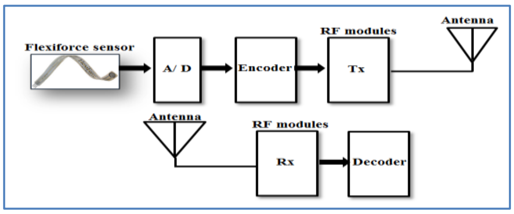

Figure 1. System block diagram

The hardware development for this project involves the development of FlexiForce sensor circuit as shown in Figure 2.

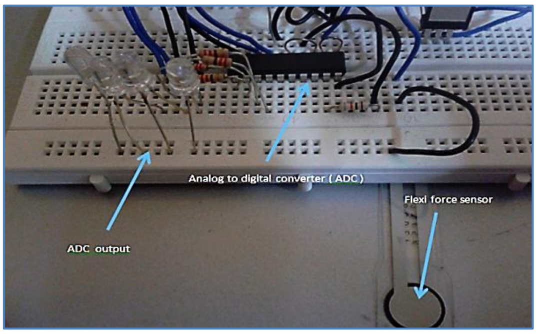

Figure 2. Flexiforce sensor circuit development

The FlexiForce sensor is an ultra-thin, flexible printed circuit. The FlexiForce single element force sensor acts as a force sensing resistor in an electrical circuit. When the force sensor is unloaded, its resistance is very high. When a force is applied to the sensor, this resistance decreases. To integrate this flexiforce sensor into application, the force to voltage circuit is the way that should be done for the interfacing with the ADC [11]. Analog to digital converters, ADC is the device to convert the signals from analog to digital form [12]. Various sensors like temperature, pressure, force etc. convert the physical characteristics into electrical signals that are analog in nature and the ADC will convert to digital form [9]. Also, the hardware development includes the implementation of RF modules to the system as shown in Figure 3 and Figure 4.

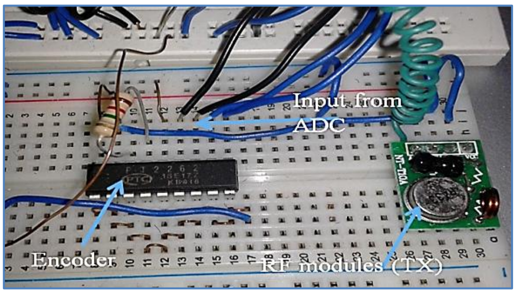

Figure 3. RF module Transmitter circuit

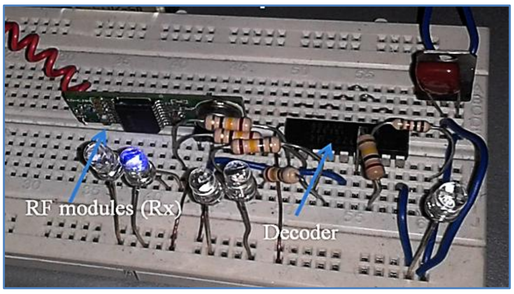

Figure 4. RF module Receiver circuit

The RF modules operate at Radio Frequency. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).The RF Modules are very small in dimension and have a wide operating voltage range (3V-12V). The low cost RF Transmitter can be used to transmit signal up to 100 meters.

This RF module comprises of an RF Transmitter and RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434MHz also available in 315MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

The RF module is used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder and the serial output that are encode by the decoder then back to the parallel data.

B. *Voltage Divider Concept*

Voltage divider is the rule that used to simplify the solution in the electronic circuit. A voltage divider produces an output voltage that is a fraction of its input voltage [10]. The voltage divider concept consists of two resistors R1 and R2 or two impendences connected in series. The output voltage used as a reference voltage for calibration or others purpose that suitable for the application that being made.

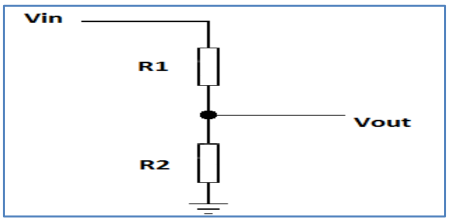

Figure 5. Voltage divider circuit

As shown in Figure 5 the voltage divider circuit can be equated by this formulas;

$$Vout = \frac{\mathrm{R2}}{R2 + R1} * Vin$$

Lets have the resistor value for R1 is 100ohm and R2 is fixed at 100ohm. As the resistance of R1 change to increase, the output voltage became to decrease. But if the value R2 is changing and R1 is fixed, the opposite value of voltage was determined. For the application purpose, the choosen of this value are important as the output voltage being be used as an input to the analog digital converter, ADC

III. Experimental Work

A. Circuit schematics diagram

The circuit connection of the identification device system follows the schematic diagram as shown in Figure 6 and Figure 7.

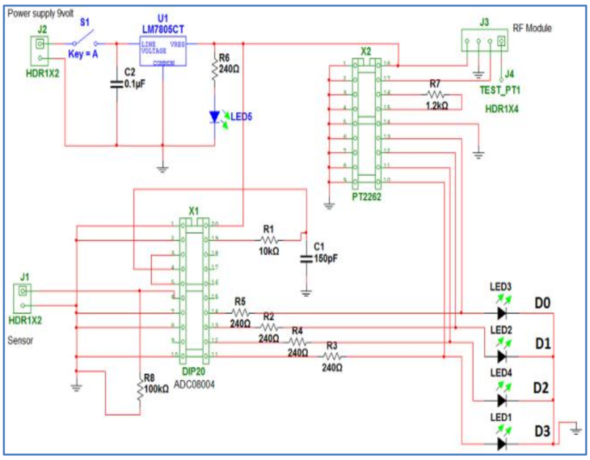

Figure 6. Transmitter circuit include with sensor interfacing circuit

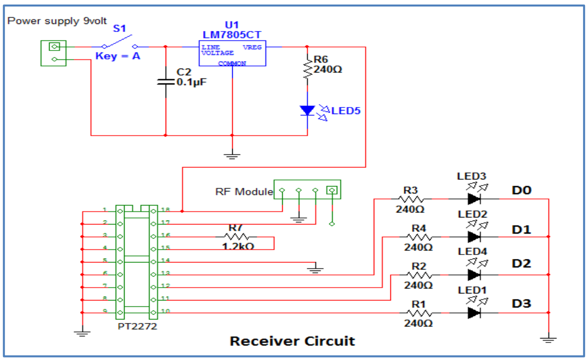

Figure 7. Receiver circuit

B. Circuit operation

Flexiforce sensor is the input that will be fed to the analog to digital converter or ADC. An ADC takes the analog input and converts it to the digital value. This digital information is in binary format consisting of 0s and 1s only. The ADC finds a fractional binary number that gives the closest approximation to the fraction formed by the input voltage and reference [9].

The digital output values of the ADC then fed to the encoder that will encode the data in serial to send wirelessly through RF modules (Transmitter, Tx). At the receiver section, the signal that trough the RF transmission then be decode back by the decoder to form the original data that is in parallel form. The signal from the decoder is then fed into the computer.

IV. Result and Discussion

A. System performance by using potentiometer

In this experiment, the 10kΩ potentiometer was used to test the whole circuit. The result of the potentiometer response shows in Figure 8.

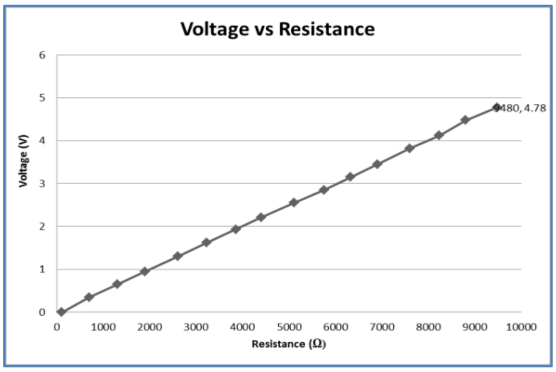

Figure 8. Potentiometer response

As the resistance change, the output voltage also change. The output voltage is proportional to the resistance change. The output voltage in analog value then fed into the ADC to convert it into digital value for encoder to take part and encode the signal for RF transmission.

B. Flexiforce sensor response

The voltage divider is used to interface the sensor input into the ADC. Figure 9 show the sensor response with the change in resistance.

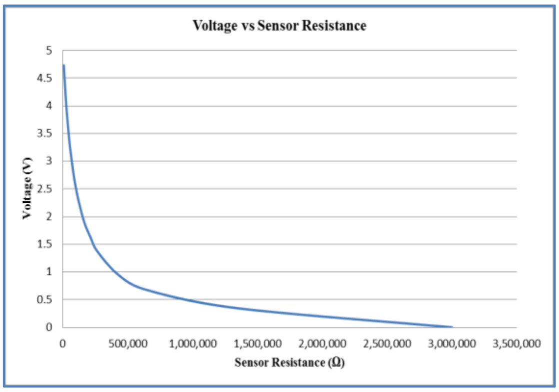

Figure 9. Sensor response graph

The result of the flexiforce sensor was different compared to the potentiometer result. The voltage increase when the resistance decrease. However, the device that can indictes force value are not avaiable to make the measurement. By referring [13], as the force applied to the sensor, the voltage vary linearly. This shows on the figure 10.

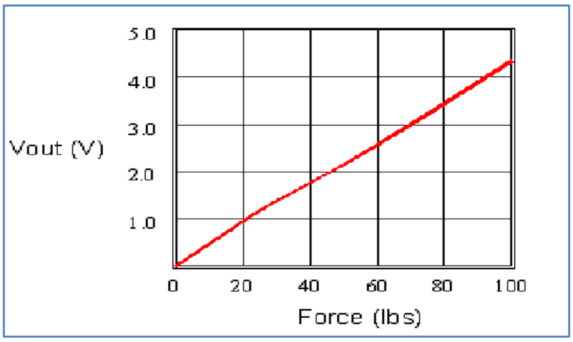

Figure 10. Flexiforce sensor force response against voltage

To interface the sensor to ADC, the divider circuit used to change the characteristic of the sensor because the voltage output must be vary from lower to upper or 0's to 5's volt. Let's look to the voltage divider as shown in figure 11 with 100kΩ resistor as the reference.

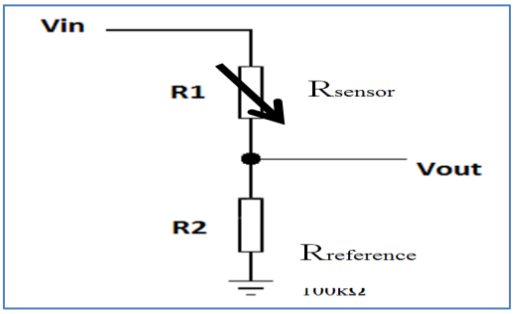

Figure 11. Voltage divider circuit with denominator 100kΩ

$$Vout = \frac{\mathrm{R2}}{R2 + R1} * Vin$$

Rsensor = 5.7k, Rref = 100k, Vin = 5v

$$Vout = \frac{100\mathrm{k}}{100k + 5.7k} * 5$$

$$Vout = 4.73\mathrm{v}$$

Although the resitance change from large to small value, the voltage output vary from 0's to 5's volt. But it is different if the choosen of R1 in the positon R2.

$$Vout = \frac{\mathrm{R1}}{R1 + R2} * Vin$$

$$Vout = \frac{5.7\mathrm{k}}{5.7k + 100k} * 5$$

$$Vout = 0.27\mathrm{v}$$

It's means that the voltage inversely to the change in resistance. That's why the choosen and placement of the references resistor is important. The rest of the result shows in the TABLE 1.

TABLE 1

OUTPUT VOLTAGE OF THE SENSOR AND THE TRANSFER DATA.

Sensor Resistance	Voltage output (Volt)	Tranfered data (Hexadecimal)
3000000	0	0
1330000	0.35	1
625000	0.69	2
420800	0.96	3
265000	1.37	4
212500	1.62	5
163200	1.9	6
120000	2.28	7
96070	2.55	8
80500	2.77	9
57230	3.18	A
44930	3.45	B
30210	3.84	C
21950	4.1	D
12610	4.46	E
5700	4.73	F

C. Data transmission between Transmitter and receiver

Figure 11 shows the result of encoding information by encoder circuit.

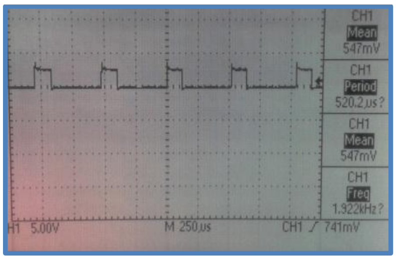

Figure 12. Square wave signal encoder encode the parellel data into serial data

From the Figure 12, the signal alternates between '1' and '0' similar as the output from the decoder that can be seen in the valid transmission or VT pin [14].

Continuous data transmission using 415 MHz RF modules has been successfully done between the sensor interfacing circuit and receiver through the RF modules. As shown in Figure 12, the encoder encode the D2 value and the receiver decode back the data D2.

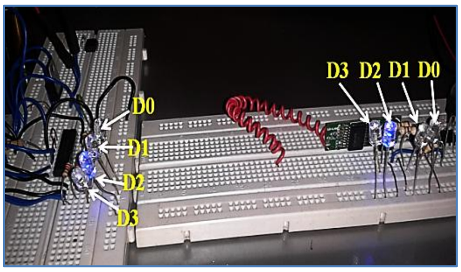

Figure 13. Wireless transmission between pair of Transmitter and Receiver

V. CONCLUSION

In this paper, the improvement of the automatic identification device for silat body protector successfully done by implemented the wireless transmission using the RF modules. The low cost of the RF modules more preferable in this improvement even though it is cheap.

For further recommendation the uses of the microcontroller unit (MCU) can be more interesting for the interfacing circuit between the sensor in this development. Also the uses of more sophisticated wireless communication such as Bluetooth could be considered as the way to send the data or signal information wirelessly.

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VI. REFERENCES

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