International Journal of Mechanical And Production Engineering, ISSN: 2320-2092, Volume- 5, Issue-2, Feb.-2017
http://iraj.in

MONITORING SYSTEM USING HANDWRITTEN SAMPLE PRESSURE POINT

[1]SYAMSUL BAHRIN ABDUL HAMID, [2]RABIATUL ADAWIYAH BINTI SHAHAROM

[1,2]Department of Mechatronics, Kulliyyah of Engineering, International Islamic University Malaysia
Email: [1]syamsul_bahrin@iium.edu.my, [2]adawiyah_910@yahoo.com

Abstract: This paper explores the possibility of using handwritten sample pressure points for robust attendance monitoring. Utilizing robust FSR as the sensing mechanism, this paper investigates the calibration process that has been conducted for using the FSR as an attendance monitoring system. From the investigation, it could be concluded that there is a possibility of using FSR as a sensing mechanism for simple geometric and block alphabet, but further research is still needed for the system cater for cursive handwritten signature.

Index terms: Biometrics; Handwriting; Pressure, Robust

I. INTRODUCTION

Attendance is one of the ethics that is most valued either in working or academic institution as it reflects the attitude of a particular person or group. However, traditional attendance system could be easily falsified or cheated. To overcome problems this problem, a new technological field known as biometrics recognition or simply refers as biometrics has been established [1]. This field can be divided into two categories - Physiological biometrics that involves comparing physical characteristics of a person such as fingerprint, retina, facial features, and etc and;Behavioral biometrics that involves analyzing data derived from an action taken by a person like keystroke dynamics, handwriting, and etc. [2].

In this project, behavioral biometrics is analyzed using handwritten signature. Signature is chosen as the comparison attributes due to few key features - it is the most socially accepted and widespread method of personal identity; and it has also been a primary form of legal verification technique, hence user acceptance is no longer an issue.

Depending on the data acquisition technique, signature verification can be categorized into two main areas, offline method or online method [3]. In offline method, a signature is obtained from a document, which will then be scan for the digital image representation. Whereas in online method, the dynamic feature including the force, pressure, and acceleration of the pen movements in addition to the shape of the signature is recorded [4].

In this research, the focus will be in developing a portable attendance monitoring system using online method to verify the identity of the claimed person, through his or her handwriting signature pressure point. By developing this system, it will become easier for the employer or lecturers to record the attendance of their subordinate or students respectively.

II. SIGNATURE VERIFICATION SYSTEM

In the design process of a signature verification system, five main issues must be considered which are: data acquisition process, pre-processing of the data, feature extraction from the data, comparison between template data and testing data, and performance evaluation of the system. **Figure 1** shows the typical signature verification system.

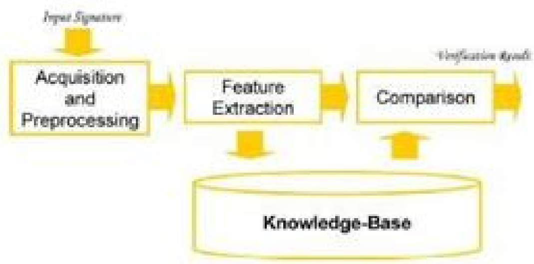

Figure 1: Typical Signature Verification System

During data acquisition process, a number of signatures are acquired from a user as training data. These data is pre-processed and will go through feature extraction process. It is then saved in the database together with user ID for comparison process. The same process happened for verification of the signature. The user will provide a signature as testing data. The data then will go through pre-processing and feature extraction process. Once the processes have been completed, a comparison process will commence. The testing data will be compared for similarity with the training data stored in the database. Based on resulting differences values, the signature is then classified as genuine or forgery and the identity of the claimed person are verified.

III. SYSTEM DESIGN

One of the key design requirements is the ability of the system to be robust and stand alone (portable, ease of use and non-network dependent). A complete self-enclosed design which includes a writing padand pen that will generate analog signal (resistance) when force is appliedhas been developed. The use of pen imitates the natural way of writing making the system morenatural and intuitive.

Figure 2 shows flowchart on how the portable attendance monitoring system will work. The system will first request a handwritten sample along with a specific ID for each user. When the user write at the specified area on the tablet, the resistance produced from the handwriting pressure will be captured by the system. If the user provides the handwritten sample for enrolment process, the data will be stored in the database. Whereas if the user provides the handwritten for verification process, the system will compare the new acquired data with the data stored inside the database for the user ID. The system will then display user acceptance or rejection based on similarity of the two data.

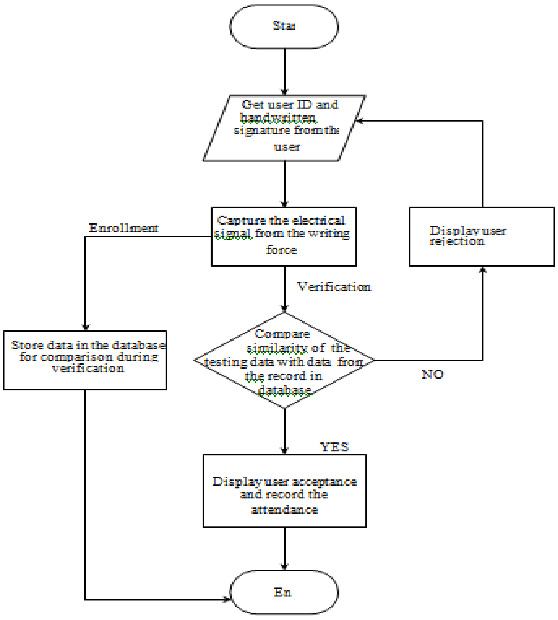

Figure 2: Flowchart of the portable attendance monitoring system

The system consists of seven force sensitive resistor (FSR) to make up the signature designated area, a LCD display to give instructions to user, and a keypad for user to input their ID. The mechanical design of the system is shown in Figure 3 and the connection between FSR and Arduino board is shown in Figure 4. The arrangement of FSR to make up the signature designated area is shown in Figure 5.

Figure 3: Mechanical design of portable attendance monitoring system

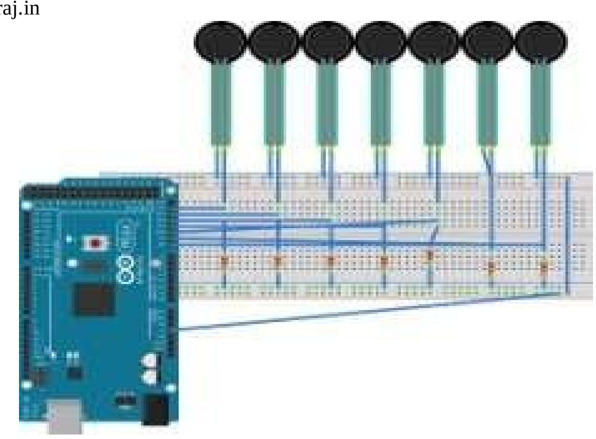

Figure 4: Connection between FSR and Arduino board

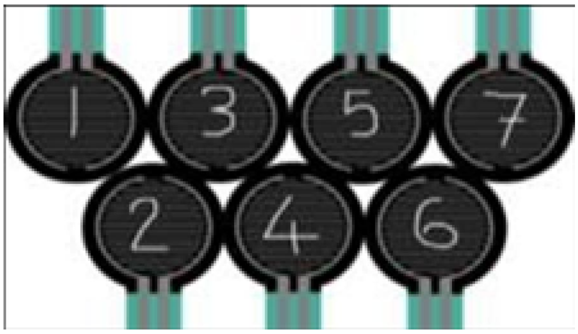

Figure 5: The arrangement of the FSR at signature designated area

IV. FORSE SENSITIVE RESISTOR

Force sensitive resistor or known as FSR is one of the different types of pressure sensors available in the market. The sensor consists of a conductive polymer, of which the resistance could be changed predictably when a force is applied to the surface. The resistance and pressure is inversely proportional. As the pressure applied to the FSR increase, the resistance will be decrease. Figure 6 shows graph displaying the relationship.

FSR is made of two layers that are separated by a spacer. When the FSR experienced force, the active elements particle will touch the semiconductor and reduce the resistance. The more of those particles touches the semiconductor, the smaller the resistance. Figure 7 shows the two layers of FSR separated by spacer opening.

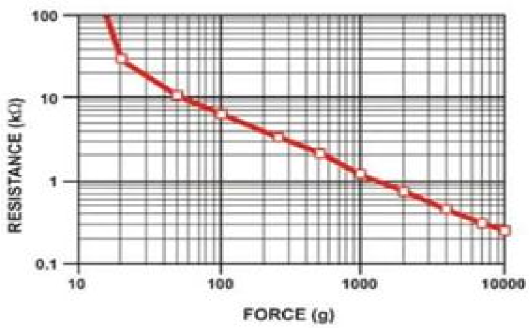

Figure 5: Graph of Resistance vs. Force for FSR

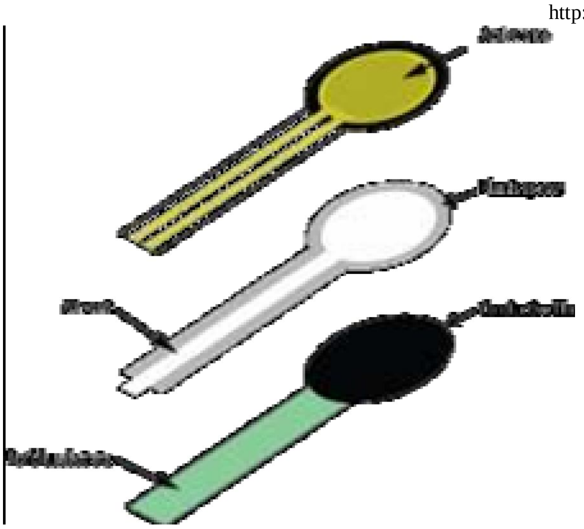

Figure 5: Spacer opening of the FSR

In this design, the FSR is connected to Arduino analog input pin A8 to A15. Arduino will read the analog value varied from 0 to 1023. This value is converted to FSR output voltage, V_o using the function maps inside Arduino. To get the Force Sensitive Resistance, FSR the following formula is utilised:

$$FSR = R\left(\frac{V_{cc}}{V_0} - 1\right) \quad (1)$$

where, Power Supply, V_{cc} = 5V, FSR output voltage, V_o from arduino, Resistance, R=10kΩ,

V. CALIBRATING FORCE SENSITIVE RESISTOR

Although thesame typeand batch of FSR is being used, the measured value tends todiffer typically in the range of 10%. Theoretically, with thesame type of FSR, the output voltage should be the same when the same amount of force is exerted. But in practice, even with the same amount of force, two FSR will not have the same output voltage. Thus, a calibration is needed for each FSR.

The measurement process is repeated 10 times for each FSR, to enable statistical analysis to be conducted. Standard deviation (SD), the mean, andthe coefficient of variation (CV) is calculated from the 10 sample measured. Small standard deviation indicates that the data are clustered closely around the mean and coefficient of variation less than one means low variance, thus signifies that the system is reliable.

The FSR is calibrated by applying same force on each FSR. The value obtained from the FSR is then recorded. The actual output of the FSR is measured using a digital multimeter (DMM). The process is then repeated to get value measured by Arduino.

Table 1: Force equals to 0.5 Newton being applied measured using DMM (a) Resistance of the FSR; (b)Output voltage of FSR

(a)

	Resistance (M ohms)		
	SD	**Mean**	**CV**
FSR1	5.56	20.97	0.27
FSR2	0.07	2.09	0.03
FSR3	1.71	15.03	0.11
FSR4	0.03	2.62	0.01
FSR5	1.77	13.05	0.14
FSR6	0.03	2.61	0.01
FSR7	0.95	14.56	0.07

(b)

	Voltage (V)		
	SD	**Mean**	**CV**
FSR1	0.06	3.68	0.02
FSR2	0.33	2.64	0.13
FSR3	0.35	3.19	0.11
FSR4	0.07	3.66	0.02
FSR5	0.17	2.73	0.06
FSR6	0.39	3.63	0.11
FSR7	0.13	2.66	0.05

Table 2:Force equals to 0.5 Newton being applied measured using Arduino (a) Analog reading of the FSR (b)Resistance of the FSR; (c) Output voltage of FSR

(a)

	Analog value		
	SD	**Mean**	**CV**
FSR1	20.02	152.9	0.13
FSR2	21.95	440.8	0.05
FSR3	19.35	297.3	0.07
FSR4	29.38	153.6	0.19
FSR5	26.13	359.1	0.07
FSR6	29.69	147.8	0.2
FSR7	28.06	392	0.07

(b)

	Resistance (M ohms)		
	SD	**Mean**	**CV**
FSR1	0.01	0.05	0.19
FSR2	0	0.01	0.1
FSR3	0	0.02	0.1
FSR4	0.01	0.05	0.24
FSR5	0	0.02	0.12
FSR6	0.01	0.06	0.23
FSR7	0	0.01	0.12

(c)

	Voltage (V)		
	SD	**Mean**	**CV**
FSR1	0.1	0.75	0.13
FSR2	0.11	2.15	0.05
FSR3	0.09	1.45	0.07
FSR4	0.14	0.75	0.19
FSR5	0.13	1.75	0.07
FSR6	0.15	0.72	0.2
FSR7	0.14	1.92	0.07

Note that the reading between one FSR to another FSR is different. Some FSR has higher value while some FSR has smaller value. But based on the standard deviation value and coefficient of variance, the FSR has repeatability attributes and can be reliable to use in our system.

VI. TESTING ON SIMPLE HAND WRITING MOVEMENT

In order determine the FSR accuracy and stability, different testing have been conducted which are: drawing a straight line across the pad, drawing a simple geometry (square) and writing in-between FSR and writing a block alphabet. These different testing methods will act as a base for adjustment of the actual system verification of signature.

1) Drawing straight line

Table 3:FSR reading when drawing straight line (a) Analog reading of the FSR (b) Resistance of the FSR; (c) Output voltage of FSR

(a)

	Analog value		
	SD	**Mean**	**CV**
FSR1	66.49	344.4	0.19
FSR2	72.14	468.2	0.15
FSR3	121.05	407.18	0.3
FSR4	60.85	236.4	0.26
FSR5	71.18	446	0.16
FSR6	23.86	185.2	0.13
FSR7	127.12	428.2	0.3

(b)

	Resistance (K ohms)		
	SD	**Mean**	**CV**
FSR1	6.78	25.06	0.27
FSR2	3.46	12.28	0.28
FSR3	0	4295 M	0
FSR4	11.25	35.59	0.32
FSR5	4.21	12.96	0.33
FSR6	7.53	46.04	0.16
FSR7	2.76	11.93	0.23

(c)

	Voltage (V)		
	SD	**Mean**	**CV**
FSR1	0.27	1.47	0.18
FSR2	0.35	2.29	0.15
FSR3	0.57	2.21	0.26
FSR4	0.3	1.15	0.26
FSR5	0.39	2.23	0.17
FSR6	0.12	0.9	0.13
FSR7	0.29	2.31	0.12

2) Simple geometry

Table 4: FSR reading when drawing simple geometry (a) Analog reading of the FSR (b) Resistance of the FSR; (c) Output voltage of FSR

(a)

	Analog value		
	SD	**Mean**	**CV**
FSR1	0	0	0
FSR2	0	0	0
FSR3	51.58	384.17	0.13
FSR4	58.97	171.33	0.34
FSR5	45.71	475.5	0.1
FSR6	24.99	230.17	0.11
FSR7	4.37	4.67	0.94

(b)

	Resistance (K ohms)		
	SD	**Mean**	**CV**
FSR1	0	44295 M	0
FSR2	0	44295 M	0
FSR3	0	44295 M	0
FSR4	10.48	57.54	0.18
FSR5	2.33	11.7	0.2
FSR6	4.81	34.9	0.14
FSR7	22873 M	14766 M	1.55

(c)

	Voltage (V)		
	SD	**Mean**	**CV**
FSR1	0	0	0
FSR2	0	0	0
FSR3	0.25	0.25	0.25
FSR4	0.12	0.12	0.12
FSR5	0.22	0.22	0.22
FSR6	16.34	16.34	16.34
FSR7	0.02	0.02	0.02

As could be observed there is a general consistency across the FSR, except few occurrences, thus the requirement for this baseline determination process.

3) Writing in between FSR

As could be seen in Figure 5, the border between each FSR also is considered as inactive area for input handwriting due to the circular FSR utilized. To validate this assumption, a handwritten sample at the periphery of the FSR is measured. Table 5 shows the FSR measurement for the handwriting pressure at the periphery. As observed, all FSR analog reading except FSR 1 and FSR 5 is equal to zero which suggest that the FSR did not sense any pressure in this periphery area. Although FSR 1 and FSR 5 indicate very small analog reading, this might be because of the referred pressure from the periphery to the active area.

Table 5: FSR reading across the FSR periphery

	Measurement at Periphery		
	Analogue	**mV**	**FSR, MΩ**
FSR1	36	175	0.275
FSR2	0	0	4294
FSR3	0	0	4294
FSR4	0	0	4294
FSR5	34	166	0.291
FSR6	0	0	4294
FSR7	0	0	4294

4) Writing with alphabet

Table 6: FSR reading when writing an alphabet (a) Analog reading of the FSR (b) Resistance of the FSR; (c) Output voltage of FSR

(a)

	Analog value		
	SD	**SD**	**SD**
FSR1	59.91	59.91	59.91
FSR2	95.22	95.22	95.22
FSR3	155.35	155.35	155.35
FSR4	57.46	57.46	57.46
FSR5	84.21	84.21	84.21
FSR6	178.65	178.65	178.65
FSR7	35.61	35.61	35.61

(b)

	Resistance (K ohms)		
	SD	**SD**	**SD**
FSR1	22874 M	22874 M	22874 M
FSR2	12.63	12.63	12.63
FSR3	6.41	6.41	6.41
FSR4	27.62	27.62	27.62
FSR5	11.73	11.73	11.73
FSR6	18.99	18.99	18.99
FSR7	1.15	1.15	1.15

(c)

	Voltage (V)		
	SD	**Mean**	**CV**
FSR1	0.29	0.29	0.29
FSR2	0.47	0.47	0.47
FSR3	0.76	0.76	0.76
FSR4	0.28	0.28	0.28
FSR5	0.41	0.41	0.41
FSR6	0.19	0.19	0.19
FSR7	0.17	0.17	0.17

From all the testing on the simple handwriting movement as shown in Table 6, the standard deviation value is relatively small and the coefficient of variation is less than one. This signifies that the system can be used to measure handwriting pressure.

VII. TESTING ON SIGNATURE

Once the system has been calibrated, and the variation between the FSR have been confirmed to be at an acceptable limit. The system is then tested using a handwritten signature pressure. The results obtain is summarize in Table 7.

Table 7: FSR reading when writing signature (a) Analog reading of the FSR (b) Resistance of the FSR; (c) Output voltage of FSR

(a)

	Analog value		
	SD	**Mean**	**CV**
FSR1	86.46	86.46	86.46
FSR2	74.24	74.24	74.24
FSR3	236.3	236.3	236.3
FSR4	72.52	72.52	72.52
FSR5	56.25	56.25	56.25
FSR6	54.36	54.36	54.36
FSR7	0	0	0

(b)

	Resistance (K ohms)		
	SD	**Mean**	**CV**
FSR1	0.08	0.08	0.08
FSR2	1920.76	1920.76	1920.76
FSR3	1920.75	1920.75	1920.75
FSR4	1920.62	1920.62	1920.62
FSR5	0.01	0.01	0.01
FSR6	2352.39	2352.39	2352.39
FSR7	0	0	0

(c)

	Voltage (V)		
	SD	**SD**	**SD**
FSR1	0.42	0.42	0.42
FSR2	0.36	0.36	0.36
FSR3	1.15	1.15	1.15
FSR4	0.35	0.35	0.35
FSR5	0.27	0.27	0.27
FSR6	0.27	0.27	0.27
FSR7	0	0	0

During the final testing phase, it has been observed even if the same person has written their signature on the pad; it was observed that the measurement obtained by the system varied greatly. In some cases, the standard deviation is large, with some of the coefficient of variance value of above one or almost equal to one; making the system unreliable as a verification device.

While it is possible to measure simple handwriting pressure using this system as stated previously, it is unlikely in the case of signature. This might be due to the inconsistency of the signature. Despite the fact that the shape and pressure of the signature is not significantly different, the pressure points location is observed to be varied - probably due to variation in signature profile and speed of the hand movement during signature process.

VIII. LIMITATION

Using several number of small FSR to make up the signature area has limited the system performance. The system can only work efficiently with normal handwriting as the input pressure. This is due to the fast and varied hand movement during signature process that causes the signature area to differ every time the user uses this system. As the results, the pressure measurement will varied greatly and cause imprecision in the validation process.

CONCLUSION

In this research, the use of FSR as a sensing mechanism for signature verification has been highlighted. The process of designing, developing and calibrating portable system that are able to monitor attendance using handwritten pressure point have been demonstrated, along with the limitation. The ability of the system have been discussed, which shows that the overall system is able to detect the handwriting pressure point for simple geometric lines and block alphabet according to the measured FSR value with coefficient of variation less than 1 as the deterministic technique. Further investigation is still required for the FSR sensing mechanism system to be utilized as signature verification.

REFERENCES

[1] J. Galbally, R. P.-G. (2012). Synthetic On-line Signature Generation. Part I: Mothodology and Algorithms. *Pattern Recognition 45*, 2610- 2621.

[2] D. Impedevo, G. P. (2012). Handwritten Signature Verification: New Advancements and Open Issue. *International Conference on Frontiers in Handwriting Recognition*.

[3] S. Sayeed, A. S. (2010). Online Hand Signature Verification.*Journal of Applied Science*, 1632-1643.

[4] R. Das, S. D. (2013). A Comparative Study of Biometric Authentication Based on Handwritten Signatures. *IJRET: International Journal of Research in Engineering and Technology*, 28-35.

[5] A. K. Jain, F. D. (2002). On-line Signature Verification.*Pattern Recognition 35*, 2963-2972.

[6] F. Hao, C. W. (2003). Online Signature Verification Using A New Extreme Points Warping Technique. *Pattern Recognition Letters*, 2943- 2951.

[7] F.A-Fernandez, J. F.-A.-G. (2005). Sensor Interoperability and Fusion in Signature Verification: A Case Study Using Tablet PC. *Advances in Biometric Person Authentication*, 180-187.

[8] G. Pirlo, D. I. (2008). Automatic Signature Verification: The State of The Art. *IEEE Transactions on Systems, Man, and Cybernetics - Part C: Applications and Reviews*, 609-635.

[9] G. Taherzadeh, R. K. (2011). Evaluation of Online Signature Verification Features. *13th International Conference on Advanced Communication Technology (ICACT)*, 772-777.

[10] J. Fierrez, J. O.-G.-R. (2007). HMM-based On-lien Signature Verification: Feature Extraction and Signature Modeling. *Pattern Recognition Letters*, 2325-2334.

[11] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

★★★