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Real time Analysis of Foot Plantar Pressure using Labview

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Abstract:- The aim of our project is to design a pressure mat, to display the maximum pressure in different parts of foot while walking and to inform the person if they exert high pressure in the pressure points of the foot. Foot plantar pressure is the pressure field that acts between the foot and the support surface during everyday locomotor activities. The measurement of plantar stress distribution is an important technique to identify the feet at the risk of ulceration. This information is based on the plot of the pressure range of their walking for both recorded and real time. The piezoelectric sensors were placed in insole and fixed in the mat. The piezoelectric sensor is used because it uses the piezoelectric effect, to measure the pressure by converting them to an electric field. And another advantage is that piezoelectric sensors are highly economical. Microcontroller is used to acquire information from the sensor and to process the signals. Lab VIEW is used to visualize the output peak to peak pressure waves.

***Keywords**:- plantar pressure, foot ulcer, insole, pressure mat, microcontroller, Lab VIEW.*

I. INTRODUCTION

A. Foot Ulcer

Foot ulcer is an open sore on the foot. A foot ulcer can be a shallow red crater that involves only the surface skin. A foot ulcer also can be very deep. A deep foot ulcer may be a crater that extends through the full thickness of the skin. It may involve tendons, bones and other deep structures. There are several causes for the foot ulcer but out of all Neuropathy is recognized to be the most leading contributory cause for foot ulceration[1]. The other reasons may include occurrence of abnormal high pressures due to the poor load distribution as a result of both sensory an motor neuropathy. The pressure ulcers are expensive and tedious to treat and even amputation may be required sometimes[2].Diabetic foot ulcer is responsible for substantial emotional and physical distress, loss of productivity, and financial loss that lower the quality of life. A foot ulcer lasts depends on the depth of the ulcer, whether there is enough blood circulation to supply oxygen and nutrients, whether the ulcer can be protected from rubbing or pressure, whether the ulcer is infected. In people who have good circulation and good medical care, an ulcer sometimes can heal in as few as three to six weeks. Deeper ulcers may take 12 to 20 weeks. They sometimes require surgery. People with diabetes and people with poor circulation are more likely to develop foot ulcers. It can be difficult to heal a foot ulcer. Even a small foot ulcer can become infected if it does not heal quickly.Foot pressure measurement can be used in real clinical settings for gait analysis and biomechanics, diabetic offloading, sports medicine and rehabilitation, Pre- and post-treatment evaluation, orthotic prescription confirmation[13].

B. Classification of Diabetic Foot Ulcer

The evaluation and classification of diabetic foot ulcers are essential in order to organize the appropriate treatment plan and follow up. The Wagner-Meggitt classification is based mainly on wound depth and consists of 6 wound grades. These include:

(i) Grade 0 (intact skin)
(ii) Grade 1 (superficial ulcer)
(iii) Grade 2 (deep ulcer to tendon, bone, or joint)
(iv) Grade 3 (deep ulcer with abscess)
(iv) Grade 4 (forefoot gangrene) and
(v) Grade 5 (whole foot gangrene).

II. LITERATURE REVIEW

During the last few decades, several methods have been developed for the analysis of plantar pressure. For example Shu et al. developed an in-shoe plantar pressure measurement and analysis system based on a textile fabric sensor array[3],Perry et al. measured the forefoot shear stress and pressure during the initiation of a gait with transducers based on strain gauge technology[4],Piezoelectric materials in plantar pressure measurements have been used by Pedotti et al. [5],Lord and Hosein recorded the in-shoe plantar shear stress locally beneath the metatarsal heads and heel with sensor based on magneto-resistor [6].In this study, a pressure mat is designed to determine the peak to peak pressure waveforms of the plantar stresses. Pressure mat is a normal cloth type mat where the shoe soles are placed on it. It is inexpensive. The shoe sole is a rubber material which has the shape of normal foot. The sole can be of different sizes based on the sex of the subject. The piezoelectric sensors are chosen to be placed in the in-sole for the pressure measurement[15]. There are fifteen areas on the sole foot that support body weight during normal activates. We have selected the heel and metatarsal areas to see if a person favors Heel Strike or Forefeet strike. Adding Mid feet and hallux would provide better results but since each amplifier can connect to 4 sensors, and adding two sensors, would force us another amplifier. The sensors are placed on the four pressure points of the foot (Heel, hallux, Metatarsal head 1 and Metatarsal head 5).This methodology is used to determine the risk of foot ulceration.

III. SENSOR PLACEMENT

A piezoelectric sensor which produces electrical signals in response to a mechanical stress. We have used piezoelectric sensor with the frequency range of 20-29KHZ[11].Taking into account the advantages of foot plantar insoles, a novel sensing method was developed to control the prosthesis both in the stance and swing phases. It is com exerts posed of 24 switches strategically placed on the heel (S1), mid-foot (S2), metatarsal (S3), and toe (S4) of the plantar insole[7]. The sensor placement was determined by considering dominant pressure points of the plantar surface during walking[13].

IV. CIRCUITRY COMPONENTS

A. Voltage Regulator

A voltage regulator is an electricity regulation device designed to automatically convert voltage into a lower, usually direct current (DC), constant voltage. The 78xx is a family of self contained fixed linear voltage regulator integrated circuits .The 78xx family is commonly used in electronic circuits requiring a related power supply because it is stable and cost effective.

B.Capacitor

Adding a capacitor to the circuits helped to remove the noise in the signal. The value of capacitor is related to the cut off frequency of the circuit.

C. Microcontroller

We have chosen ATmega8 microcontroller which is a low power CMOS 8-bit microcontroller based on the AVR RISC architecture.By executing the powerful instructions in a single clock cycle, the ATmega8 achieves throughput approaching 1MIPS per MHZ, allowing the system designer to optimize power consumption, versus processing speed. The ATmega8 provides the following: 8K bytes of In-system programmable Flash with Read-While-Write capabilities, 512 bytes of EEPROM, 1k byte of SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timers/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, a 6-channel ADC(eight channels in TQFP and QFN/MLF packages) with 10-bit accuracy, a programmable Watchdog Timer with Internal oscillator, an SPI serial port, and five software selectable power saving modes. The idle mode stops the CPU while allowing the SRAM, Timer/Counter, SPI port, and interrupt system to continue functioning.

Features of Microcontroller (Atmega8)

The risk of foot ulceration may found both in the diabetic patients and in the normal subjects who exerts excess pressureintheirfoot.

PARAMETER NAME	VALUE
Program Memory Type	Flash
Program Memory(KB)	8
CPU Speed(MIPS)	16
RAM bytes	1024
Data EEPROM(Bytes)	512
Digital communication peripherals	1-UART,1-SPI,1-I2C
Capture/compare/PWM Peripherals	1 Input capture,1 CCP,3 PWM
Timers	2*8-Bit,1*16 Bit
Comparators	1
Temperature Range©	-40 to 85
Operating Voltage Range(V)	2.7 to 5.5
Pin count	32

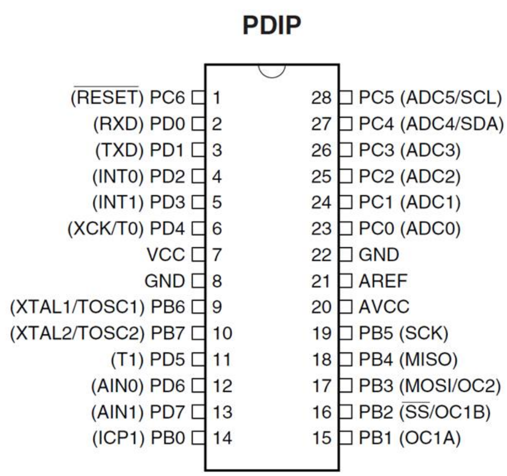

Fig 1:- Pin diagram of ATmega8

D. USB CP2102

The CP2102 is a highly-integrated USB-to-UART Bridge Controller providing a simple solution for updating RS-232 designs to USB using a minimum of components and PCB space. The CP2102 includes a USB 2.0 full-speed function controller, USB transceiver, oscillator, EEPROM, and asynchronous serial data bus (UART) with full modem control signals in a compact 5 x 5 mm MLP-28 package. No other external USB components are required. Single-Chip USB to UART Data Transfer has: Integrated USB transceiver, no external resistors required, Integrated clock, no external crystal required, Integrated 1024-Byte EEPROM for vendor ID, product ID, serial number, power descriptor, release number, and product description strings ,On-chip power-on reset circuit , On-chip voltage regulator: 3.3 V output ,100% pin and software compatible with CP2101.

E. Labview

LabVIEW (Laboratory Virtual Instrument Engineering Workbench), created by National Instruments. It is a graphical programming language that uses icons instead of lines of text to create applications. Lab VIEW programs/codes are called Virtual Instruments, or VIs for short. All the parameters that are acquired from the sensor unit using microcontroller will be given to computer via USB serial port CP2102.The extracted output voltage can be analysed the LabVIEW[9].

V. BLOCK DIAGRAM

The block diagram of the proposed system is shown in fig.2:

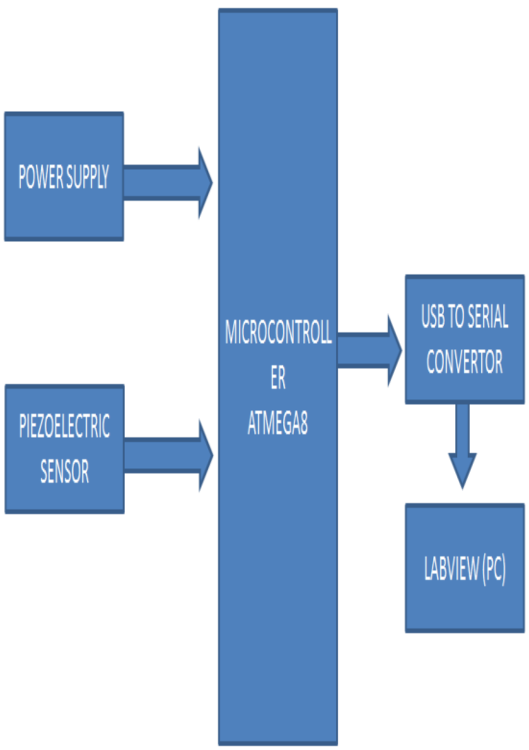

Fig 2:- Block diagram

The piezoelectric has two leads(positive and negative leads).The positive lead is soldered in the ceramic area and the negative lead is soldered on the outer ring of the disc. These sensors are placed in four pressure points[14]. They are metatarsal head(1 and 5), hallux and heel. When the subjects exert pressure on these four pressure points(where the sensors are sticked), we receive analog signal from the piezoelectric sensors. The system uses low power consumption microcontroller ATmega 8 which has inbuilt ADC that converts the acquired analog signal from sensor to digital signal. The signal is then given to LabVIEW through USB CP2102.In the LabVIEW, a blankVI is created. The acquired digital voltage signal is to be converted to pressure values by creating a loop. Inside the loop the voltage value is multiplied with a constant value and the initial voltage is added to it[10].Then this voltage value is multiplying with 6896 and dividing by 1000 for converting to kPa[8].

VI. CIRCUIT DIAGRAM

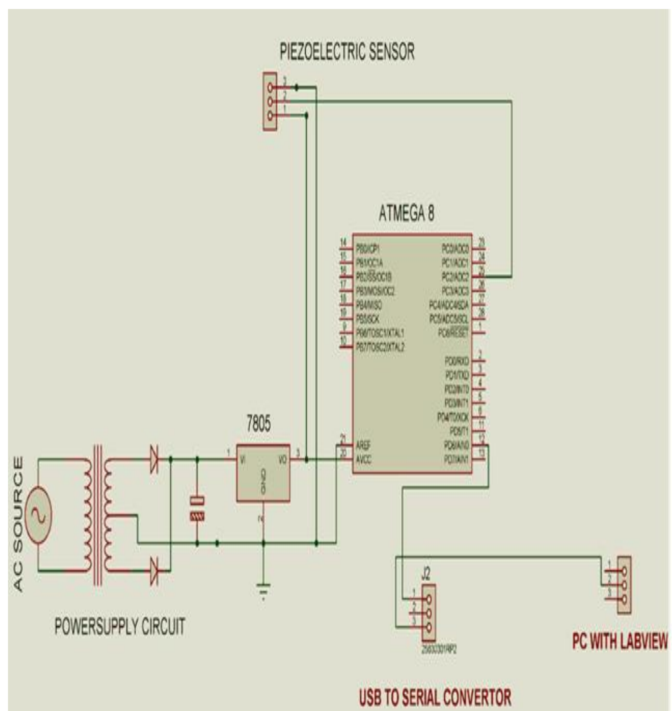

Fig 3:- Circuit Diagram

In this circuit, the transformer is used to convert the AC voltage to DC voltage by using half wave rectifier. The voltage regulator 7805 is used to regulate the circuit on 5V. The output of voltage regulator is connected to the pin 20 of the microcontroller. The outputs from the sensors are directly given to the port A (pin 22-28). The output can be taken from port B and port C and given to the USB to Serial converter CP2102 and then to the LabVIEW.

VII. RESULTS

From pressure mat that has been designed to measure the pressure affecting different region of the foot , we have canned to make the difference between each types of feet. The instrument plantar pressure measurement system pin point areas of high pressure in a waveform display. We can after use these accurate, high resolution images to aid in development of better treatments, so the patients feel better faster. The images also make it easier to explain diagnoses and treatments to patients and other providers.

VIII. CONCLUSION

The plantar pressure measurement system is a very inexpensive and easy way to display the maximum pressure in different parts of the foot and inform the person correct way of walking and running. It can also help in other applications such as footwear research for design, comparison, screening, isolation of foot function and identifying pressure range for medical purpose and personal running regulation.

REFERENCES

[1]. N.Singh,D.G.Armstrong, and B.A.Lipsky, “Preventing foot ulcers in patients with diabetes”, JAMA, vol.293, no.2, pp. 217-228, Jan. 2005.

[2]. P. Laing, “The development and complications of diabetic foot ulcers,”Amer. J. Surg., vol. 176, no. 2, pp. 11S–19S, 1998.

[3]. L. Shu, T. Hua, Y. Wang, Q. Li, D. D. Feng, and X. Tao, “In-shoe plantar pressure measurement and analysis system based on fabric pressure sensing array,” IEEE Trans. Inf. Technol. Biomed., vol. 14, no. 3,pp. 767–775, May 2010.

[4]. J. E. Perry, J. O. Hall, and B. L. Davis, “Simultaneous measurement of plantar pressure and shear forces in diabetic individuals,” Gait Posture,vol. 15, no. 1, pp. 101–107, 2002.

[5]. A. Pedotti, R. Assente, G. Fusi, D. De Rossi, P. Dario, and C. Domenici,“Multisensor piezoelectric polymer insole for pedobarography,”Ferroelectrics, vol. 60, no. 1, pp. 163–174, 1984.

[6]. M.Lord and R.Hosein,”A study of in-shoe plantar shear in patients with diabetic neuropathy.”Clin.Biomech., vol.15, no.4, pp.278-283, 2000.

[7]. F. Abouaesha, C. H. M. van Schie, G. D. Griffths, R. J. Young, andA. J. M. Boulton, “Plantar tissue thickness is related to peak plantarpressure in the high-risk diabetic foot,” Diabetes Care, vol. 24, no. 7,pp. 1270–1274, 2001.

[8]. SabaNaghipour, “In shoe pressure measurement and analysis in relation to FootStrike”,Washington University in St. Louis, May 2012.

[9]. Keleshis C, Ionita C, Rudin s, c; Rudin, s(june 2006).”Labview(sic) graphical user interface for micro angio-fluroscopic high resolution detector”. Medical Physics 33(6); 2007.Doi: 10,11,18/1.2240285.

[10]. Schaff PS. An overview of foot pressure measurement systems.ClinPodiatr Med Surg. 1993;10:403– 415.

[11]. Gross TS, Bunch RP. Measurement of discrete vertical in-shoestress with piezoelectric transducers. J Biomed Eng 1988;10:261-5.

[12]. Mueller, "Application of plantar pressure assessment in footwear and insert design," The Journal of orthopaedic and sports physical therapy, vol. 29, p. 747, 1999.

[13]. D. Rosenbaum and H.-P. Becker, “Plantar pressure distribution measurements.technical background and clinical applications,”Foot and AnkleSurgery, vol. 3, no. 1, pp. 1 – 14, 1997.

[14]. Birke JA, Sims DS Jr, Buford WL. Walking casts: effect on plantarfoot pressures. J Rehabil Res Dev. 1985;22(3):18 –22.

[15]. Mueller MJ. Use of an in-shoe pressure measurement system in the management of patients with neuropathic ulcers or metatarsalgia.*J Orthop Sports PhysTher*. 1995;21:328 –336.