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Foot Pressure Measurement by using ATMEGA 164 Microcontroller

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ABSTRACT

One of the latest biomedical applications is the foot plantar pressure distributions. It is the interface of pressure between the shoe sole and the foot plantar surface, where it is very accurately measuring the foot pressure. Also a lower limb problem, sport biomechanics, footwear design, injury prevention are the pressure measures which is used for knowing information for gait and posture research. Foot pressure is very useful in neurological disorders and biomechanical applications. Healthy peoples of gait analysis have revealed to decrease stride length, increased variability in gait parameters. Age was associated with low pressure under mid-foot, hallux and hell in the analysis of multivariate. Foot Pressure Measurement (FDP) is used in walking, it helps in young and old health to evaluate of force, pressure and relative loads. The technology is also inexpensive thus giving the potential for a small cost instrument with reliability and higher accuracy.

KEYWORDS: FDP FSR PODIOSCAN ATMEGA Harris Mat

INTRODUCTION

This paper deals with measurement of foot pressure [1] considering the human anatomy, all the nerves from various part of the body end at foot. Hence the pressure applied to the foot is of greater significance. During walking, a pull of same magnitude and opposite direction is extended upon the foot due to the human foot. Pressure-sensing technology is widely used for research, clinical applications and also in activities for walking and running. According to the medical studies the human foot can be described as a three part organ. They are mid foot, hind foot and fore foot. Each part of foot should be applied with a standard rate of pressure are Hind Foot - 9.1 to 13.1 psi, Mid Foot - 2 to 5 psi, Fore Foot - 8.7 to 13.9 psi.(1 psi $=6.8948\times10^3$ Pascal's). In case of high pressure in any part of the foot, will affect the nerves in that region causing severe organic problem. For instance consider the fore foot in which the nerve from the heart ends. If the pressure applied to that region is higher than 13.9 psi then this will lead to serious trouble in the heart. This paper will help the patient to find the cause of the problem and can avoid going for a surgery directly. Major problems like heart attacks are also caused due to the improper pressure distribution in foot during walking. Most of the human population especially Indians do not have the knowledge of improper pressure distribution in foot, it will also cause severe problems in heart.

System Design:

The proposed system is used to design a system to measure plantar pressure and to display different pressure gradients in a pressure map. In order to measure the plantar pressure, eight FSR sensors [4] is placed beneath the foot sole. The pressure signals acquired from the eight sensors are then sent to the ATMEGA 164 microcontroller. Since it has an inbuilt ADC, the acquired signals are converted into digital values and are

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displayed using a LCD and simultaneously the values are displayed on the computer using MAX232 cable and depending upon the values, the plantar pressure is mapped pictorially using Lab VIEW software.

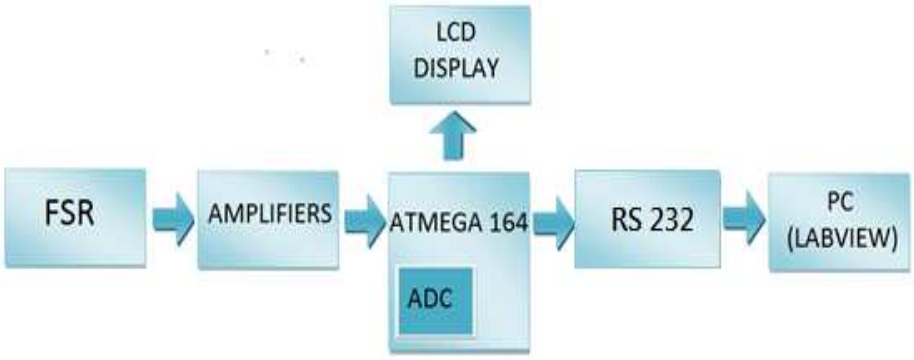

Fig. 1: Block diagram

Foot Pressure Measurement Methods:
Harris Mat:

As the current foot pressure measuring devices are expensive, various hospitals follow a less accurate method for foot pressure measurement [6]. One of the commonly followed methods is using harries mat. The patients are made to stamp on the ink pad and the foot impression is made. This paper is then scanned in a special scanner copier and printed as colored output. This is known as PODIOSCAN. It is simple and user friendly system, that provides podiatrics and bio-mechanist with an efficient and economic static as well as dynamic plantar pressure distribution.

Impression of Foot and Predictions:

Fine lines- normal pressure areas, small squares- low pressure areas, Large squares- High pressure areas, blotches – very high pressure areas.

Problems Identified from Foot Impression:

Areas of potential ulceration, Pre and post-surgical evaluation, Degree of phonation or supination, Weight bearing after surgery Orthotic efficacy.

Matscan Foot Pressure Measurement:

Foot pressure measurement system [5] using matscan can be classified into two platforms based and in shoe based. A 10 m walkway will utilized and with the matscan in the middle of this walkway. A two step gait initiation protocol is being used .The sampling frequency for the system will be 40Hz.

Testing And Simulation:

LabVIEW is a graphical programming language for instrumentation systems and building data acquisition. Within LabVIEW one can easily create user interfaces that give interactive control of the software system. To specify the system functionality, one can simply assembly block diagrams-a natural design notation for engineers and scientists. Its tight integration with measurement hardware facilities rapid production of acquisition of data and its analysis also solutions of presentation. The ATmega16 [7] has 512 bytes EEPROM, 1K byte SRA.

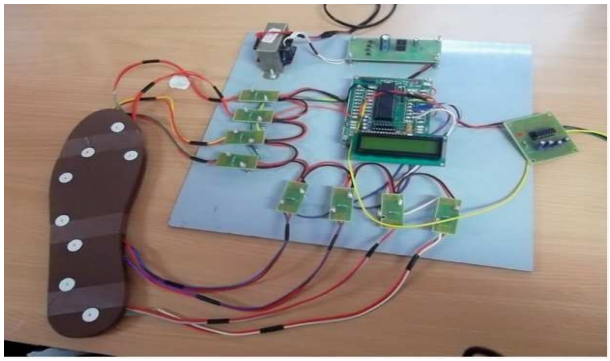

Fig. 2: Foot Pressure Measurement set up

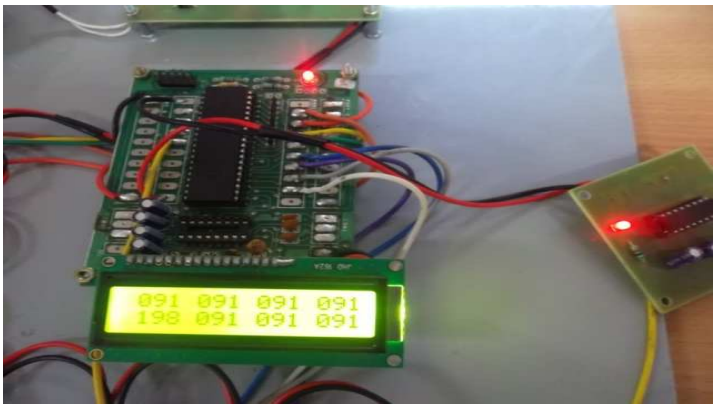

Fig. 3: Display of Pressure Values while placing the foot

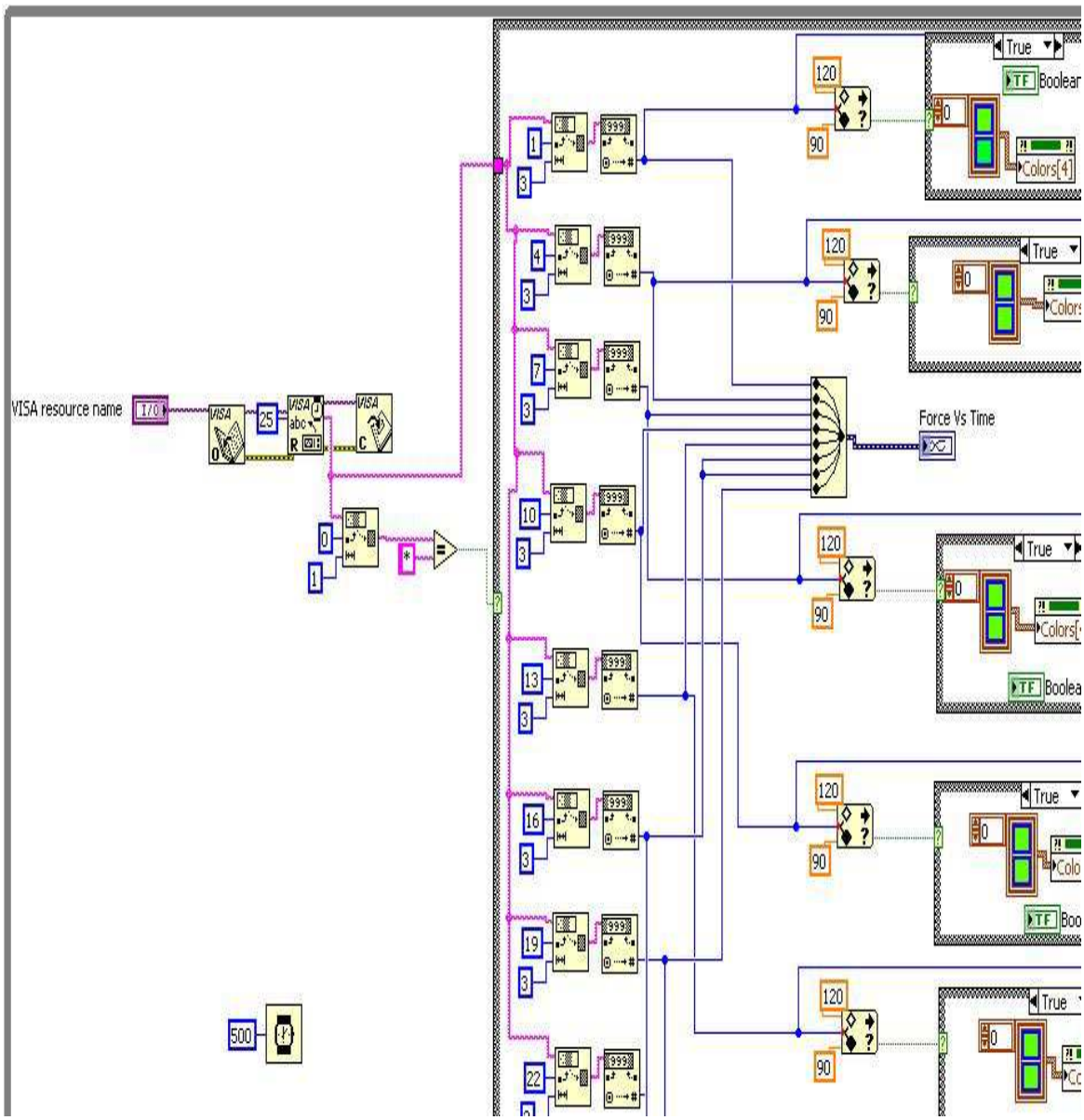

Fig. 4: Block diagram

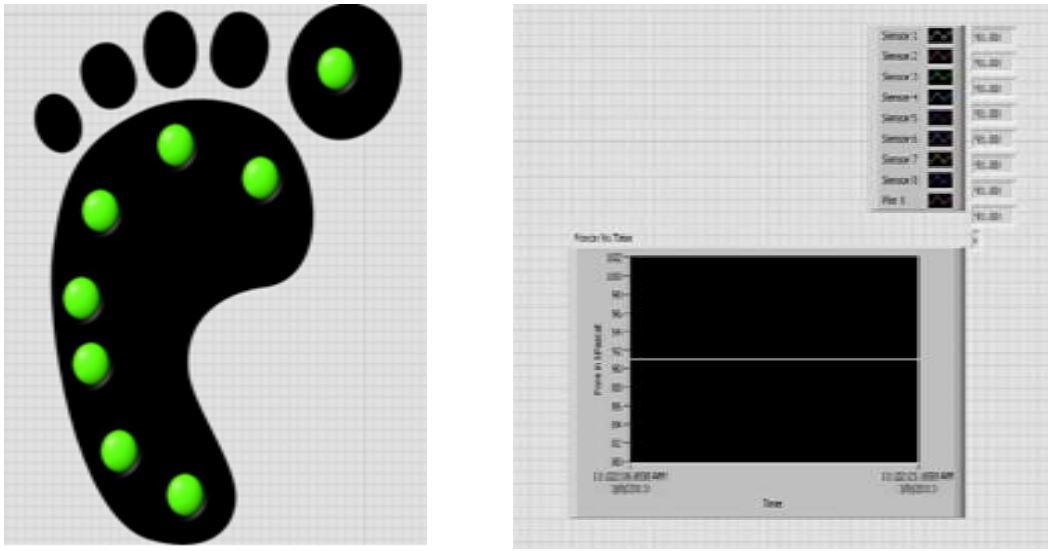

Fig. 5: Lab view module for display of pressure values

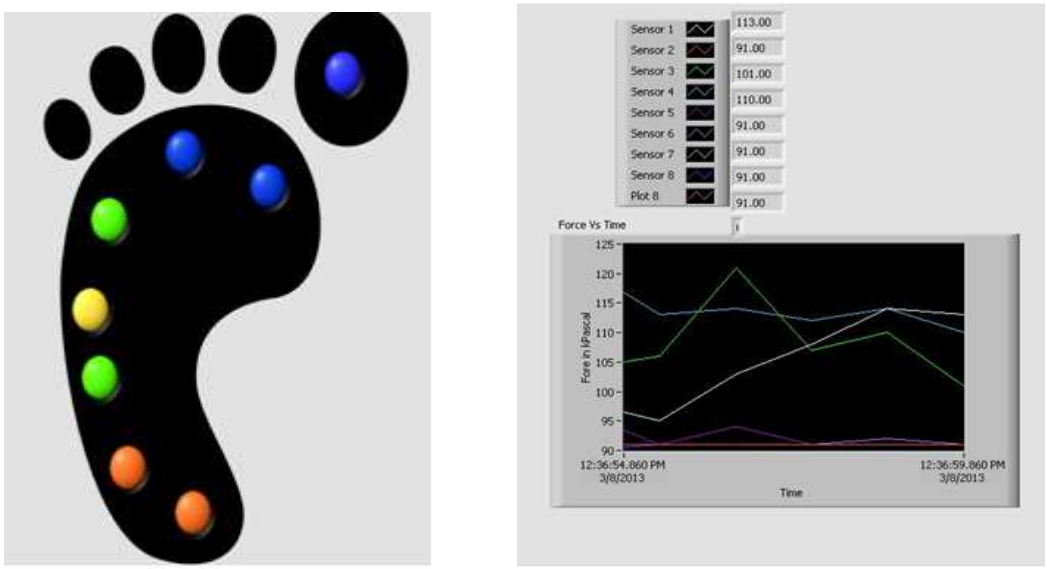

Fig. 6: Pressure Map of the person

Applications of Foot Pressure Measurement:

Athletic trainers and podiatric specialists use pressure measurement to get their patients back on their feet and back in the game faster. So Foot pressure measurement improves the sport biomechanics. High-resolution pressure sensors provide objective and accurate information on location and severity of high pressure areas on the plantar surface, making them an ideal tool for developing or selecting offloading footwear. In this case, it is also used to quantify pressure at the ulcer site [5] of a diabetic patient and confirm that the orthotic treatment is producing the desired effect, helping her patient heal faster and avoid further complications. Analysis of foot pressure helps the Physicians to easily identify the lower limb problems like pain in the lower extremities, injury, swelling, changes in gait pattern etc. So this system facilitates an easy approach in diagnosing and treating these problems. Plantar pressure and timing data provides clinicians with an objective way to measure change after or during treatment or rehabilitation. It assesses the gait of a patient who suffers from chronic ankle and lower back pain following several knee surgeries. The patient had previously been treated with multiple ankle braces with no improvement. In the field of rehabilitation analysis of pressure distribution helps to the most suited lower limb prosthesis for the person. The person with slightly non uniform pressure distribution will be recommended with prosthesis of different material than the person with uniform pressure distribution. Pressure analysis [3] in the foot helps to predict the most suited foot wear. The foot wear suggested will be in such a way that it reduces the pressure in high pressure areas and helps to obtain a uniform pressure distribution in the foot of the person. Prescription orthotics does not always produce the desired effect on the first try. In

shoe pressure measurement removes the guesswork from orthotic development by allowing clinicians to validate new footwear immediately, improving patient comfort and reducing the need for follow-up visits.

Conclusion:

A Foot Pressure Measurement system is developed based on FSR sensor. Each sensor element was constructed separately. Before proceeding to the experimental tests the sensors were calibrated and trimmed. According to the specificity of the sensor, an analog signal processing was realized and analyzed. The conditioning circuit output signals from the eight transducers are coupled to microcontroller. The software program which was analyses and calibrates the sensors signals. The data obtained from the plantar pressure assessment is stored into a database and provides a physiotherapist with valuable information to support his/her evaluations during the rehabilitation process and various other applications. This system has been used in rehabilitation for designing lower limb prosthesis, analyze pressure distribution in diabetic patients and prevent them from getting their conditions worsen. Thus Foot Pressure Measurement system developed has inexpensive technology thus giving the potential for a low cost instrument with reliability and higher accuracy.

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