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Design and Development of a Foot Pressure Scanner for Diabetic Patients

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Abstract

Objective: The purpose of the study is to develop a system for measuring the pressure level at several points on the foot sole. **Methodology:** The pressure sensors placed on the pressure plate develops a voltage for the corresponding exerted pressure and the voltages are amplified to a considerable value and fed into the multiplexer for digitization by using A/D convertor for further processing. All the data are normalized to obtain an appropriate image. The image colour intensities indicate different pressure distributions of the foot. **Findings:** The diabetes patients are made to walk on the pressure device and the distributions of pressure are simulated with various color coding using Visual Basic (VB) and the range of pressure from minimum to maximum is validated. **Applications/Improvements:** The pressure distribution of a patient is found in the foot sole and an appropriate foot wear can be designed to avoid foot ulcers and other deformations.

Keywords: Capacitive Sensor, Contact Area, Diabetes, Pressure Level

1. Introduction

It is found that foot pressure[1] is affected by the weight of the person, gait patterns, foot deformities and walking velocity. It is also reported that the high magnitude of pressure ulcers as well as bone deformities brand. In an effort to determine the role of pressure we built foot pressure data acquisition system to monitor the pressure distribution[2] beneath the feet during regular walking and correct the abnormal distribution of foot pressure. Observing of the pressure variations of foot sole[3] is carried out for the below key purposes

- Research purpose.
- Medical analysis.
- Foot deformities.

As a part of investigations, the information gathered in feet for normal and abnormal locomotive positions were acquired by pressure monitoring device. The clinician diagnosis the patient's foot pressure distribution using this pressure monitoring device and assess the treatment. In certain situations, foot conditions responds stubborn to the cases such as medication physiotherapy or surgery. The studies have shown that leprosy or diabetes patient experiences dumb feet. This pain sensation loss and aching, affects the distribution of pressure and areas around the metatarsal heads. So the measurement of foot pressure plays an important role. This diabetic foot is especially susceptible to the complications of vascular disease and neuropathy (i.e.) such as temperature susceptibility in their feet and loss pain. During walking or standing[4] information about pressures are been relieved. Thus they can injure their feet accidently without being aware of the injury. Bone changes are produced by repetitive injury, causing their foot to become deformed. According to the changes made new pressure points are created which result in ulceration. Infections frequently develop in these ulcers, with the risk of progressing to gangrene and amputation. In attempt to solve the problem, footwear is being designed incorporating pressure transducers at vital pressures points to indicate any abnormalities in the pressure distribution pattern and to

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correct the abnormalities in the foot pressure distribution this system is developed.

Recently some research has been done for foot pressure measurement and interpolates those results. Foot pressure has to discriminate normal and abnormal subjects however, improved performance is required for clinical use. Another method of measuring the pressure distribution under the foot is to place sensors in the sole of a shoe. This technique can measure the plantar pressure[5–8] during the normal activity of a shoe-wearing subject. Bauman and Brand[1], tapped capacitive pressure pads Hundred (mm^2) in area and 1mm dense to the sole of the foot with adhesive tape. These sensors were positioned beneath[9] the 5 metatarsals heads, the great toe and the heal. A similar system using piezoelectric sensors in pads 735mm^2 where are several problems with the sensors because of its structure shape and attachment to the shoe to solve this problem they subsequently used a flexible capacitive sensor[10] made of rubber sponge and copper coils. There are several studies has done before.

To rectify the disadvantages, capacitive type system can be established and united with computerized health care systems that purpose at supporting nonstop and remote monitoring of aided livings. The foot pressure measurement system was developed for the patients with foot deformities especially for diabetic people[11]. This system consists of pressure sensors, incorporated in the foot pressure plate, multi-channel data acquisition system[7,12], signal conditioner, process software, display unit.

2. Methodology

The procedure followed is depicted in Figure 1. The human has to walk in the pressure plate results that there is a change in the capacitance which results the change in output voltage. In this output, voltage change can be converted into digital by the use of analog to digital converter. After converted, the digital pulses will be given to the processor for further processing. By the use of computer, the system can be analyzed and interpolated. There is a color coding scheme can be followed in this system. There are seven set (VIBGYOR)[13] of color scheme can be used for plotting. Red color is used for peak pressure and violet is used for violet. Visual Basic (VB) tool is used to create a GUI system.

The system strives to give an indication of the pressure points in an easy and decipherable form. This site facilitates the pressure acquisition with no complex circuitry. The concept and components of the system

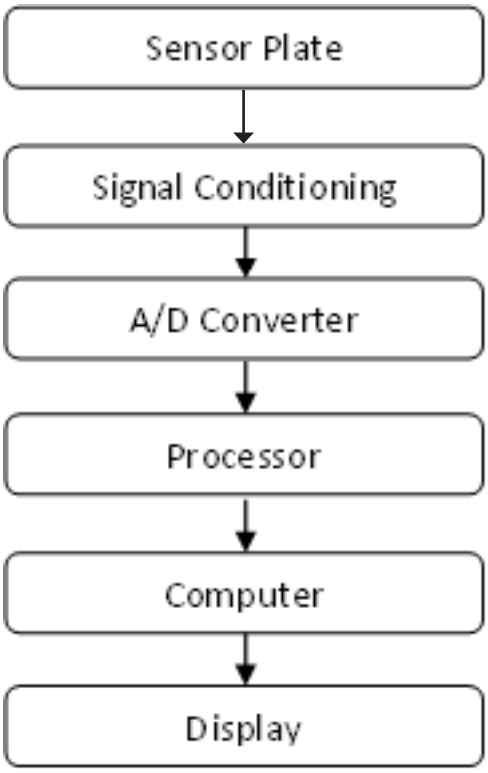

Figure 1. Flowchart of the system.

are easy to implement and they are also minor and light enough so as to disturb the subject's gait[14]. The flow chart shows the general description of the system. The pressure sensors are inculpated in the sole of the footwear[15]. When pressure is exerted, these sensors show a change in characteristic change in the features is proportional to pressure and thus a corresponding increase in the output voltage. This voltage is brought to a well-suited level by means of the amplifier unit.

The output from the multi-channel data acquisition system is then multiplexed and converted into the digital form by an A/D which is inbuilt in microcontroller. The digitized output will be processed for normalization and symbolic representation by means of suitable software and the final display gives the appropriate color strengths to specify different pressure spreading on the foot.

3. Results and Discussion

The patient's foot pressure variation deeply affects the output voltage due to the change in capacitance. All the patient details can be entered in the VB platform as shown in the Figure 2. As a preliminary investigation, a male

patient of age 48 affected from diabetes allowed to walk on the electronic foot pressure device and the respective voltages, color coding with pressure differences is plotted in the system which is shown in the Figure 3. The coding depends upon the VIBGYOR color format. Violet indicates the minimum voltage obtained through which it varies to red which is coded as the maximum output voltage range. For an instance, the subject's pressure is observed with different colours of VIBGYOR. Likely, in the heel, it was observed with maximum pressure (i.e.) red color.

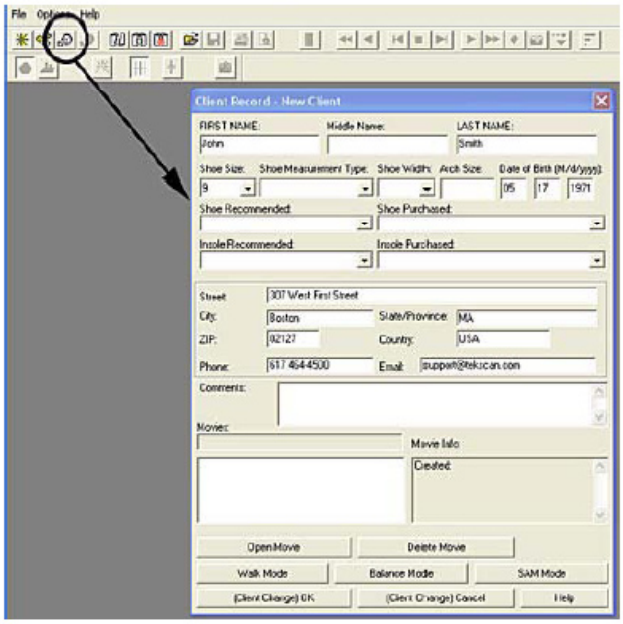

Figure 2. Snapshot for entering the patient details.

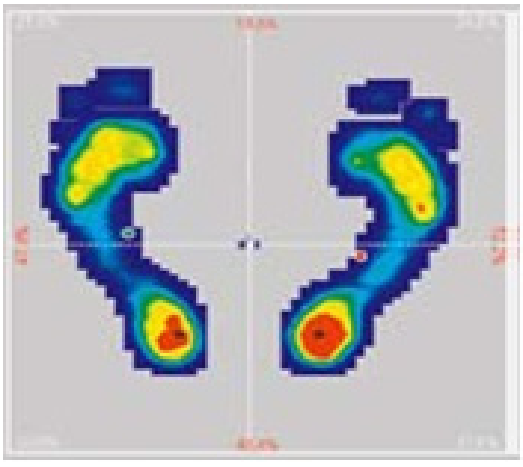

Figure 3. Simulated output of a foot sole.

4. Conclusion

This paper provides the solution about the pressure distribution in the foot sole through colour mapping. From the results it is found that the minimum and the maximum pressure distributions are mapped to narrow down the region of pain. According to the results found from the study different foot wears can be designed, according to the individual subject's pain region.

5. Acknowledgement

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