International Journal of Emerging Trends in Engineering & Technology (IJETET)
Vol.03, No.02, 2015
ISSN No. 2248-9592

A Wearable Device For Foot For Diabetic Neuropathy

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Abstract- **In recent year, progress in biomedical field reach at higher level as the more portable devices and the equipment helping patient in monitoring and controlling different disease at different stages. On the other hand in many work environment worker has lot pressure and continuous movement on daily basis tends to foot related disease as getting exact details about the foot movement throughout the daily work routine is not possible. In available treatment options in such conditions, they are recommended to use bandage therapy delivered based on compression mechanism or wound healing therapy. Whereas these forms of therapy can deliver very little enhancement in curing process, costly solution hence the patients are having some problem at this level. As solution of the above condition, wants a new light weighted, wearable, portable device having less cost as compared to the available systems. The proposed system is to design and implementation of wearable device for foot disease monitoring where the system will be capable to detect the level of foot ulcers related issues along with daily exercise level monitoring.**

Keywords: ***plantar pressure, pressure sensor, Pedobarography, wireless system*****.**

I. INTRODUCTION

Chronic venous insufficiency and leg ulcers affects approximately about 2 people per 1000 of general population with growing number in developing countries like India and China[1]. The Pedobarography can provide a focused and specific form of human gait analysis [9], [11]. The resulting information from plantar pressure data means the on the foot membrane pressure that the human limb can suffer during day to day actions [2] which can provide support in the detection of neurological disorders. Also it can be employed for managing and monitoring the related symptoms associated with the variety of rheumatoid arthritis, musculoskeletal disorders and diabetic neuropathy [9]. In the diabetic persons those are not properly sense the painful feelings of the foot soles, the planter pressure may increased for the extended time the normal pressure value. Resulting an obstacle for the blood reaching to the peripheral tissues, which could result in the sole ulceration, the most common cause of amputation in diabetic patients. Diabetic feet develops calluses that can become ulcerated [3], [15].It has been shown that greater foot pressure is the main reason of developing calluses. So, in concern with diabetic foot ulcers, measuring the plantar surface pressure point of the foot is important.

Research has been shown that inability to detect a 10g of force (i.e. 98 mN) applied to the key weight bearing points indicates a degree of neuropathy which is consistent with increased risk of ulceration [3]. Hence, it is a need to study related to pressure of planter surface is to investigate a novel approach to fabricate an automated system for sensory neuropathy of the planter surface. Researchers are attracted towards the area in biomedical and exercise related applications are the analysis of foot plantar pressure distributions between the foot plantar surface and the shoe sole. Its applications are designing the footwear, injury prevention and sports performance analysis, enhancement in balance control, and diagnosing disease

[6]. Now a day the inventive products are there which are ready for biometric, human recognition, monitoring position allocation and rehabilitation support systems. As a result of this research it is essential that things for accurately and efficiently measuring pressure of sole skin are vital to further advancement.

A foot sole can be divided into 15 areas, as heel (area1–3), mid-foot (area 4–5), metatarsal (area 6–10), and toe (area11–15), as shown in Figure1. All of these parts can bear nearly all the body weight of the human and adjust the equilibrium of body.

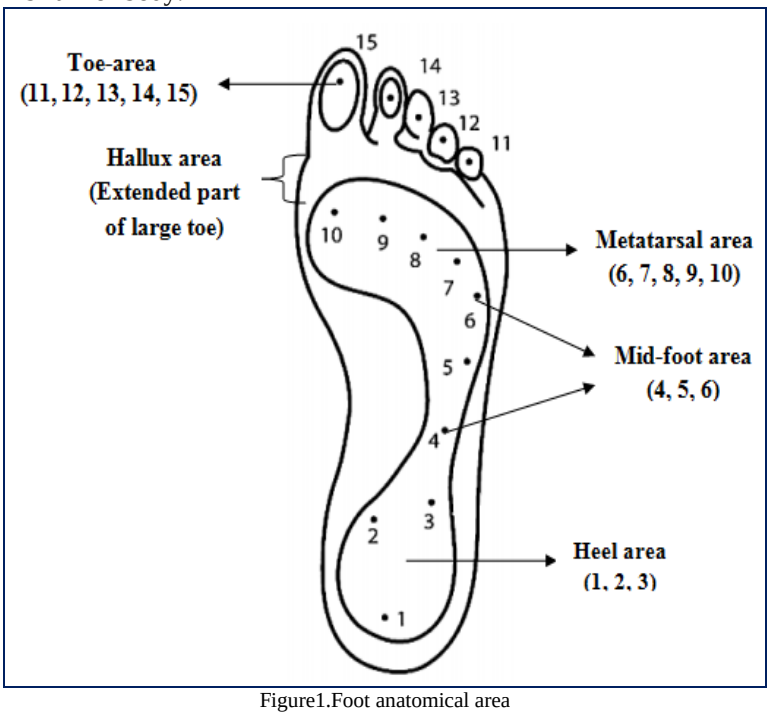

Figure1.Foot anatomical area

II. RELATED WORK

There are various methods which have been used for detecting and monitoring the gait analysis of the people especially the diabetic persons. This will be helpful for early diagnosis of vascular diseases like chances of ulcerous condition and other neurological disorders on basis of planter pressure of the foot of diabetic person.

1. Types of Systems for measurement of pressure of foot

There are a various types of plantar strain measurement devices available. They are broadly divided into two types. First one is the platform based systems and second is In-shoe plantar measurement systems.

A) Platform Based System

Platform based systems are manufactured with a plane, groups of strain sensing elements arranged in a template format and predetermined in the ground to give normal way of walking [6]. Platform based systems can be useful for both studies of static and dynamic studies. But they are normally limited to research laboratories. The benefits of this system is a raised area based and it is easy to use since it is motionless and flat but has the difficulty that the patient should having adaptation to ensure normal way of walking. Also it is significant for the foot to get in contact with the centre of the sensing area for precise readings [3], [6], [14]. Figure2 shows a platform-based system. The commercial product is capacitance transducer matrix platform mounted in on the floor. This system can be used for various researches for diabetes related issues [11], [12], gait analysis [13], etc.

Figure 2.Platform based system

B) *System placed inside the shoe*

Inside the shoe pressure measurement systems are bendable and implanted inside the shoe sole in such a way that compute the pressure of the lower limb plantar skin. This device is elastic and portable. This allowed it the variety of studies with different gait analysis tasks, footwear designs, etc. Hence they are highly recommended for studying footwear design [4], [7], [10], [11]. But there are some disadvantages like the possibility of the sensor slipping; the spatial declaration of the records is less as compared to flat based measurement systems due to lesser amount of sensing elements. Hence sensors should be suitably secured to avoid the slippage and get consistent results. Figure 3 illustrate in-shoe based systems [6].

Figure3. In-shoe system

The authors propose a SWAN-iCare project in which the fabrication of wearable negative pressure device equipped with data Acquisition and communication technologies. This can allowed doctors to accurately monitor the wound parameters, early identify the infections [3], [6] and remotely provide an innovative personalized two-line therapy. This is the solution for the system which are restricted to apply in a research places or infirmary, and used for exposed pressure measurements. Proposed system can record the plantar pressure distributions among the shoe. The collection of SWAN-iCare historical data from multiple patients when this service is in full usage, will allow for providing new knowledge and scientific data that result out of the correlation of stored data within the clinic[1].

The author Lin Shu, Tao Hua, Yangyong Wang proposes an Inside the shoe system based on a textile force sensing arrangement. This type of material weight sensible array developed by them is implanted in sole of

the shoe. A reading acquirement system is planned with undersized dimension [14].Flexible wireless configuration modes are developed on the basis of utilized Bluetooth virtual serial port technology to craft this system right for research based project fields and many more. The Graphical User Interfaces are designed to provide a concurrent display and scrutiny on various types of pressure exerted on various parts of foot [2].

In addition to this, the authors propose an automated device to replace the need for a specialist (Doctor) to attend in person. Such a device could be deployed in the home which enable the users to test themselves much more regularly, in a more reliable and in proper manner. This device would give direct feedback to users after testing and communicate results directly to health care trusts or doctors' surgeries as per the need of patients. It would encourage patients to manage their own care under guidance and in this way, significantly reduce the risk of ulceration and loss of limbs, having a dramatic affect on the quality of life of many diabetes sufferers [3].

The author Vishwa Goudar and Miodrag Potkonjak proposed CICA based algorithm for the perspective of gait diagnostics derived from platform of foot plantar pressure measurement and present a method for generating the low power sampling schedules that are useful for the sensor faults while archiving high diagnostic fidelity [4].

S. Meguerdichian, F. Dabiri, M. Potkonjak gives a medical shoe, and fined that the ordinary in the air, hallway, and impersonation segments have exactly dissimilar and repeated properties. Semantic multimodal compression models can extract the segmentations very well; By choosing the good firmness method for each section and hence minimizing the totality of communication power [5].

III. PROPOSED SYSTEM

In the proposed system, portable wearable in-shoe system (footwear) is designed. The temperature sensors or pressure sensors are being use to detect infected area. Here six to eight planter pressure sensors are implemented in sole of the shoe at various places like toe-area, metatarsal area, heel-area and mid-foot area. There are various types of sensors available in market for foot plantar pressure measurement which based on capacitance based, resistance based and voltage based. So, anyone from the above can be use here. Wirelessly output data of the various sensors can be transmitted to the hospital system as well as the doctor's system and database is generated of the entire patient under treatment.

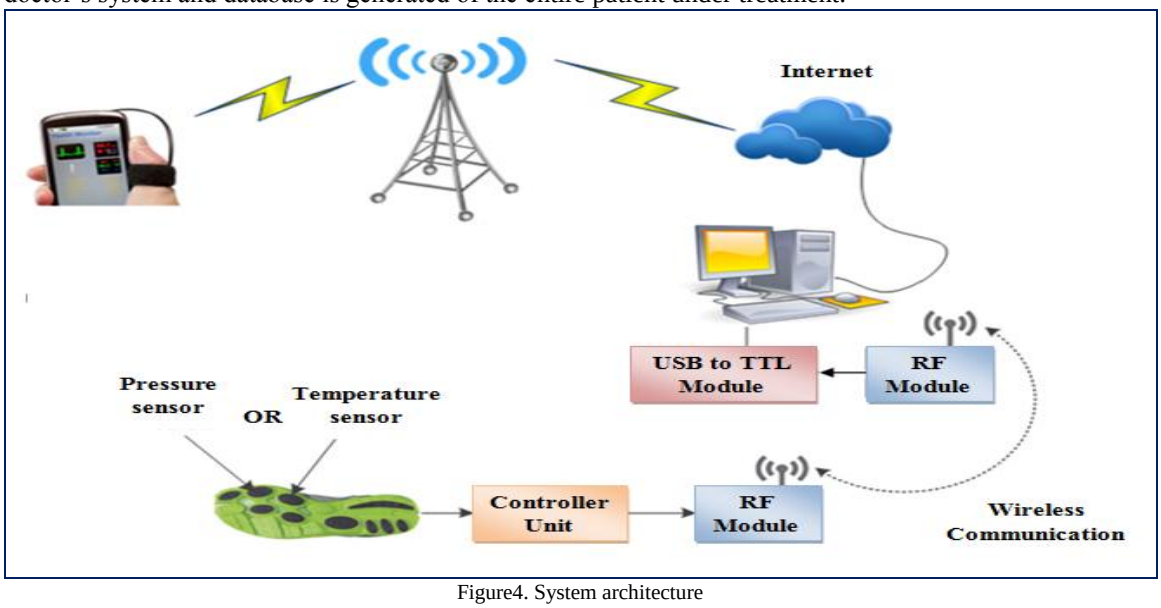

Figure4. System architecture

Figure 4 describe the overall architecture of the propose system. Here plantar pressure sensors i.e. flexiforce pressure sensors and accelerometer are implemented in sole of shoe and data of all the sensors are collected in the data acquisition system. The data acquisition is done by means of controller pin-out board. This data is transmitted wirelessly up to certain distance to the computer system through the RF transmitter-receiver pair. Other modules can also be used like Bluetooth module or XBEE as depends on

the requirement of the system. Through that receiver the data can be sending to the computer system serially by using USB cable and that is display to the user by using user interface as shown in figure 5 and figure 6. Obtained data of the wearer can be save in database as shown in figure 7 and goes to the doctor's system with the help of the internet as shown in figure 8. Because of this; doctor can monitor that patient's data and gives the suggestions depend on the readings of sensors. This will be helpful for the patients as well as the doctors. Also, on the basis of previous reading record the patient as well as doctor can see the progress.

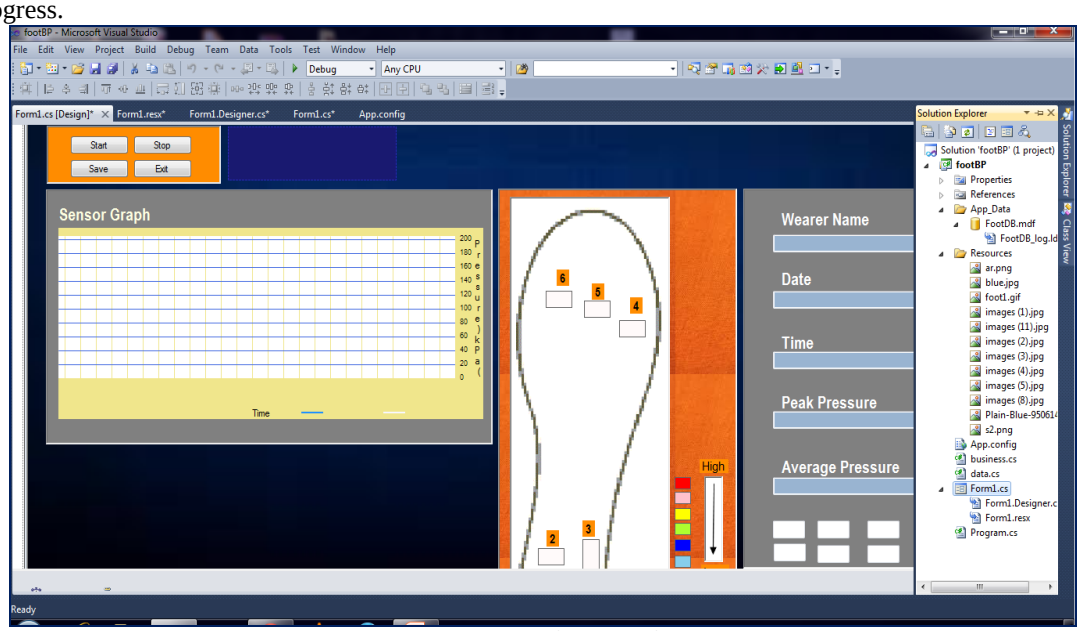

Figure5. Design of User Interface

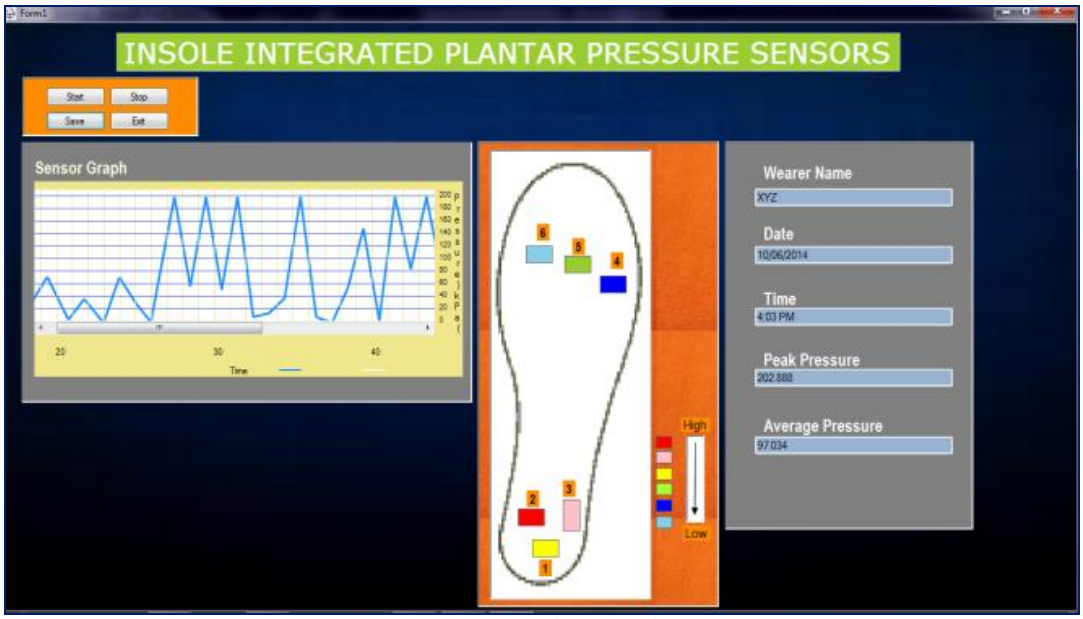

Figure6. Output of User Interface

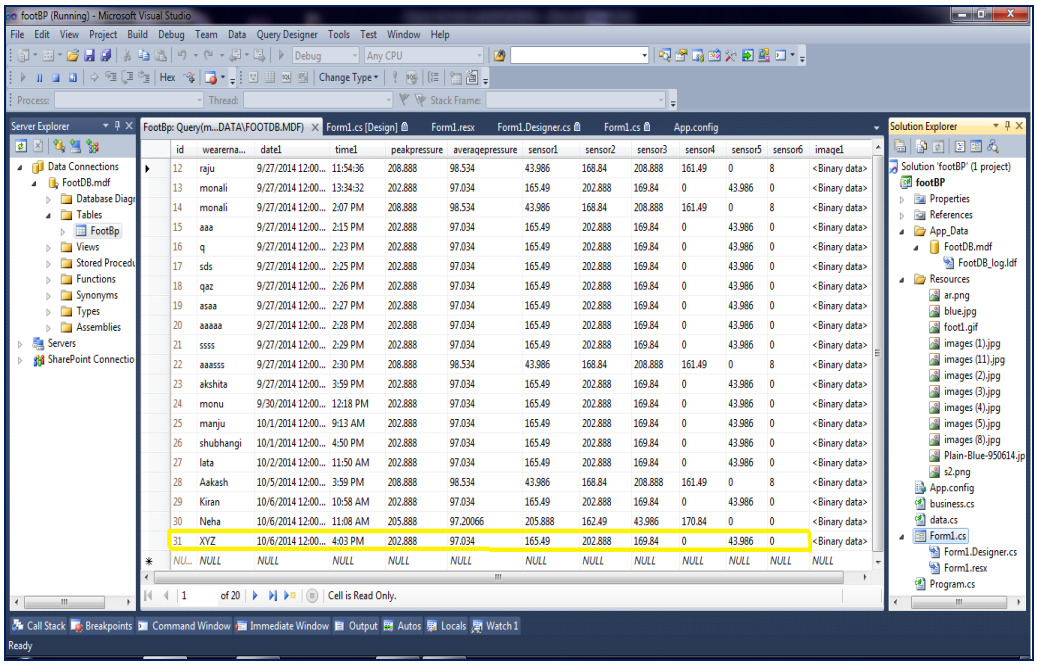

Figure7. The data of Patients ii stored in Database

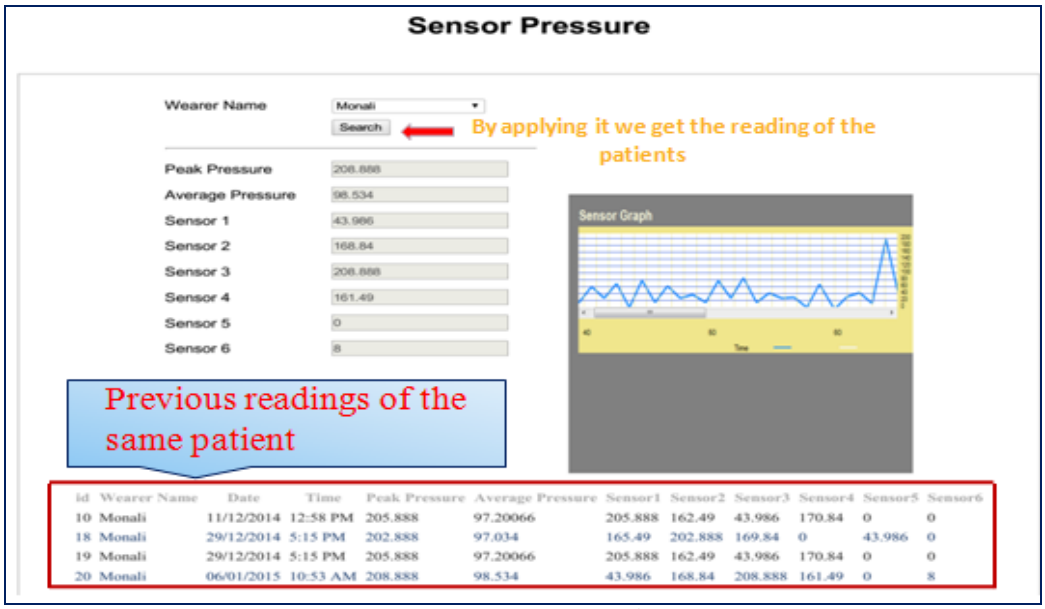

Figure8. Online showing the data of Patients

This system can also help the patients for rehabilitation so they can improve their gait and the athletic people also use this for guidance of pressure on foot specially the new ones.

IV. CONCLUSION

In this paper we proposed a wearable device for foot for the Diabetic person of sensory neuropathy that identifies the ulcerous condition which may be creating in foot plantar surface area. This system can be used in rehabilitation so they can improve their gait and athletic people also use this for guidance of pressure on foot specially the new ones. User and doctors can easily access the data by using internet. We introduced one distance measuring parameter in this system to measure the distance walked by the wearer.

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