Wireless Smart Insole Based Foot Pressure Monitoring And Analysis

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Abstract - Diabetic foot ulcer leads to several problems to the patients. It engenders illness and sometimes deals that. Those wounds lead to nervous problem along with the development of ulcer and amputation which produces high pressure in legs. Perpendicular slope and applied mathematics operation analyzing will be utilized to get foot malformation. The experiential showed a fragile one-dimensionality and an important division in weigh acceptance. Systems can be applied to evade ulceration during the shoe monitoring. Ulceration is the endpoint of the diabetics. The main etiological factors in foot ulceration are diabetic neuropathy and peripheral vascular disease.

Keywords - Diabetic foot patients, pressure, IoT, sensors

1. Introduction

About 5.1% of the United States population suffers from diabetes. Most of the diabetic individuals are affected by foot ulcer. Healthcare providers would improve the quality of life for many individuals. Diabetic patients have problem with feet because of reduced blood flow, unfortunate sensation, reduced wound healing rate and struggling off infection. Primary methods inhibiting foot ulcers are regular foot inspection, temperature monitoring, and orthotic shoes. Finding raised foot temperature is a notable early indicator of ulceration.

These studies show that such a system was possible. Both systems mandatory a calculating device or a gateway involved to the waist. Our system is similarly a lab prototype attachable to the shoe. We validate our system with an 11-person walking trial and show that our results are consistent with other studies. We also compare the use of 1 inch and 3.75 inch diameter sensors and examine the trade-offs for each choice.

2. Objective of The Project

Proposed method will measure and normalize the foot pressure and get accurate measurement which recovers foot ulcer earlier and will fetch the measurement using force sensitive resistor sensor

3. Technical Background and Survey

Recently there were several numbers of shoes with different structure and application. It can be done by different FSR and capacitors.

Harshanand J Poalwar (Springer 1999)

He introduced the shoe for diabetic foot patients in India. He found the technique to find out the pathological complication and to analysis the plantar foot. 102 patients are evaluated through assessments and found 62% had vascular problem, 51% had nail vagaries, 51% had foot lesion, 52% had foot irregularity, 5.8% had inter-digital impurity, 38.2% had limited joined motility, 20% had foot ulceration, 71% had high peak pressure point (healed ulcer). Meticulous clinical examination easily gives these complications earlier. The advantages are to prevent the life of diabetic patients. [1] The disadvantages are cross sectional nature of the study doesn't establish exposure and outcome

Peter D Milburn ACM(2015)

The purpose of the research is to develop a low-cost plantar sector system for capture human sole pressure. The main causes we're unusual high peak plantar pressure, gradient and shear. In this investigation, off-the-shelf pressure thin sheet sensor pads were assembled and calibrated [3]. It is useful in large precise pressure sensing system. Test result shows the suitable system for high quality pressure data. The advantage is it predict the acquired data displayed on the computer monitor and stored in further spacing. The disadvantage is it may cost high to display as a image.

SACCO Taylor Series (2018)

The patient with diabetic neuropathy can suffer by re-ulceration. The best method to study diabetic neuropathy would be long term longitudinal study to inspect the pressure supply during gait earlier and after ulcer creation. A short-term estimation is to relate two dissimilar groups of patients at dissimilar stages [4]. It is said that even with healed ulcers the patient with record of ulceration would still show altered distribution during walking. When comparing patients with latent ulceration. The advantages help to find out the factors of foot ulceration in both neurotic groups. The disadvantages are the development of neuropathy could not be explained clearly.
Kejiser Mexican Press (2015)

Kejisers shows that finding out the disease from could be inaccurate and difficult. Usually figuring out the disease is based on the doctor and equipment. Recently a model using convolution neutral network from a cooperative hospital achieved 98.36% accuracy. The demerit is that the data collected differs in people with and without anterior ligament deficiency. The future efforts would concentrate on lower limb diseases.

Nakajima (2018)

Nakajima k presented a system of identifying people by gait patterns. By that he divides people into two classes. Walking pattern and stepping pattern. The condition is that there must be less than 10 people walking in barefoot. It identifies pattern by sensors in floors. The result shows that both walking and stepping pattern is good enough to identify users and improves recognition accuracy. The software developed for extracting walking pattern are left foot extraction walking feature extraction.

Dr.D.Ganeshkumar

A Low Complexity and High Accuracy ECG Detection and Recording Based on Wavelet Transform was derived and elaborated

IOTT(2016)

IOTT said that grand reaction is from walking stress the soft tissue of the foot. It may cause ulceration. The study shows that how the variables are associated. Twenty subjects 12 male, and 8 female with diabetic mellitus, peripheral neuropathy, and plantar ulcer participated. Footwear and orthotic devices tested in the study reduced pressure and soft tissue draining at the second ray of the foot.

4. Block Diagram

This study investigates the forefoot load of diabetic patients using foot motion data. Regular walk quantities using wearable motion sensors appear feasible and safe also they are smaller and lighter. Regular walks of two diabetic patients were measured and examined. The sums of all consecutive steps did not occupy much of the recorded time of DMDI as he may travel by bus or train also. Consecutive steps not less than 30 seconds were also analyzed.

Operation

The designed smart insole will fetch the pressure from the patient foot and the controller is used for static and dynamic pressure characteristics whereas the voltage regulator act as power supply and wi-fi module as interface with IoT as shown in Figure 1. DMDI and DMDZ had Foot Load (FL) sensor grid in the insole at the rate of 1 per 5 steps and 1 of 2 steps respectively. The excessive FL occurred may be different due to difference in walking speed and properties of road surface. Industrialists should conduct future research on estimation of regular forefoot load of patients and examine the association between them. IoT platform can as a server to store the fetched foot pressure values and strydialzer app is created for a closed monitoring and surveillance.

Sensor Size

The sensor covers the risk area and estimate the peak pressure. The average pressure across the sensor can be obtained by dividing the total force by sensor area. Except the heel, other regions show strong peaks. Smaller sensors are not good as they underestimate the total force and can't able to receive the peak pressure. The total force is the sum of entirely forces in solo regions, whereas peak pressure can be found by selection extreme pressure from all sensors.

Pressure Areas

The large sensor's analysis may be a prominent assessment of the peak pressure. To relate the pressure circulation the sensor size, has to be analyzed from the reading for two insoles. Both large and small sensors are taken where the small sensor is covering the large sensor. Three small sensors covering MTI and Toe were placed. The peak pressure of the large sensor differs by the reading. Small sensors are the sum of the forces whereas peak pressure is the maximum force. IDE is published by GNU. It takes 30s, 25hz, 9.7% pressure instantaneous deviation is the major factor. Sole ensure accurate analysis and its result is almost 0.7. Snap shot converts patient's weight to pressure.

FSR

FSR changes when a force applied. Force sensing resistor are trademarks of interlink electronics.

Properties

FSR consists of conduct polymer which changes resistance to its surface. Sensing consists of both electrical conducting and non-conducting in matrix. These are micrometer size, reduce temperature improve mechanical properties and increase surface duration. As all resistive based sensors, FSR require simple interface. Compared to other the FSR has low cost and good shock resistance. FSR gets damaged if pressure applied for long time. Disadvantage is low precision, measurements differ 10% and more.
Electrical Characteristics
The electrical properties and specifications of the smart insole are given here under.
Working Voltage: 3.3V
Maximum IO Driving Power IMAX: 12 mA
Maximum IO Voltage Level VMAX: 3.6V
Current Consumption: 100mAmp.

Hardware Used
This module contains piezo-resistive force sensor and 6-axis inertial motion sensors. Battery used is Lithium ion (Li+). The insole's
1) Sensing -10Hz
2) Thickness 3mm
3) Pressure range – 30 to 1200Kpa
4) Power – 1 to 5V
5) Operating temperature – 20° to 60° C
6) Operating humidity – 10 to 90%
7) Weight – 50/pair
8) Size – 20cm to 31cm

5. Internet of Things
The internet of things is a hot topic in the industry for which Kelvin Ashton laid foundation and Gamble improved its business. The concept was simple but powerful. The objects were equipped with identifiers and wireless connectivity. These objects could communicate with each other and are managed by computers. IoT describes a system where items in physical world, and sensors within are connected to the internet. These sensors can use various types of local area connectivity and it can have wide area connectivity. The vision of IoT has expanded to connect everything from industrial equipment to everyday objects including living organisms [11]. It uses sensors for data collection. Connected objects will possess one or more sensors and provide new information. Each sensor will monitor a specific condition. IoT enabled objects will share information about their condition and the surrounding environment with people and machines. It can identify track and communicate with objects. IoT data differs from traditional computing in size and frequency in transmission. The number of devices that are connecting to the network are also greater [12]. Machine-machine communications and intelligence drawn from the devices will allow businesses to automate certain basic tasks. These attributes are used to collect a wide range of data but also provide challenge in data networking and security.

Need for Enabling IOT
IoT impacts every business. It will change the types of devices that connect into a company's systems. These devices will produce new types of data. IoT help business gain efficiency, harness intelligence from different equipments and improve operations and customer satisfaction. It will improve public safety, transportation and healthcare with better and faster communication of information. Communication, control and cost savings are three major benefits of IoT that will impact every business.

Enabling IOT
Each sensor produce a small amount of data. Firms must build a data collection from thousands to millions of sensors and analytics strategy that supports this new information in a scalable and cost efficient manner. Big data technology can give companies the ability to collect, store and analyze large volumes of IoT data. A company should always collect relevant data in cost efficient way.

6. Sensor Placement
The sensor placement has become crucial in the smart insole.
- Power supply is given and is stored in the lithium battery
- Connect insole with the trans-receiver.
- Observe the reading of pressure from the sensors.
- The pressures are noted down and viewed in the application
- The pressure reading noted on the application.

7. Results and Discussions

![Graph 1](https://via.placeholder.com/150)
(a) 4 large sensors

![Graph 2](https://via.placeholder.com/150)
(b) 6 small and 2 large sensors

Fig.2: FSR static and dynamic characteristics

The FSR static and dynamic characteristics of 4 large sensor grid and 6 small and 2 large networks are mapped are shown in the above Figure 2.

8. Conclusion
The most critical and expensive problem is foot complications. In recent times shoes and orthotic inserts are all used to control it. But there is no perfect method to determine on diabetic patients. The sensor architectural parameter receives peak pressure which results in size trade off.
9. Future Trends
A well designed and defined advanced thermal camera with better image quality is necessary for future processing. But it was not allowed due to strict regulations. Valid commanding and grammar for each code line in Android board is essential. Before downloading compiler catches and the flag, the syntax errors get generated. Sometimes there are message do hunts as their respective error was flagged. The fascinating way to remove the error is to understand the actual line by reading it. Skilled debugging has to takes place in future.

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