VOETZWEER DETECTION USING LABVIEW

N. Nithya Rani,
Assistant Professor,
Dept of EIE,
Sri Sairam Engineering College, Chennai.

P. Sumithra,
B.E Final year student,
Dept of EIE,
Sri Sairam Engineering College, Chennai.

R. Janani,
B.E Final year student,
Dept of EIE,
Sri Sairam Engineering College, Chennai.

R. Maheswari,
B.E Final year student,
Dept of EIE,
Sri Sairam Engineering College, Chennai.

K. Jayakrubha,
B.E Final year student,
Dept of EIE,
Sri Sairam Engineering
College, Chennai.

***Abstract*— "Voetzweer" means foot ulcer in Dutch language. Nowadays Diabetic foot ulcer is more common in neuropathy diabetic patients which occur due to lack of protective sensation from sensory neuropathy. The vascular complication in diabetic patient results in wound and nerve weakness in the foot. This leads to poor blood circulation to the foot due to which there is an increase in the pressure and temperature on the foot region. This may cause painful injury, trauma and severe infection may lead to lower limb amputation [1]. So prevention and early detection of foot ulceration are needed. Till date there are many research works happening to detect the foot ulcer in early stage, with pressure or temperature of the foot. The main aim of this project is to incorporate pressure, temperature and humidity sensors on the same foot which increases the accuracy of early detection. The signal from each sensor is given to Arduino for data acquisition and processing. Then voltage signal after amplification is given to the LabVIEW (the graphical programming environment) for real-time monitoring and representation of output. LCD screen and buzzer are included for displaying the message and alerting with a sound. If the values are within in normal ranges, LCD will display "Wow! your foot is healthier" and buzzer will be in off condition. If there is any abnormality detected then it will display "Oops! Foot Ulcer" and buzzer will alert with a sound.**

Keywords- Diabetic foot ulceration-Vascular complication-Amputation- Arduino interfacing - LabView.

I. INTRODUCTION

More than 50 million people have diabetics while considering the whole world and the occurrence of diabetes is more among those who are over the age group of 45-65. Diabetes mellitus is identified as a diseases associated with "sweet urine". Hyperglycemia leads to leakage of glucose in the urine, hence the name sweet urine. Insulin produced by the pancreas, controls the blood glucose level and keeps it low in the blood. There are three types of diabetics namely,

- **Type 1 diabetics**- failure to produce insulin
- **Type 2 diabetics**- cells fail to use insulin
- **Gestational diabetics**- high level of glucose during pregnancy.

The major complication of diabetes mellitus is Diabetic Foot Ulcer [DFU]. Poor blood circulation in foot and vascular complication leads to neuropathy problems. Due to which lack of protective sensation from the sensory neuropathy may occur that leads to trauma and results in ulcer. Foot ulceration occurs in 25% of the diabetic patients, in which 85% leads to lower limb amputation. There are many methods to detect foot ulcer like Monofilament test, Doppler test etc. But these are costlier and time consuming.

In proposed model, we have taken three parameters (pressure, temperature, humidity) of the foot into account. We have incorporate pressure, temperature and humidity sensors for earlier detection. With the help of 3-D Foot Print Device, planter foot pressure is measured for normal and diabetic patients with foot ulcer. The results show that foot pressure of the patients with peripheral neuropathy is 40% higher than the normal person's foot pressure [2]. Here we use Force Resistive Sensor (FSR) for foot pressure measurement and it gives the output in voltage values with respect to the pressure. When foot pressure is higher than the normalized pressure then there is a chance of foot ulceration. Lm35 sensor is used for the temperature measurement of the two foot and the difference between them is found. If the difference is in the range of 2.5 degree Celsius then there is a chance of getting ulceration and if temperature difference of 4.5 degree Celsius then it confirms the presence of foot ulceration [7]. Humidity sensor is use to check the moisture content of the foot. Normal humidity of a human being is in the range of 30-60% of relative humidity. The pressure, temperature and humidity of the foot of the patient are checked frequently and stored, which helps in confirmation of foot ulceration.

II. FOOT ULCER

Foot ulcer is generally considered as non-mechanical factors. Foot ulcer mainly occurs due to peripheral neuropathy, dry skin, or vascular problems. Normally even patients may not feel that they are having foot ulcer. Initially there may be itching, burning, swelling in the foot or some may notice a callus, rash, brown or redness and discoloration of the skin.

Foot ulcer may not be painful in diabetic patients with decreased nerve sensation lower leg, but when unnoticed this may lead to many problems. Foot ulcers often occur at the bottom or sides of the foot, due to which it go unnoticed and also can occur in toe [4]. Development of foot ulcer is indicated by drainage of fluid and foul odor from the foot. There are three types of foot ulcers namely,

- Diabetic or Neurotrophic ulcers
- Venous statis ulcers
- Ischemic or arterial ulcers

Diabetic ulcers are the most common foot problem which leads to lower limb amputation. This primarily occurs to the diabetic patients. The person having type 2 diabetics for long time may have a chance of foot ulceration.

Fig.1 Diabetic Foot ulcer

All patients with diabetes have chances of getting foot ulcers, due to multiple causes. Some factors that increases the risk of getting foot ulcers, including:

- Poor fitting shoes or poor quality shoes
- Poor hygiene
- Trimming of toe nails improperly
- Alcohol consumption
- Heart disease
- Kidney disease
- Obesity
- Use of tobacco (inhibits blood circulation)

Different stages of diabetic foot ulcer

Stage 1	No ulcer but foot is at risk
Stage 2	Presence of ulcer but not infected
Stage 3	Ulcer is deep in exposing joints and tendons
Stage 4	Extensive stage of ulcers and infected

Table.1 Diabetic foot ulcer stages

III. Diagnosis Methods

A. *Normal Blood Pressure Test*

This is the simple and easy test in diabetic foot ulcer diagnosis. In this test, we use Sphygmomanometer for blood pressure measurement. The systolic pressure of both right and left hands and the pressure in the foot ankle are measured. The variation in these pressures is an indication of abnormalities in foot.

B. *Monofilament test*

It is also a simple method but sensitive evaluation is needed as thin piece of plastic fiber is pressed against various parts of the sole of the foot and the patient's ability to feel varying pressure applied is assessed. Some doctors may keep tuning fork at the bottoms of the foot to check the whether it senses the vibration. Electromyography (EMG) is taken by inserting thin needles into the muscles to measure the electric impulses which also a diagnostic method. But the latter methods are painful. So monofilament test is the effective one.

C. *Sensitometer*

In this technique, vibration sensation in the foot of the patient is checked. Vibration Pressure Threshold (VPT) is fixed in the system. At this threshold value patient should feel the vibration else there are some issues with the foot.

D. *Doppler test*

This test is performed to check the flow of blood in foot region. Here we use a gel which is spread on the foot area. Then the device is moved over the foot area and the blood flow in the foot is recognized by a sound. If there is a region with no blood flow then device would not produce sound.

IV. Literature Review

According to International Diabetes Federation (IDF), in India, larger number of people suffers from diabetes that is around 40.9 million people as per Diabetes Atlas2006 and is expected to reach 69.9 million by 2025 [8]. All diabetic patients have chances of getting foot ulcer and when unnoticed this may lead to amputation. Therefore monitoring of foot tissues and early detection and relieving the foot ulcer in patients are important. Foot ulcer affects 30% of diabetic persons older than 40 years. Foot ulcer is worrisome itself and also more feared because it may lead to limb amputation.

Many techniques are available for analyzing plantar pressure of the foot. Main proposed techniques that are useful for the analysis of plantar pressures, Hams Mat and Tekscan. But these two systems lack repeatability and consistency that create difficulties for the physician in determining precise pressure areas of the foot where the pressure is dangerously high. Many techniques involving image processing were proposed considering only one parameter i.e. temperature. In this method they compare the image of both the foot and the temperature difference in both the foot would indicate the chances of foot ulcer. Disadvantage of this method is that image processing requires more time and is not cost effective.

A wireless electronic orthotics called Electronic Orthotics Shoe was introduced for prevention ulceration and it is a lightweight embedded system containing non-invasive sensors. Diabetic patients those who suffer from peripheral neuropathy can use this shoe [3]. The main challenge in this system is interpretation of data and pattern classification procedures. Cost of this system was not affordable by all patients.

Many scholars and companies involved in discovering new methods and products for early detection of diabetic foot ulcer. There are many diagnostic methods available in hospitals like monofilament test, sensitometer, Doppler method etc but these methods also requires more time and there are many disadvantages in each method.

V. BLOCK DIAGRAM

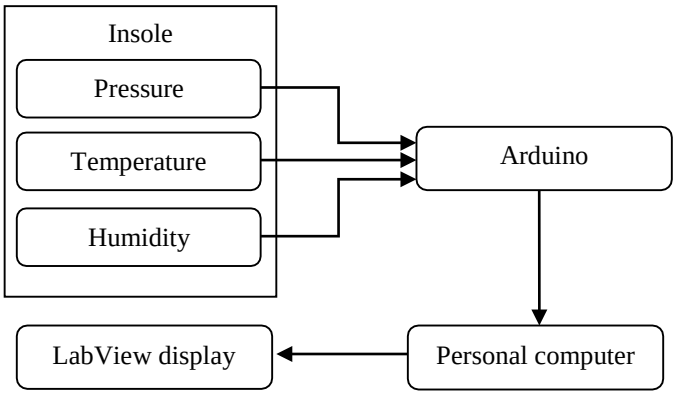

Fig.2 Block diagram of the whole setup

Data signals from pressure, temperature, humidity sensors are given to the Arduino mega 2560 board. Arduino board is used for data acquisition and processing. Personal computer is connected to the board using USB cable. Arduino is interfaced with the LabView. After creating the program for this process, the program is made to run continuously such that three parameters are shown in the indicator. If the parameters valves exceed the normal person's values, then it can be concluded that there is a chance of occurrence of foot ulcer.

VI. SYSTEM COMPONENTS

A. *Sensors*

- Force sensing resistor (FSR)

It is a thick film polymer sensor where resistance decreases when there is an increase in the applied force to the active surface of the sensor. The two major operating principles in FSR are: percolation and quantum tunneling. The FSR mainly consists of two membranes which are separated by a thin air gap. One of the membranes has two set of interdigitated fingers and it is separated electrically. FSR ink is coated in the other membrane. When the FSR sensor is pressed, FSR ink in the membrane, shorts the two traces depending on applied force with corresponding change in resistance. Here we use two model of FSR i.e. model 400 and 406 series.

- Temperature sensor

Lm35 is an integrated temperature sensor which gives a voltage output which corresponding to Centigrade temperature. It is manufactured such that it operates over 55°C to 150°C temperature range.

It operates from 4 V to 30V. It gives more accurate values when compared to thermistor and it also does not require any external calibration. These characteristics make it more comfortable to use.

- Humidity sensor

HR202 is the humidity sensor which is made up of organic polymer materials. It has stable performance and has better humidity sensing range. It has an operating range of 20-95% RH. It is used in the medical field.

B. *Arduino uno*

Arduino Uno is a microcontroller board which consists of ATmega328P .It consists of 14 digital I/O pins and 6 analog inputs. It has a power jack, a USB connection, quartz crystal, a reset button and an ICSP header.

C. *LabView*

LabView (Laboratory Virtual Instrument Engineering Workbench) is a graphical based programming language which is used as a tool to achieve the goals and it was developed by national instruments. Because of its graphical nature makes it useful for Test and Measurements, instrumentation control, Automation, data analysis applications and Data acquisition. It has two windows namely front panel block diagram. In Front panel, we can place knobs, indicators etc for indicating the pressure, temperature and various parameters. The input from patients is interfaced to lab view with help of Arduino.

VII. SENSORS PLACEMENT AND WORKING

Here we totally use seven sensors,

- 4 FSR sensors (two 400 series and two 406 series)
- 2 temperature sensors
- One humidity sensor

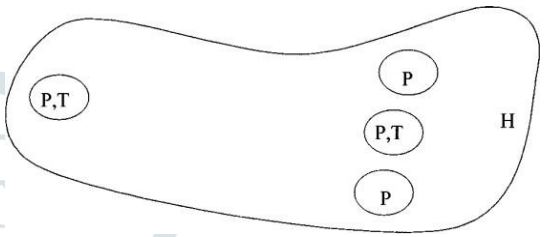

Fig.3 Placement of sensors

Pressure sensors are placed under three metatarsal heads and the heel. Temperature sensors are placed under the heel and under the 3rd metatarsal head. The humidity sensor is placed at the toe of the shoe. The outputs of these sensors would be in voltages. These voltage signals are given to the Arduino board's analog pins. As LabView is interfaced with the Arduino board, the outputs of the sensors are represented graphically. Output values are compared against the normal constant values (pressure, temperature, humidity) of normal persons. If they exceed the constants then the led light glows indicating that there is a chance of getting an ulcer.

VIII. LABVIEW PROGRAM

A. LabView Arduino interface

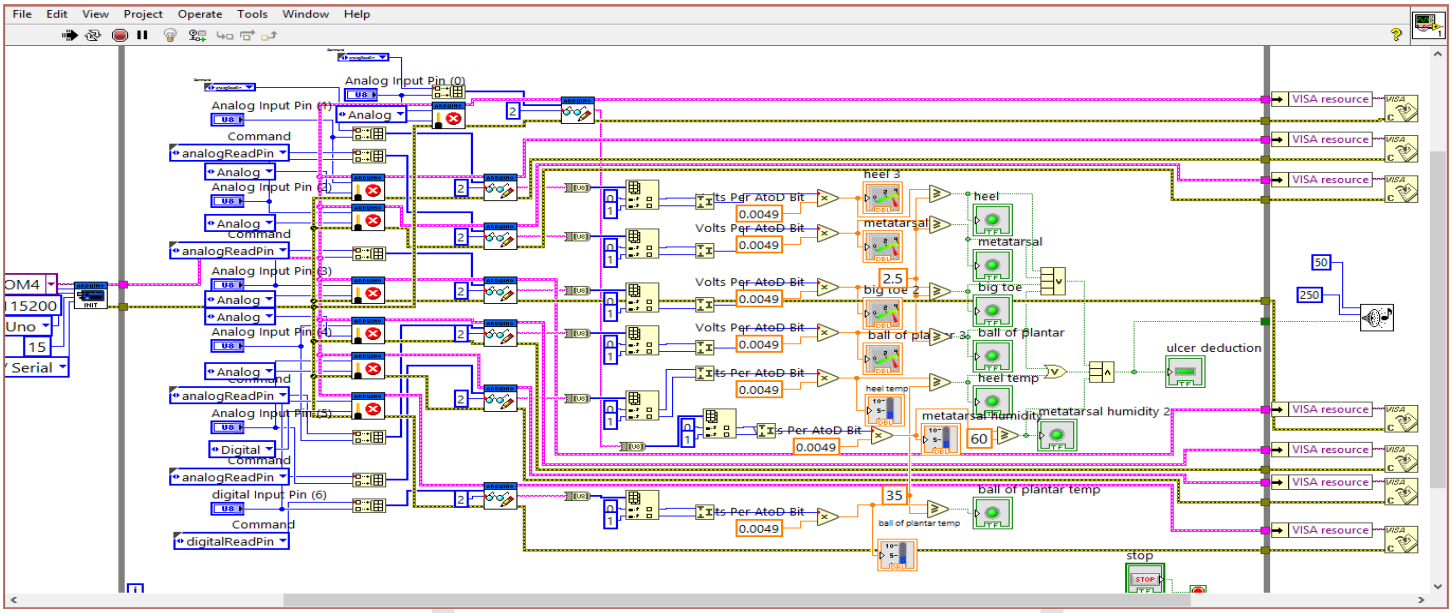

Fig.4 LabVIEW-Arduino interface program

LabView is interfaced with the Arduino mega 2560 by downloading "LabView Interface for Arduino" from VI manager. In LabView 'Init' block used to acquire the date signals from the Arduino. In 'Init' block requires five parameter namely baud rate, port number, board type, bytes/packet and connection type. Baud rate means the speed of data transmission, and it is the value derived based on the number of symbols that is transmitted per second.

Baud = (Gross Bit Rate / Number of Bits per Symbol) When we interface the Arduino with LabView it is connected to a specific port. That port number is given here. In board type, name of the board is give. Here the board name is mega 2560. Bytes/packet is 115200 and the connection type is USB.

B. Proposal work

In previous works they have incorporated either pressure or temperature sensor for detection of foot ulcer. In the proposed model, we have incorporated pressure, temperature and humidity sensors to improve the accuracy of detection. Normal peak pressure of non-diabetic persons is considered as the reference valve. With the reference value of pressure, the patient's foot pressure is compared. If it exceeds, then there is a chance of foot ulcer. Difference in temperature of the foot in various regions indicates that there is a chance of foot ulcer. Normal humidity of a human being is in the range of 30-60% of relative humidity.

C. LCD interface

In the proposed model we have included LCD display for displaying the message with respect to the values of the three parameters. If the values are within in normal ranges, LCD has to display "Wow!, your foot is healthier". If there are any abnormalities detected then it should display "Oops!!!, Foot Ulcer".

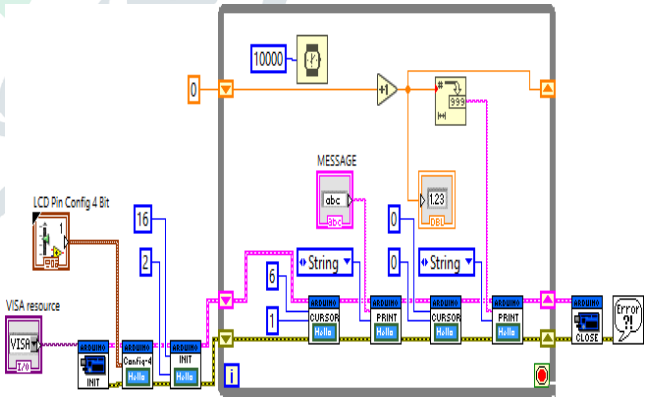

Fig.5 LCD display program

IX. LABVIEW PROGRAM

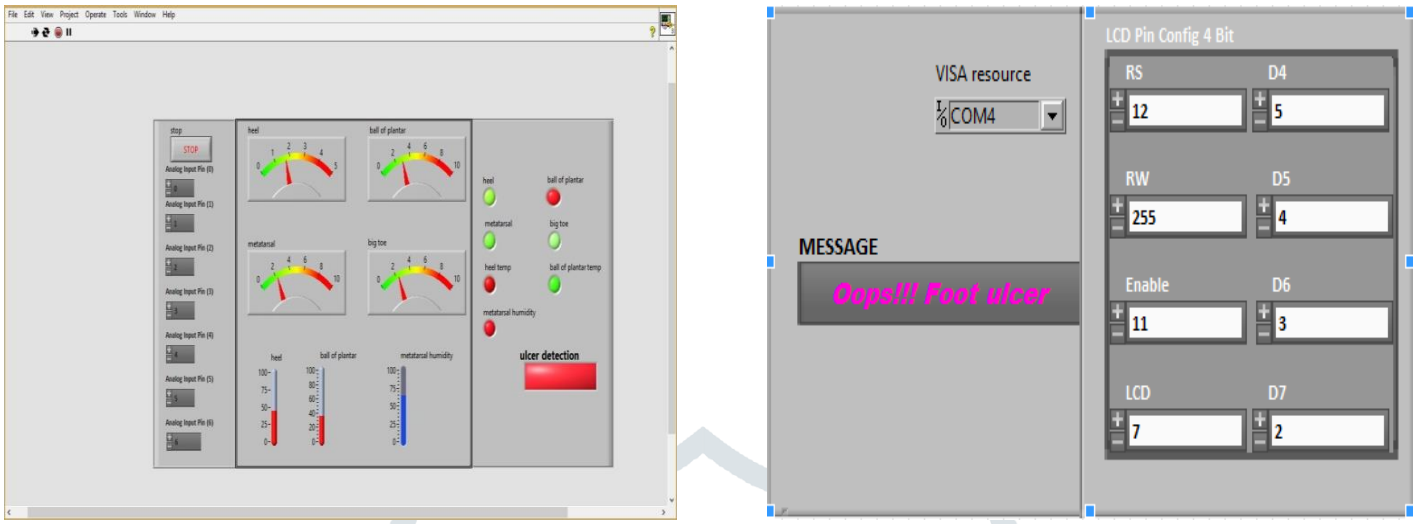

Fig.6 Front panel

Left side panel shows the parameters values of the patient and the right side panel shows the LCD program's front panel. Here we have tested with a diabetic patient. So after checking the data with the normal values and it finds that there is chance of getting foot ulcer. So it shows the message "Oops!!! Foot ulcer" in the front panel display and also in LCD screen and buzzer will alert with a sound.

VII. CONCLUSION

Till now projects and researches are done with considering either pressure or temperature. In our project, by considering three parameters (pressure, temperature, humidity) of the foot, we have tried to increase the accuracy in early detection of foot ulcer in diabetic patients. Our future work includes displaying percentage of occurrence of foot ulcer in a LCD display and to transmit these data to the doctor's mobile.

REFERENCES

[1] A.N.Nithya,R.Premkumar,S.Dhivya,M.Vennila,2013,"RealTime Foot Pressure Measurement For Early Detection Of Ulcer Formation In Diabetic Patient, using LabView", International conference On Design And Manufacturing, 1302-1309.

[2] V.Rameshkumar, K.Murugadas Pandian, B.N.Vinoth, Diabetic Foot Pressure Monitoring System , IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 01, 2015.

[3] Robert E. Morley, Jr.*, Senior Member, Edward J. Richter, Joseph W. Klaesner, Katrina S. Maluf, Michael J. Mueller, "In-Shoe Multisensory Data Acquisition System," IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 48, NO. 7, JULY 2001.

[4] Diabetic Foot Pressure Monitoring System, IJSRD - International Journal for Scientific Research &Development|, Vol. 3, Issue 01, 2015.

[5] http://www.cmj.org/viewimage.asp?img=ChinMedJ_2015_128_24_3283_171394_b2

[6] Anwar S. Benbakhti, Samir Boukhenous, Cherif Zizoua and Mokhtar Attari , An Instrumented Shoe for Ambulatory Prevention of Diabetic Foot Ulceration, Laboratory of Instrumentation, LINS, Faculty of Electronics and Computers USTHB, BP.32, El-Alia, 16111 Bab-Ezzouar, Algiers, ALGERIA.

[7] Anke M Wijlens, Samantha Holloway, Sicco A Bus & Jaap J van Netten, "An explorative study on the validity of various definitions of a 2·2∘C temperature threshold as warning signal for impending diabetic foot ulceration", International Wound Journal ISSN 1742-4801.

[8] Ashu Rastogi, Anil Bhansali, "Diabetic Foot Infection: An Indian Scenario", The Journal of foot and ankle Surgery (Asia-Pacific), July-December 2016; 3(2):71-79.

[9] Sarah Ostadabbas, Adnan Saeed, Mehrdad Nourani, "Sensor Architectural Trade off for Diabetic Foot Ulcer Monitoring", 34th Annual International Conference of the IEEE EMBS San Diego, California USA.

[10] S. Krishna Priya, A.N.Nithyaa, R.PremKumar, "Screening Of Foot Ulceration in Diabetic Neuropathy Patients Using Flexi Force Sensor Platform", International Journal of Scientific & Engineering Research, Volume 5, Issue 4, April-2014 87,ISSN 2229-5518.

[11] Abdul Hadi Abdul Razak , Aladin Zayegh , Rezaul K. Begg and Yufridin Wahab, Foot Plantar Pressure Measurement System: A Review, sensors ISSN 1424-8220.

[12] http://www.cmj.org/viewimage.asp?img=ChinMedJ_2015_128_24_3283_171394_b2.

[13] Dmitry Yudovsky, Aksone Nouvong, and Laurent Pilon 2010Evaluation of Diabetic Foot Ulcer Development using Hyperspectral Imaging IEEE transaction on image processing.

[14] John Essick, Hands on Introduction to LabView for Scientists and Engineers,OxfordUniversity.