



## EARLY DETECTION OF DIABETIC FOOT DISORDER BY CALCULATING FOOT TEMPERATURE USING RASPBERRY PI

<sup>1</sup>Monali D. Rathod, <sup>2</sup>Ramesh R. Manza, <sup>3</sup>Deepali D. Rathod, <sup>4</sup>Ganga Bedke

<sup>1</sup>PhD Student, <sup>2</sup>Professor, <sup>3</sup>PhD student, <sup>4</sup>PhD student

<sup>1</sup>Department of Computer science and Information technology,

<sup>1</sup>Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India

**Abstract:** Day by day number of diabetic patients are increases rapidly. In diabetes ulcer is the major problem. Once the ulcer is occurred it cannot be cured easily. If ulcer detected in early stage then it can be cured easily. But many people does not go for their regular medical check-up may be they have panic of injections or maybe they does not afford the hospital/pathological test fees. For avoiding this problem we are working on this device which is totally non-invasive, cost effective device. This device working on calculating foot temperature. In diabetic peripheral neuropathy changing foot temperature is the major symptom.so for detection of diabetic ulcer this device calculate the foot temperature with the help of DS18B20 temperature sensors

**Index Terms – Diabetes, Diabetic Peripheral Neuropathy, Ulcer, Foot Temperature, Temperature sensors, Raspberry pi.**

### I. INTRODUCTION

Diabetes can occur when your blood sugar level or blood glucose is increases. Diabetic neuropathy is one of the major problems in the diabetes [1]. Nerves are damage due to the diabetes is called as diabetic neuropathy. Diabetic neuropathy is the short form of the diabetic peripheral neuropathy. In diabetic peripheral neuropathy, nerve damage in the peripheral nervous system. Peripheral neuropathy firstly affects the feet and leg, followed by hands and arm. The common symptom of peripheral neuropathy is, it increases the temperature of feet uncertainly [2][3]. When the temperature of particular area in foot is increases continuously for 6-7 days that time there is a chance of ulcer. In diabetes the main causes of ulceration is diabetic neuropathy. Uncontrolled diabetes can affects nerves, kidneys, eyes, heart and feet, in those foot complications is one of the serious problem. In diabetes patients near about 50% patients are get admitted because of the complications of foot [4]. There are ten points which are firstly affected by the ulcer. The following figure shows the main ten areas which are mostly affected due to the ulcer [5]

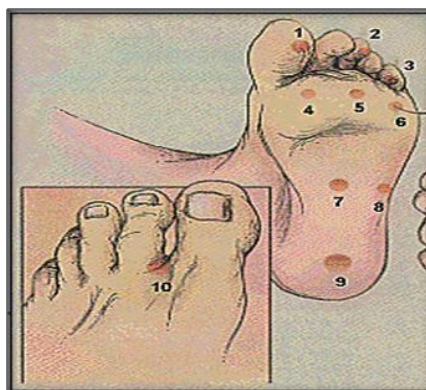


Figure 1.1: Ten points which are mainly affected due to the diabetic ulcer

The main aim of this project is to monitoring the real time temperature of foot in a cost effective way. Here for monitoring foot temperature raspberry pi 3 b+ model is used. For Programming language Python is used. To calculate temperature DS18B20 temperature sensors are used. Sensors are connected to raspberry pi by using a jumper wires.

## II. LITERATURE SURVEY

Luay Fraiwan et. Al has worked on diabetic foot ulcer on thermal images, they said the temperature of feet on different location shows difference of  $2.2^{\circ}\text{C}$  means there is chances of diabetic ulcer [6].

H.Maldonado et. Al has worked on diabetic foot ulcer with the help of thermography images .According to their work, when temperature differences in foot sole zones is greater than  $2.2^{\circ}\text{C}$  it means it has a chances of ulceration[7].

H. Peregrina-Barreto et al. has worked on diabetic feet for early detection of abnormal area. Thermography technique is used for this work. According to their work if the temperature between both feet's is more than  $2.2^{\circ}\text{C}$  ,that time it will be consider as abnormal [8].

Adam L Isaac et.al has work on diabetic foot. They have calculated the foot temperature of six different points, they conclude the temperature difference between two points of same foot is more than  $2.2^{\circ}\text{C}$  then the subject have a chance of ulceration[9].

Amanda L Killeen et.al has work on diabetic foot temperature, according to their work when Persistent localized temperature differences exceeding  $1.75^{\circ}\text{C}$  between the left and right feet prompted the clinical staff to call the patient to collect subjective history for further triage [10].

## III. WORKING OF SYSTEM

Following fig. Shows the working of system,

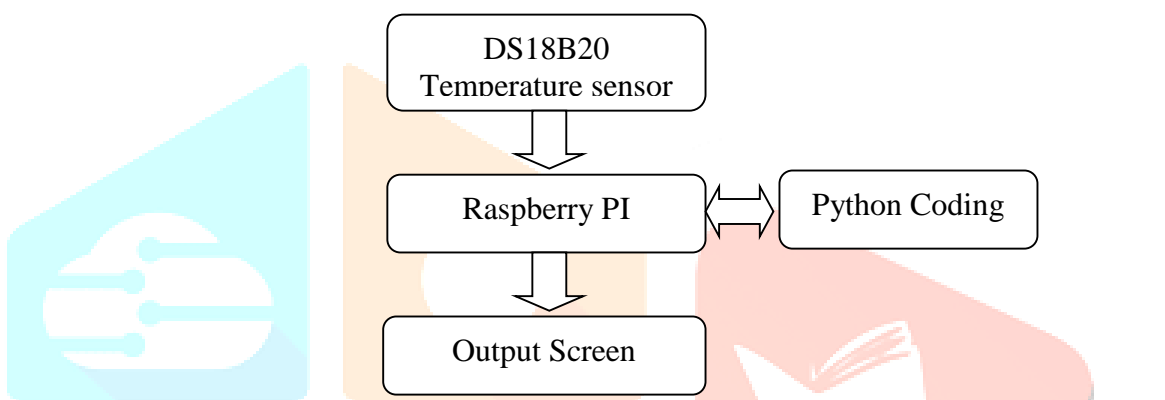


Fig3.1: Working of System

### 3.2Raspberry pi

- Raspberry pi is a small single board computer.
- Size wise Raspberry pi look like ATM card or a credit card,
- Linux OS used in raspberry pi
- Operating system of a Raspberry Pi supports like python programming languages.
- Sensors and other devices can be direct connecting to the raspberry pi [12].



Fig.3.2.2: Raspberry PI

### 3.3 Python

Python is very easy and powerful programming language. it is very easy to use with raspberry pi for connect your work to the real world[13]. There are a number of Python IDEs are by default installed in the raspbian, but in that official Python 3 IDLE is simplest one to use [14].

- **Software/ Hardware Requirement**

Software:

- OS -raspbian-stretch
- Python

Hardware:

- Raspberry pi 3 b+
- 3.2 inch LCD Display
- DS18B20 Temperature sensor
- 5v charger
- Breadboard
- Jumper wires
- Mouse
- Keyboard
- 4.7 k ohm resistor

## IV. DATABASE COLLECTING METHOD

For this work there are total 30 volunteers of two groups,

- First group of diabetic peripheral neuropathy subjects and
- Second group of non-diabetic peripheral neuropathy subjects

At the time of data collection there is a certain requirements,

- Subject must be removing their foot cloths like socks and shoes.
- Before calculating a foot temperature subject should be seated in a relax position of 10-15 min for making their body temperature constant
- At the time of calculating temperature subject must be in ideal position

Limitation of database:

At the time of database collection we not maintained any room temperature

Using a slipper which is attached with DS18B20 temperature sensors we collect the data. For data collection total ten sensors used. Five sensors are attached to Right slipper which take the foot temperature of right foot and five sensors are attached on left slipper take the foot temperature of left foot.

Following figure shows the ten points of foot from which foot temperature collected,



Fig.4.1: Ten points of feet from which we collect the temperature

At the time of database collection it necessary to subject to remove their foot wear and foot cloth and then put there feet's on slipper which is attached with a ten ds18b20 temperature sensors. After 5-6 min system get a constant reading of feet temperature which is seen on LED screen. According to this reading this subject have diabetic peripheral neuropathy or non- diabetic peripheral neuropathy

is decided, and if the subject have diabetic peripheral neuropathy then next step will be to find this subject have a chances of ulceration or not. If there is chances of ulceration then with the help of this 10 temperature sensors it try to find exact which area will be affect due to ulcer.

Following figure shows position of feet at the time of database collection.



Fig 4.2: system shows the foot temperature of the subject

#### IV. FLOW CHART

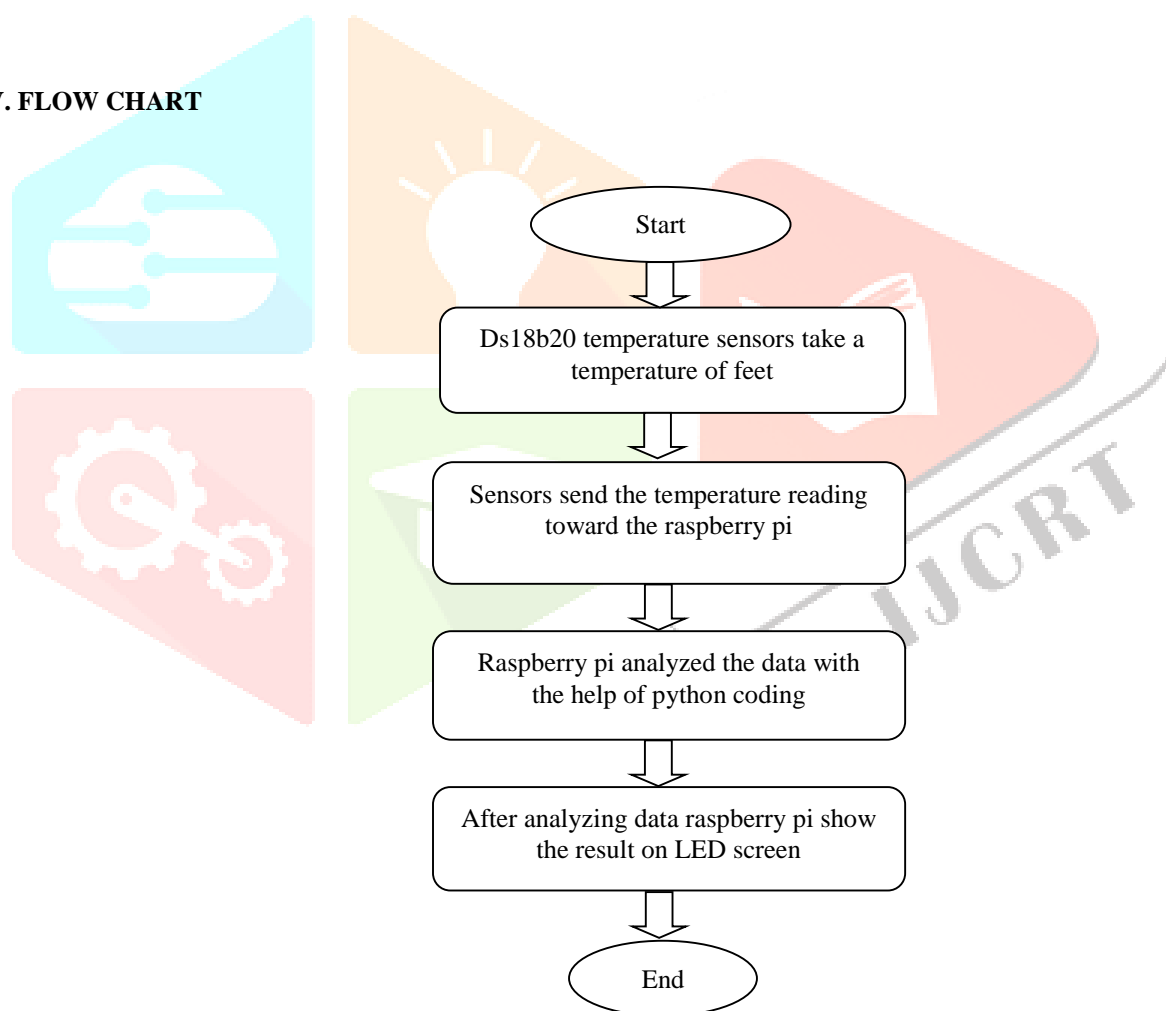


Fig 4.3: Flow chart of system

First system take a foot temperature of subjects with the help of DS18B20 temperature sensors. Then sensors send the foot temperature reading toward the raspberry pi. Then raspberry pi analyze the data by using python coding language. After analyzing the data raspberry pi show the result on LED screen.

## V. METHODOLOGY

### Detection of Diabetic Ulcer

To detect ulcer first of all check the foot temperature of this diabetic patient and if there is temperature difference between both left and right foot are more than 2.2 °C then this diabetic person have a chances of ulcer. After knowing the chances of ulceration, the next stage will be to detect the exact area of ulceration. For calculate the temperature of different areas of foot ds18b20 temperature sensors are used, and if any area will affect due to ulcer that time this particular area will show the higher temperature as compare to their surrounding areas. For more accuracy check the foot temperature continually for 6-7 days.

## VI. RESULTS

At the time of data collection, first of all system checked the room temperature with the help of ds18b20 sensors which is attached on the slipper, after sometime when the system shows the constant reading of room temperature subject will be put there foot on the slipper, after sometimes system get the constant readings of the foot temperature.

Hear total ten ds18b20 temperature sensors are used for taking a feet temperature, 5 sensors for left foot and 5 sensors for right foot.

Following table 1 shows the result of diabetic peripheral neuropathy subject

Table 5.1. Result of diabetic peripheral neuropathy subject

	Right Foot	Left Foot
Temperature of Sensor 1	31.4°C	33.5°C
Temperature of Sensor 2	31.5°C	32.9°C
Temperature of Sensor 3	31.0°C	33.5°C
Temperature of Sensor 4	32.1°C	33.6°C
Temperature of Sensor 5	31.0°C	<b>34.5°C</b>

Following table.2 shows the result of non- diabetic peripheral neuropathy subject

Table 5.2. Result of non-diabetic peripheral neuropathy subject

	Right Foot	Left Foot
Temperature of Sensor 1	27.5°C	28.01°C
Temperature of Sensor 2	27.6°C	27.8°C
Temperature of Sensor 3	28.01°C	27.2°C
Temperature of Sensor 4	27.4°C	27.2°C
Temperature of Sensor 5	28.2.5°C	28.3°C

According to table 1 and table 2, when temperature of foot is between 27-30 °C then the subject is non-diabetic peripheral neuropathy and when temperature is between 32-35°C then the subject is diabetic peripheral neuropathy.

Table 1 shows foot temperature of subject is between 32-35°C, means this subject is a diabetic peripheral neuropathy patient. The temperature difference between right foot and left foot is more than 2.2 °C means that diabetic patient have chances of ulceration. Temperature of sensor 5<sup>th</sup> of left foot is very high according to their surrounding areas. 5<sup>th</sup> sensor calculate the temperature of heel area it means this patient have a chances of ulceration on their heel area of left foot.

Table 2 shows the foot temperature of subject is 31-32 °C . It means this subject is non diabetic peripheral neuropathy.

## VII. CONCLUSION

In diabetic the major problem is an ulceration, once the ulcer is occurs then it's difficult to cure. If the diabetes detect in early stage then ulceration problem can avoid. So avoiding this problem daily self-monitoring of diabetics is necessary. These device is self-monitoring so there is no need to go any were, this device is totally non-invasive technique so there is no need to inject any needle in our body, and it is cost effective, these device is easy to used, there is not required any deep knowledge for handling it so any one can use it easily.

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