Research Article

Patient skin temperature monitor over internet of things

Abstract

This paper emphasizes more on the technical details of monitoring Patient's Core Body Temperature continuously without any intervention. This can be done by measuring Patient's Skin (Surface) temperature by attaching temperature sensing probe to patient's skin. The work is basically realized based on Internet - Of - Things (IoT) over Wi-Fi using ESP8266–ESP12 Module which allows user to monitor patient Skin Temperature Online and also give indication of Hypothermia and Hyperthermia Offline for alerting patient attendant.

Keywords: ESP12, body core temperature, arduino 1.6.5 IDE, temperature sensors

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Introduction

Skin temperature monitoring is not the accurate way for measuring Core Body Temperature, as it varies according to ambient temperature, but still gives a fair estimate of Body Core Temperature. Body temperature can be measured from many locations on your body. The mouth, ear, armpit, and rectum are the most commonly used places. Temperature can also be measured on your forehead. An abnormally low body temperature (hypothermia) can be serious, even life-threatening. Low body temperature may occur from cold exposure, shock, alcohol or drug abuse. Keeping in mind the importance of measuring the body temperature, we need to be precise over this activity.[1]

Designated PCB is designed internally and fabricated and the temperature sensor is incorporated in it. Conversion of Body temperature from the raw analog values are handled properly using DSP algorithm so that proper sampling is done and data fetched is correct. Body Temperature is remotely sent over internet falling under the category of Internet of Things-IOT. For this real-time scenario we take one digital temperature sensor, interfaced to a Wi-Fi module to send live data to a remote location anywhere in the world over internet.[2,3]

Platform overview and specifications

This Device is designed around ESP8266–ESP12 Wi-Fi Module operating on 3.3V power Supply and programmed through Arduino IDE. (Figures 1–4)
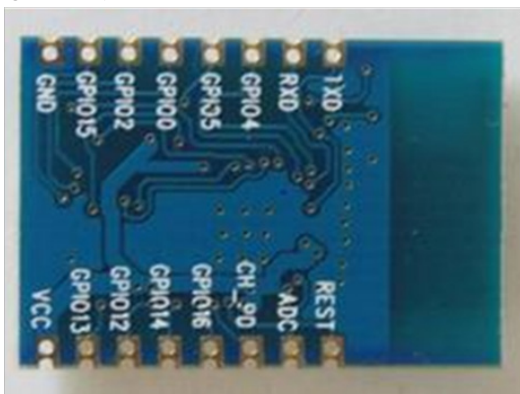

Figure 2 Wi-Fi module.

Figure 3 Wi-Fi module pin overview.
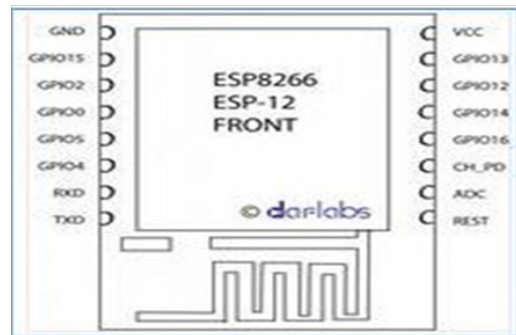

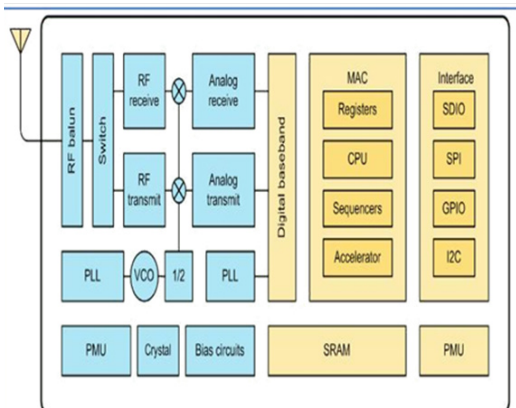**Figure 1** Wi-Fi module PCB overview.

Figure 4 Controller overview.

Component description

Power Supply & other related accessories:

a. One 230-5 V DC adapter

b. One -Regulator IC LM-1117 (For 3.3v regulated output)

c. One micro USB connector

d. Two Capacitors (10 micro farad)

e. One Red LED with 680 Ohm resistor to indicate 3.3V regulator output OK.

Switches:

a. One Buzzer Mute switch with 10k ohm resistance and 0.1 µF ceramic Capacitor to avoid debouncing.

b. One Reset switch with 10k ohm resistance and 0.1 µF ceramic Capacitor to avoid debouncing.

ESP programming connector:

ESP programmed with Arduino IDE using UART serial Communication on 3.3v logic.

ESP8266 Module: ESP8266 ESP12 is 16 pin Module with one ADC pin.

Display & Alarm:

a. One GREEN LED with 680 Ohm resistor to indicate Wi-Fi Connected/Normal Temperature.

b. One RED LED with 680 Ohm resistor to indicate Hyperthermia.

c. One YELLOW LED with 680 Ohm resistor to indicate Hypothermia.

d. Buzzer to indicate abnormal temperature triggered with BC547 Transistor.

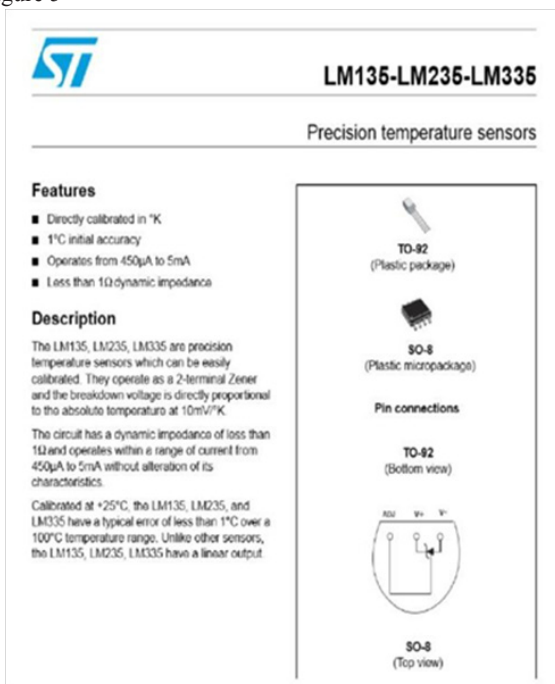**Temperature sensor LM235 IC:**

Figure 5

Figure 5 Temperature sensor overview.

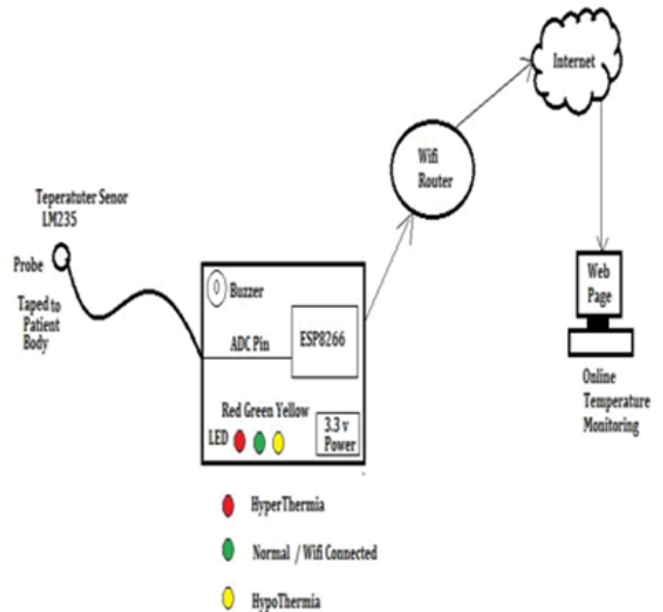**Block diagram:**

Figure 6

Figure 6 System overview.

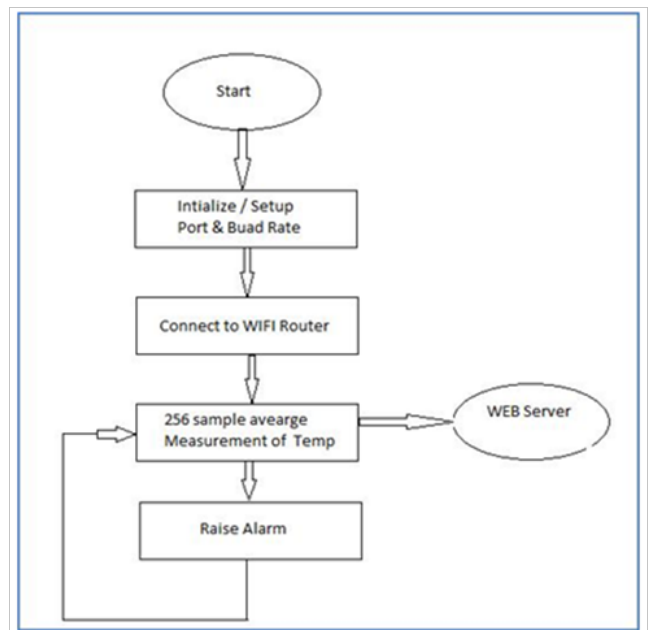**Software implementation flow:**

Figure 7

Figure 7 Implementation flow.

On Power ON this device will try to connect to the configured Wi-Fi network with fixed Local IP 192.168.1.150 and service Port number 80. If connected successfully the GREEN Led will initially blink 3 times before going stable; otherwise device will operate in Offline Mode (Table 1).

In Online Mode when device is connected with Wi-Fi network, the GREEN LED will start blinking when data is requested from device.

This device acts as a webserver in online mode and can be accessed directly through any web browser with IP address or configured DNS name (nsittemp.ddns.net).[4–6]

Table 1 It shows the range when device is connected in wi-fi network

Condition	Range	Green	Red	Yellow	Buzzer
After 2mins of reading	Centigrade	LED	LED	LED	
Normal skin temperature	33 to 35°C	On	Off	Off	Off
Hypothermia	< 32.5°C	Off	Off	On	Beep
Hyperthermia	>35.5°C	Off	On	Off	Beep

Limitation for estimating core body temperature by measuring skin temperature:

Figure 8, 9

Count of sensors needed for measurement:

Figure 10

Circuit diagram:

Figure 11
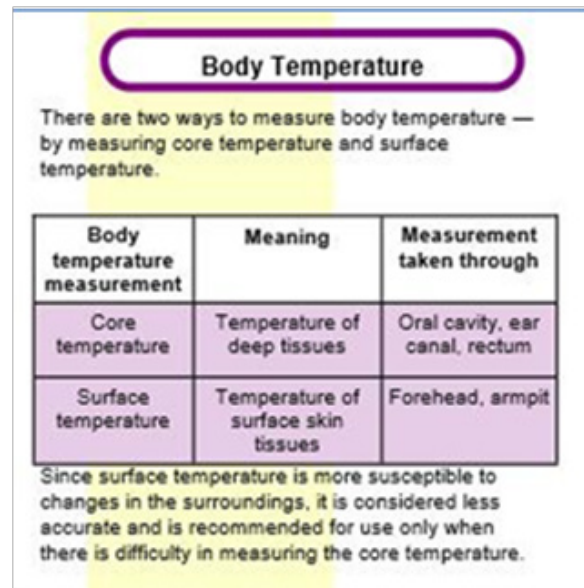
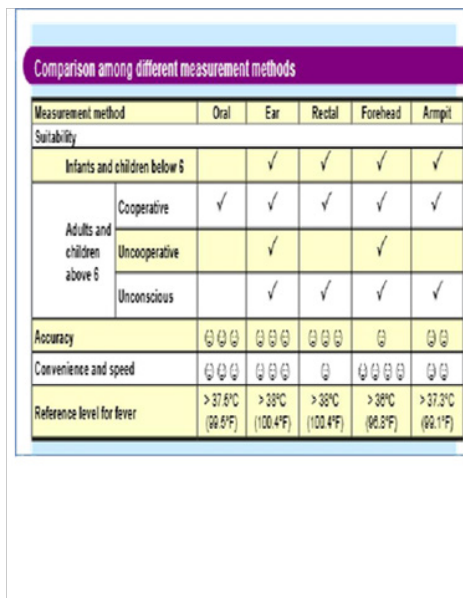**Figure 8** Measurement strategy.

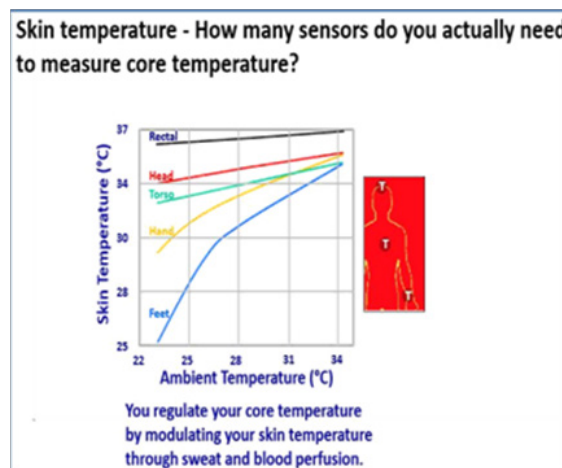**Figure 9** Comparison between methods.
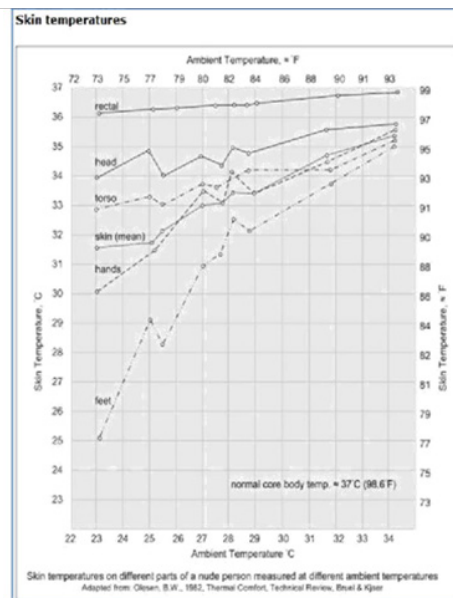
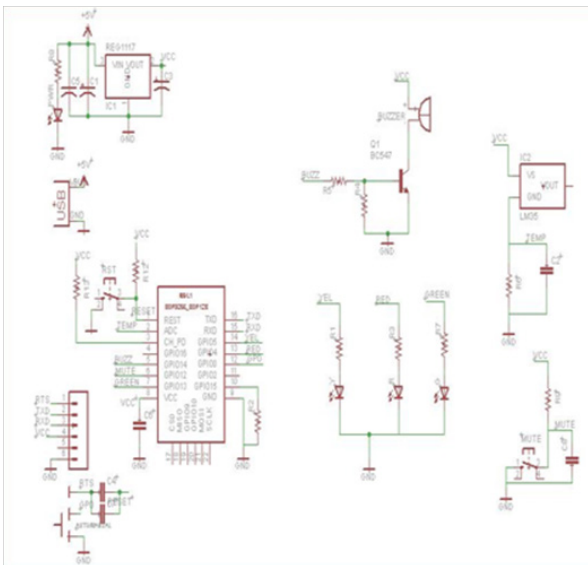**Figure 10** Skin temperature Vs ambient temperature.

Figure11 Circuit details.
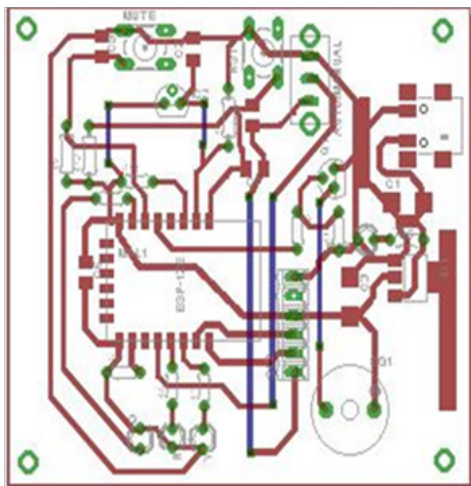
Layout:

Figure 12
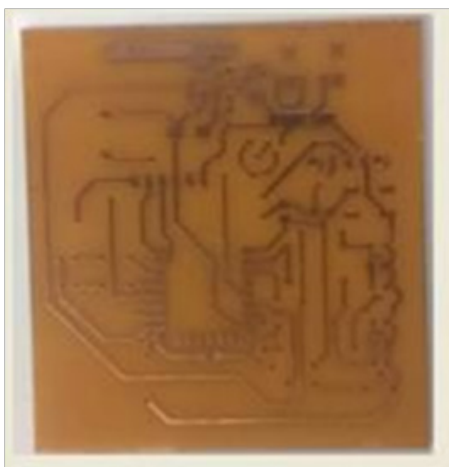

Figure 12 PCB schematic.

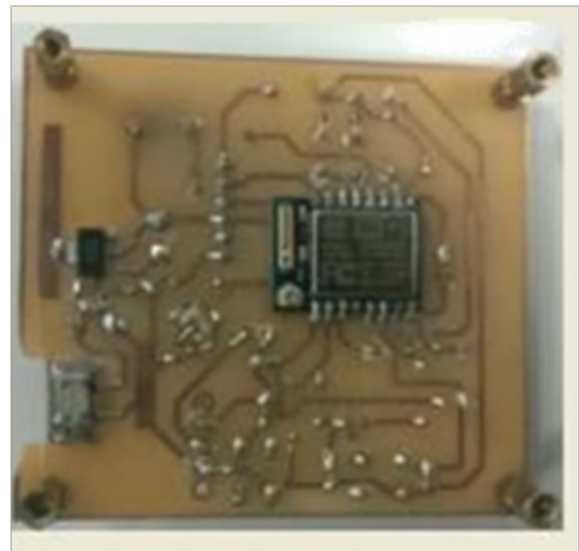**Figure13** PCB imprinted.

Device view:

Figures 13–16

Figure 14 PCB with components added1.
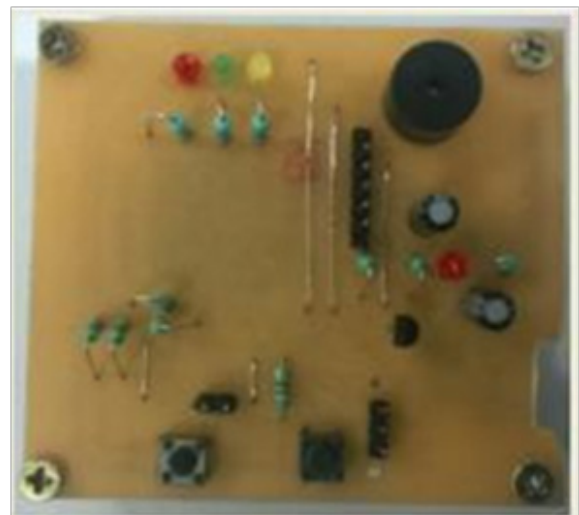
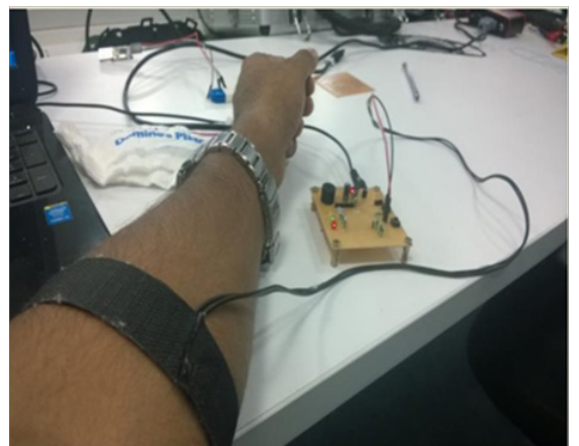**Figure 15** PCB with components added2.

Figure 16 Overall working system.

Acknowledgments

Conflicts of interest

Author declares that there are no conflicts.

References

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