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PREECLAMPSIA RISK MONITORING AND ALERT SYSTEM USING IOT

Banu Sundareswari M[1], Nirmalvel S[2], Lokesh S[3], Manikandan V[4], Pranav Sajesh S[5]

Assistant Professor, Instrumentation and Control Engineering, Saranathan College of Engineering, Trichy, India[1]

Student, Instrumentation and Control Engineering, Saranathan College of Engineering, Trichy, India[2-5]

Abstract: Preeclampsia is a pregnancy complication characterized by high blood pressure and signs of damage to another organ system, most often the liver and kidneys. Preeclampsia usually begins after 20 weeks of pregnancy in women whose blood pressure had been normal. Initially, we have to monitor the heartbeat rate, temperature, and blood pressure of pregnant women. Using the previous outcomes of preeclampsia results and machine learning which is used to predict possible outcomes and predict preeclampsia. And we are going to monitor blood pressure and if there is a sudden change be monitored and intimated.The data are stored in a cloud device IoT.

Keywords: HB sensor, Temperature sensor, BP sensor, Machine Learning

1. INTRODUCTION:

The 24-hour ambulatory blood pressure monitoring system was based on Internet of Things architectures, and is comprised of the following components:Users: there are two users involved in the system - the expectant mother and the caregiver. It consists of a BP sensor, Temperature sensor, HB sensor, Arduino, IoT, Machine Learning. Expectant mother's Smartphone: after the F1 smart wristwatch reads the real-time data, the data is then sent to the mother's smartphone that is connected to the smart band via Bluetooth connectivity. The smartphone has a blood pressure monitoring mobile application installed on it and is developed specifically for expectant mothers.Blood Pressure Monitoring Mobile Application: This mobile application consists of two modules: Expectant Mother and Caregiver modules.

Antenatal blood pressure measurements between 20 and 36 weeks' gestation contribute to the prediction of pre-eclampsia and its associated adverse outcomes.[1]

The study aimed to assess the difference in blood pressure readings between the standard and large cuff and to determine if such a difference applies over a range of arm circumferences in pregnancy.[2]

The study showed a rising trend in the incidence of pre-eclampsia over the years, though the overall prevalence was 1.2%. A little less than half of the women were nulliparous and majority had caesarean delivery.[3]

A device that can monitor the blood pressure is a smart bracelet that incorporates a pressure sensor along the wrist for continuous recording of blood pressure values. This enables the prediction of the emergency disorders using a decision support system.[4]

The reduction of maternal mortality as is envisaged by the SDG Number 3 will require concerted efforts by multiple stakeholders, addressing different dimensions of the challenge, and using a variety of processes and technologies.[5]

The classic definition of HTN is based on office blood pressure (BP) measurements, and most data relating HTN to cardiovascular morbidity and mortality are derived from office measurements.[6]

2. BLOCK DIAGRAM OF BLOOD PRESSURE MONITORING FOR PREECLAMPSIA MANAGEMENT:

The block diagram of blood pressure monitoring for preeclampsia Management is shown below

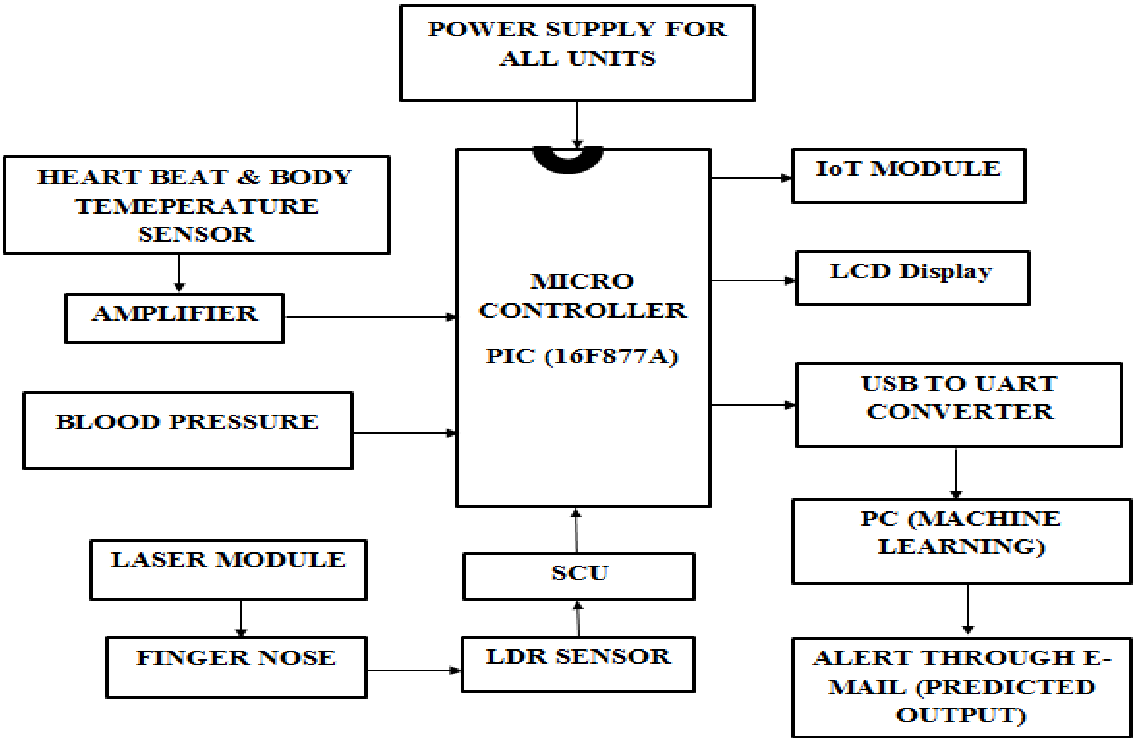

Fig 2.1 Block diagram of the system

3. HARDWARE DESCRIPTION:

3.1 HEARTBEAT SENSOR:

The basic heartbeat sensor consists of a light-emitting diode and a detector like a light detecting resistor or a photodiode. The heartbeat pulses cause a variation in the flow of blood to different regions of the body. When tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in the form of an electrical signal and is proportional to the heartbeat rate.

This signal is a DC signal relating to the tissues and the blood volume and the AC component synchronous with the heartbeat and caused by pulsatile changes in arterial blood volume is superimposed on the DC signal. Thus the major requirement is to isolate that AC component as it is of prime importance.
Manual Way: Heartbeat can be checked manually by checking one's pulses at two locations- the wrist (the radial pulse) and the neck (carotid pulse). The procedure is to place the two fingers (index and middle finger) on the wrist (or neck below the windpipe) and count the number of pulses for 30 seconds and then multiply that number by 2 to get the heartbeat rate. However, pressure should be applied minimum and also fingers should be moved up and down till the pulse is felt.
Using a sensor: Heart Beat can be measured based on optical power variation as light is scattered or absorbed during its path through the blood as the heartbeat changes.

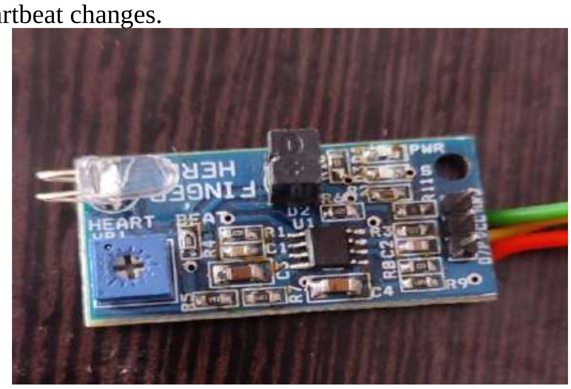

Fig 3.1.1 Block diagram of the Heartbeat Sensor.

3.2TEMPERATURE SENSOR:

LM35 is a temperature sensor that outputs an analog signal which is proportional to the instantaneous temperature. The output voltage can easily be interpreted to obtain a temperature reading in Celsius. The advantage of lm35 over thermistor is it does not require any external calibration. The coating also protects it from self-heating. Low cost (approximately $0.95) and greater accuracy make it popular among hobbyists, DIY circuit makers, and students. Many low-end products take advantage of low cost, and greater accuracy and used LM35 in their products

the working principle of LM35 temperature sensor we have to understand the linear scale factor. In the features of LM35, it is given to be +10 mills volt per degree centigrade. It means that with an increase in output of 10 mills volt by the shoutout pin the temperature value increases by one. For example, if the sensor is outputting 100 mill volt at v out pin the temperature in centigrade will be 10-degree centigrade. The same goes for the negative temperature reading. If the sensor is outputting -100 mills volt the temperature will be -10 degrees Celsius.

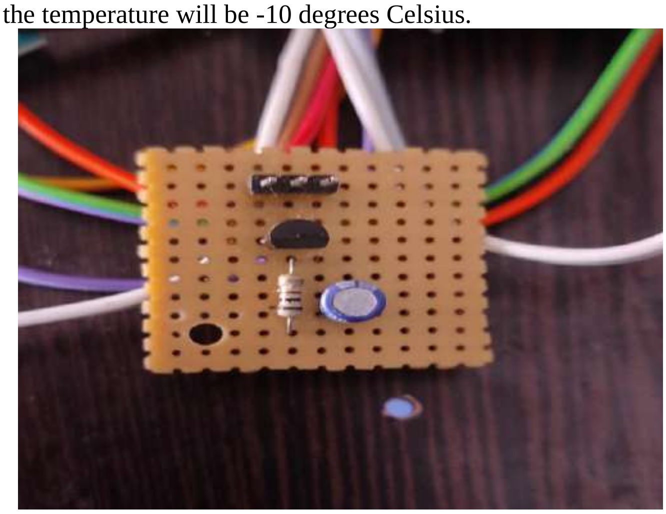

Fig 4.2.1Temperature Sensor**.**

3.3 BLOOD GLUCOSE SENSOR(Using LDR and Laser):

The technology is based on the scattering property which has a direct effect on glucose. This includes passing red laser light through the finger and the amount of light present on the other side of the finger is measured. The presence of glucose blocks the light from passing through the finger. The blood glucose present can be measured by analyzing the variations present in the light intensity striking laser light can possibly reflect, refract, absorb, scatter and transmit depending upon the nature of the light. Wavelengths of laser light from 500 nm to 1200 nm are generated using LEDs of 1.5-watt power (Po) and the generated laser light is passed through the human finger. The transmitted light through the human finger is measured as a ratio between the output power (P)at the phototransistor and the power (Po) when laser light directly falls on the phototransistor when there is no human finger inserted in the RLBGM. The transmittance is converted into OD by using and the absorbance can be estimated. OD measures the throughput of the human finger whereas OD is directly related to the transmittance.

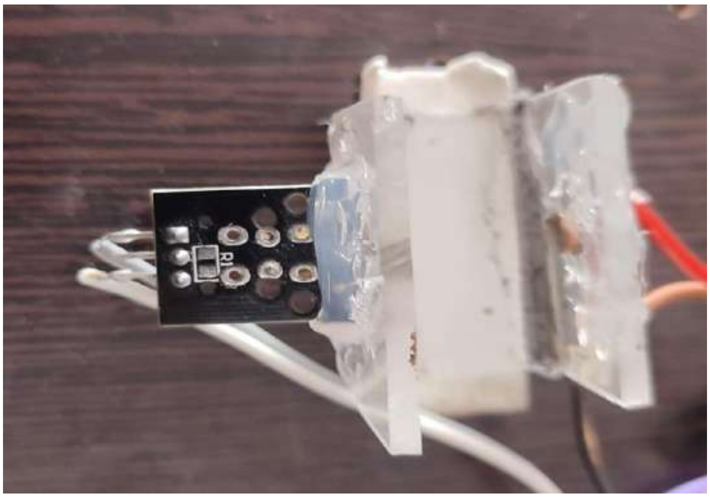

Fig 3.3.1 Blood Glucose Sensor.

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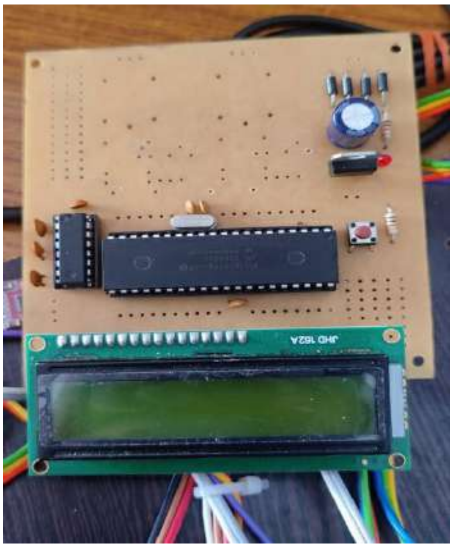
3.4 PERIPHERAL INTERFACE CONTROLLER (PIC16F877A):

The PIC microcontroller PIC16F877A is one of the most renowned microcontrollers in the industry. This microcontroller is very convenient to use, and the coding or programming of this controller is also easier. One of the main advantages is that it can be write-erase as many times as possible because it uses FLASH memory technology. It has a total number of 40 pins and there are 33 pins for input and output. PIC16F877A is used in many pic microcontroller projects. PIC16F877A also has much application in digital electronics circuits.

PIC16f877a finds its applications in a huge number of devices. It is used in remote sensors, security and safety devices, home automation, and many industrial instruments. An EEPROM is also featured in it which makes it possible to store some of the information permanently like transmitter codes and receiver frequencies and some other related data. The cost of this controller is low and its handling is also easy.



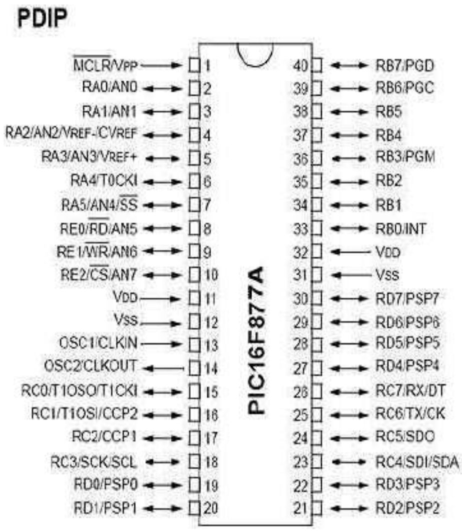


Fig 3.4.1 PIC Fig 3.4.2 PIC PIN DIAGRAM

3.5 NODE MCU:

The NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the “computer” on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a TensilicaXtensa LX106 core, widely used in IoT applications

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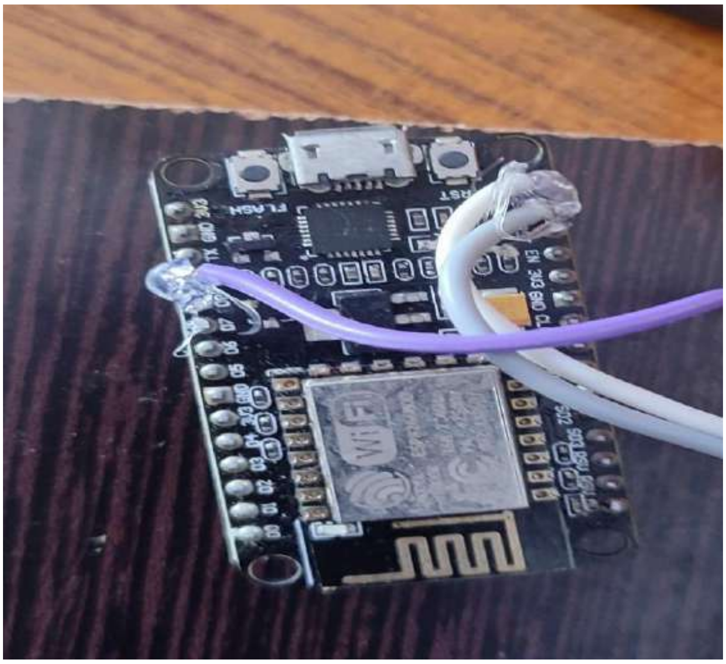

Fig 3.5.1 Node MCU

3.6 ZIGBEE:

Zigbee is a low-cost[citation needed], low-power, wireless mesh network standard targeted at battery-powered devices in wireless control and monitoring applications. Zigbee delivers low-latency communication. Zigbee chips are typically integrated with radios and with microcontrollers. Zigbee operates in the industrial, scientific, and medical (ISM) radio bands: 2.4 GHz in most jurisdictions worldwide; though some devices also use 784 MHz in China, 868 MHz in Europe, and 915 MHz in the US and Australia, however even those regions and countries still use 2.4 GHz for most commercial Zigbee devices for home use. Data rates vary from 20 kbit/s (868 MHz band) to 250 kbit/s (2.4 GHz band).

Zigbee builds on the physical layer and media access control defined in IEEE standard 802.15.4 for low-rate wireless personal area networks (WPANs). The specification includes four additional key components: network layer, application layer, Zigbee Device Objects (ZDOs) and manufacturer-defined application objects. ZDOs are responsible for some tasks, including keeping track of device roles, managing requests to join a network, as well as device discovery and security.

Fig 3.6.1 Zigbee

3.7 BP SENSOR:

Blood Pressure (BP) is one of the important vital signs. It is the pressure exerted by the circulating blood on the walls of blood vessels. Blood Pressure is expressed as the ratio of the systolic pressure over diastolic pressure. A Mercury sphygmomanometer is being used for measuring blood pressure. In this, the height of the column of mercury is considered for measuring the blood pressure. The oscillometric method is used for automated blood pressure measurements since 1981. With the advance in technology devices for measuring blood pressure through the non-invasive oscillometric method are being developed. One such device is the Blood Pressure Sensor.

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In an automatic Blood Pressure measurement system, instead of mercury a pressure sensor is used to detect the pressure in the artery and give output. This digital output is displayed on the monitor. This monitor has an onboard processor to process the output given by the pressure sensor, record results, and display them on the digital read-out screen. This sensor is very important for High Blood Pressure patients, as it is also available as an 'at-home' solid-state Blood Pressure Monitor. This system is portable. It is easy to carry and operate and highly useful in remote areas where medical facilities are not available.
The main sensing element of this system is the pressure sensor present in the chuff. For an accurate and reliable measurement, this pressure sensor should be carefully selected.

Fig 3.7.1 BP Sensor

4. SOFTWARE DESCRIPTION:

4.1 MP LAB IDE:

MPLAB is software in which we write a programming code for PIC Microcontroller. It is a compiler that compiles the code and then creates its hex file, which we later upload in our microcontroller. I have explained this thing before in Getting Started with PIC Microcontroller. Now before going any further, we will first have a look at how to install MPLAB software in Windows. So in this tutorial, I will explain step by step the whole process of installing MPLAB. MPLAB supports assembly language, which we are not gonna learn in this class so, after installing the MPLAB software we also have to install the MPLAB C compiler, which we will install in the coming tutorial, so first install thisMPLABsoftwareand then move to the next tutorial to install C compiler. Using embedded C Language we have coded in MP Lab software.

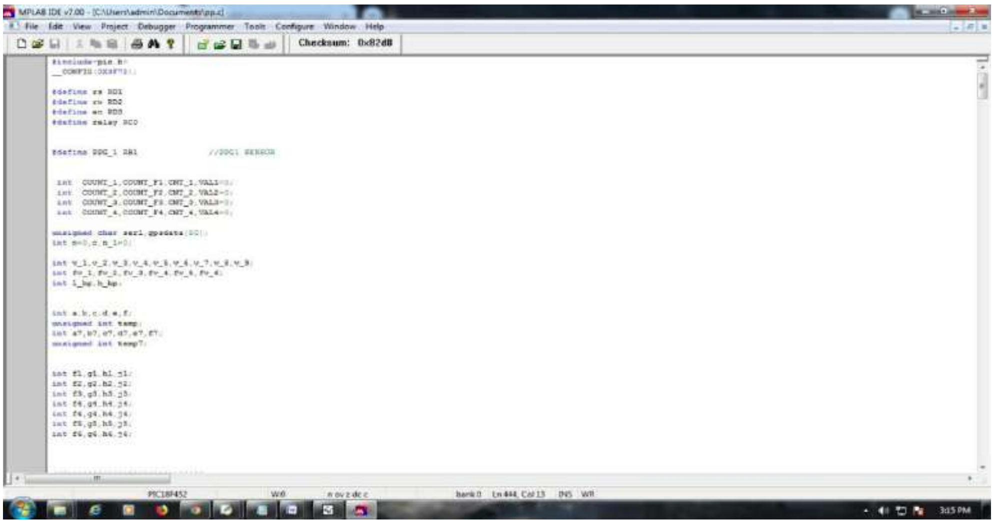

Fig 4.1.1 MP Lab Software(Embedded C Language)

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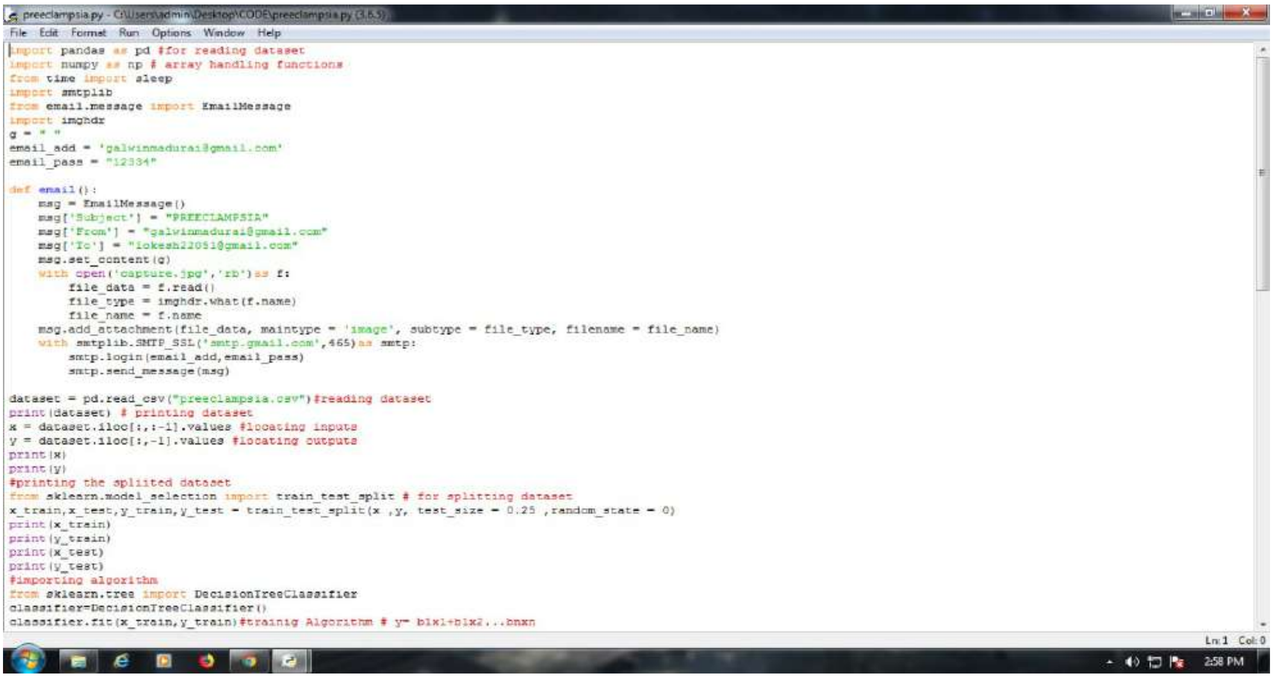
4.2 PYTHON IDE SOFTWARE:

Python is a high-level, interpreted, general-purpose programming language. Its design philosophy emphasizes code readability with the use of significant indentation. Python is dynamically-typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly procedural), object-oriented and functional programming. It is often described as a "batteries included" language due to its comprehensive standard library.



```
import pandas as pd #for reading dataset
import numpy as np # array handling functions
from time import sleep
import smtplib
from email.message import EmailMessage
import imghdr
g = " "
email_add = 'galwinmadurai@gmail.com'
email_pass = "12334"

def email():
    msg = EmailMessage()
    msg['Subject'] = "PREECLAMPSIA"
    msg['From'] = "galwinmadurai@gmail.com"
    msg['To'] = "lokesh22051@gmail.com"
    msg.set_content(g)
    with open('capture.jpg','rb')as f:
        file_data = f.read()
        file_type = imghdr.what(f.name)
        file_name = f.name
    msg.add_attachment(file_data, maintype = 'image', subtype = file_type, filename = file_name)
    with smtplib.SMTP_SSL('smtp.gmail.com',465)as smtp:
        smtp.login(email_add,email_pass)
        smtp.send_message(msg)

dataset = pd.read_csv("preeclampsia.csv")#reading dataset
print(dataset) # printing dataset
x = dataset.iloc[:,:-1].values #locating inputs
y = dataset.iloc[:,-1].values #locating outputs
print(x)
print(y)
#printing the splitted dataset
from sklearn.model_selection import train_test_split # for splitting dataset
x_train,x_test,y_train,y_test = train_test_split(x ,y, test_size = 0.25 ,random_state = 0)
print(x_train)
print(y_train)
print(x_test)
print(y_test)
#importing algorithm
from sklearn.tree import DecisionTreeClassifier
classifier=DecisionTreeClassifier()
classifier.fit(x_train,y_train)#trainig Algorithm # y= b1x1+b1x2...bnxn
```

Fig 4.2.1Python IDE(Machine Learning)

5. EXPERIMENTAL SETUP / HARDWARE PROTOTYPE

The below figure depicts the hardware prototype that has been developed to realize the proposed methodology. The tests were conducted using the below experimental setup

Fig 5.1 Experimental Setup

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6. RESULT

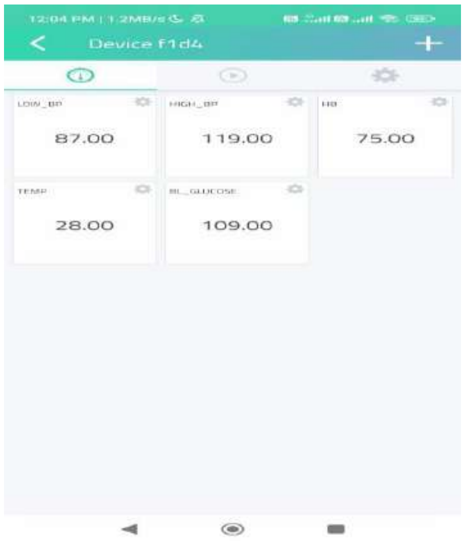

Fig 5.1 Real-time output in IoT

- In this paper we have developed a basic proof of concept of a system that is intended to perform continuous health monitoring of pregnant women in a non-invasive manner by using their bio-signals.
- In a nutshell, preeclampsia is a major issue that occur during pregnancy which may lead to maternal death or infant loss. So, to reduce the health loss from this disease, there is a need to continue health assessment of the pregnant woman.
- This study proposed an E-healthcare system for a pregnant woman to capture the blood pressure level of the woman and generate the required alert according to the situation.
- The proposed system is divided into four layers DAL, DPML, CL, and APPL. These layers are responsible to perform different functions and are responsible to provide the services to the other layers.

7. CONCLUSION

- A set of indicators relevant to the preeclampsia diagnostics was formulated and substantiated.
- It includes both the results of instrumental tests and quality indicators reflecting the subjective pregnant woman's health state.
- Information about indicators changing, collected during the monitoring will improve the accuracy of diagnosis and can be used to assess the risk of preeclampsia.
- The purpose of monitoring, while preserving the diagnostic value of the results obtained.
- The principles of constructing an algorithm for preeclampsia detection using a system of long-term remote monitoring are formulated. Fundamental is the principle of using existing medical protocols, which will significantly increase the physician's loyalty and will be one of the key advantages in implementing the system into medical practice.

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