Patient Remote Monitoring System using IOT and ML.

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ABSTRACT

The advancement of the Internet of Things (IoT) technology plays a major role in developing the health sector by making it much more reachable and desirable. The integration of IoT-cloud can play a vital purpose in the smart healthcare by offering deep understanding the healthcare content to support inexpensive and standard person care. Hence the combination of IoT and cloud helps in the betterment of quality of patient health care on a regular base integrated, processed the patient-data. Many physical devices capture transmit data, and provides data to various interoperability methods in IoT. The basic functionalities of IoT is for storage, display and communicate the information. Hence the e-Health monitoring system with IoT is adapted for distant patient monitoring on a continual basis and aggregated, analyzed the data. It can bring about a massive positive transformation in the field of eSmarthealth management for the rural or urban patients. This may help the people who wants or having good opinion on the technology diagnosis. This system can bring enormous variation in the Digital based health maintenance for patients. The Patient Remote Monitoring System involves a LM35 (temperature sensor),MAX-2000(Blood Pressure sensor),MAX30100(Oxygen level sensor),SEN11574(Pulse rate sensor) and ESP32 bit microcontroller to collect the biotic parameters from the patient's body and transmit the data to the Thingspeak via ESP8266 Wi-Fi module and that can be accessed by the doctor from the remote location for diagnosis and medication.

Keyword –*Internet of things, sensors ,health sector, ESP8266, Thingspeak.*

1. INTRODUCTION

Internet of Things (IOT) is a network of devices that are capable of exchanging data with other devices within the system or over the Internet. In recent years, if we take into account the fastest growing technologies in wireless communication, then IoT will be in top positions. Devices can always be connected to the real word using IOT. The examples for real time IOT applications are environment monitoring, smart manufacturing, healthcare, transportation etc. In present days, post-operative patients or elderly patients or any other other patients need to be monitored constantly. When patients are monitored in their homes, they might lack in getting correct medications because their caregiver might make delay in understanding the situation that there might be wrong in the patient's health condition which might result in some problems. Inorder to check the patient's health conditions, we need to consider various parameters like temperature, pulse rate, blood pressure, Oxygen level in blood, etc. To get these data, we need to use multiple devices for each of the health parameters. If the working people need to have their health-checkup, it will be a time-consuming process. Due to this, they tend to postpone their regular health checkups. So, to overcome these problems, an IOT based patient remote monitoring system has been developed using which the patient's health can be remotely observed. This proposed system will have a single device which has been designed and developed by incorporating all the sensors including the LM35 sensor(temperature sensor), SEN11574 sensor(pulse-rate sensor), MAX-2000(blood pressure sensor). These sensors will collect biological behaviors of patients and then it will be transferred to the cloud. These stored data will be analyzed, processed and then through these data's, the proposed system can identify critical status of the patient’s health. Mobile Application will be developed which continuously streams these data in the graphical form as well as numerical value. The mobile application will be used by doctors and patients. The system will alert the doctor by sending notification to his mobile app when it detects the critical condition of the patient. In this proposed system, we are also predicting the recovery rate of the patient using the Machine Learning algorithm in real time.

2. LITERATURE SURVEY

Rahman [1] checked up ECG signals by using a single lead heart monitor(AD8232) ,temperature sensor ,Raspberry Pi , Arduino Uno.The data then collected and saved in the cloud using ThingSpeak.And data can be accessed by the users. If there is any variation with optimal value the message is sent to the saved individual .Data can be retrieved from mobile locations and on any mobile devices.
Swamy’s [2] is based on the monitoring of the patient using the novel Iot system with the help of Temperature sensor, oxygen saturation (SpO2) measurement sensor,Blood Pressure sensor, Arduino ,Bluetooth ,and APP technologies or techniques.
Warsi [3] set up using sphygmomanometer attached with arduino which transfer its data to server using the wifi module by connecting the thermometer ,electric-cardiogram sensor.The servers then enumerate the data which can be shown on mobile devices.Supposing the readings are above the optimal range the the alerts will be sent to the user of the application.
Uddin [4] mainly focused on monitoring the patients on icu. Hence they came up with the Mobile application and Website and data stored in thinger.io cloud will be streamed in mobile app in real time . Graphical representation is done using it.
Mathew [5]is IoT rooted real time patient monitoring and scanning using Raspberry Pi with sensors affix to the patient and pass on wirelessly to websites and includes [1].
Bose’s [6] dual objective was focused and IOT based on an MPM system with an effective SVM algorithm was modelled and tested with an email alerting system.

3. MANIFESTO

Our manifesto is established approaching routine of retrieving patient health related values from sensors connected to a device and granting this particulars to the cloud-Service for the motive of repository, transform, and dissemination using Thingspeak cloud and ESP32. The Fig. 2 interprets the suggested imitation. The system involves four main components: sensors, Esp32, Thingspeak-server, and Operators. These sensors are connected to ESP32 which looks through data from the sensor connected to ESP32 microcontroller and dispatches it to a Thingspeak-server. The Thingspeak-server additionally processes composed data and provides it to discrete users like the Thingspeak-cloudService,operators to distinguish and observe health problems.

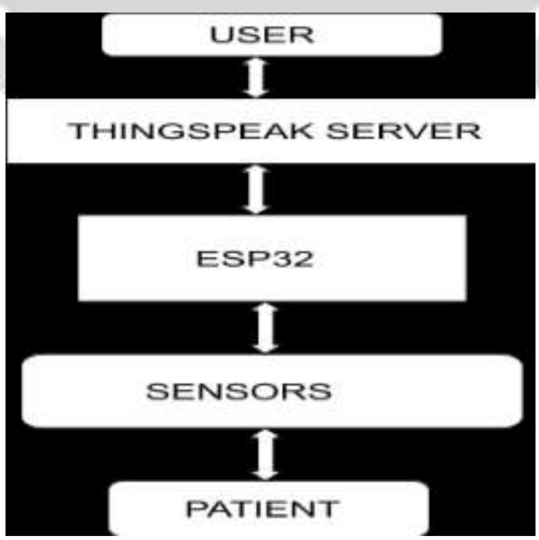

Fig-1: proposed model for IoT result in Healthcare framework.

We use the LM35(temperatureSensor), (SEN11574)PulseRate sensor, MAX-2000(bloodPressuresensor) ,MAX30100(Oxygen-l evel sensor) in order to observe the patient's body Data Values.Sensors start sensing.Then we will set the threshold values for heart beat and temperature. If the value exceeds the threshold value then it will give an indication of abnormality. The patient must be sent to hospital. In order to sort out this set of circumstances, we narrate the outline of ESP32 microcontroller for efficient performance in a health monitoring system. ESP32 is 32-bit microcontroller,provides low power & connectivity ,wifi & bluetooth for low energy consumption and Low power system on chip(SOC),clock speed of ESP32 can be controlled independently . ESP32 has dual core processor,one is application cpu which handles code and another is protocol cpu which handles wifi and indicative peripheral for A2D controller and D2A controller .Below mentioned are the traits of suggested imitation:(i).Collection of health data : In order to determine the health status of a patient, we need to consider various health parameters and instead of using different devices for the collection of data, this single IOT device will collect real time and accurate data.(ii).Analyzing the data : The data collected will be stored in the cloud.The variations in the data for specific duration can be plotted as graphs.This graph helps the doctor to analyze the patient's responsiveness to the medication.(iii).Prediction of recovery rate: After Analyzing the data, we can predict the recovery rate of the Patient accurately in real-time using Machine-Learning Algorithm considering the dataset.

LM35 Temperature sensor we are using, in which we get the analog output and we are setting the operating voltage to 5Volts.The formula to calculate the temperature=analog read*5(operatingVolts)/2^10.We can maintain low-impedance output with. 1 ohms of resistance for 1mA load using this sensor.Advantage:Thermistor requires an external calibration. Accurate value Operates from 4v to 30v. Low self -Heating, 0.08degree Celsius in still Air. This sensor measures from -55 degree to 150 degree.It consumes 60micro Ampere of current.Library :SHT31, SHTC3.

OXYGEN-LEVEL sensor: The MAX30100 sensor is used for finding the oxygen level in the blood of a patient's body. This sensor has 2 LEDs, 1 photodetector and 1 analog low-noise signal processor. This sensor's breakout voltage is from 1.8 Volts and 5.5Volts. This sensor has 2 LEDs in which one emits the red light and the another emits the infrared light. When the blood is pumped by the heart, the volume of oxygen in the blood will be more and when the heart relaxes, the volume of oxygen in the blood decreases. When the oxygen level is more, the blood absorbs more infrared light and the passed red light will be more. Similarly, when the oxygen level is less, red light will be absorbed and infrared light will be passed more. By measuring these changes of the red-light absorption in the oxygenated blood and deoxygenated blood, the volume of oxygen in the blood of the person is determined. Features are that it operates at Ultra-Low-Power and it has less Shutdown Current which is 0.7 micro amperes.

PULSE RATE sensor: The SEN 11574 sensor is used for determining the pulse rate. This sensor has two faces. On one face it has a light sensor and on the other face it has some circuits. This circuit-System oversees the amplification and noise termination tasks. The LED is placed on the fingertip or ear tip. The LED present on the sensor will emit light. When the heart pumps, the blood flows in the veins. If we keep track of the flow of blood, we can observe the heartbeat also. The blood will reflect the light, as a result the light sensor will absorb more lights. These changes will be analysed over time to determine the pulse rate. It is a sensor which identifies itself and remembers the calibration data which in turn saves the set up time and voltage in which it operates voltage is +5Volts or +3.3Volts and Current Consumption rate is 4 milliAmpere

Table -1: Demonstrating the threshold values for sensors data values

SL.No.	**Sensor's Threshold Data Values**		
	Sensor	**Edge values**	**Edge values**
1.	**Heart rate**	**Ev.heart rate**	**< 50 and > 120**
2.	**Temperature**	**Ev.Temperature**	**< 35 and > 3 in Celsius**
3.	**Spo2 blood**	**Ev.SPO2**	**Under 90%**
4.	**Upper blood**	**Ev.upperblood**	**< 120 and >**

			180
5.	**Lower blood pressure**	**Ev.lowerblood**	**< 80 and > 110**

Evidence of pattern flow:

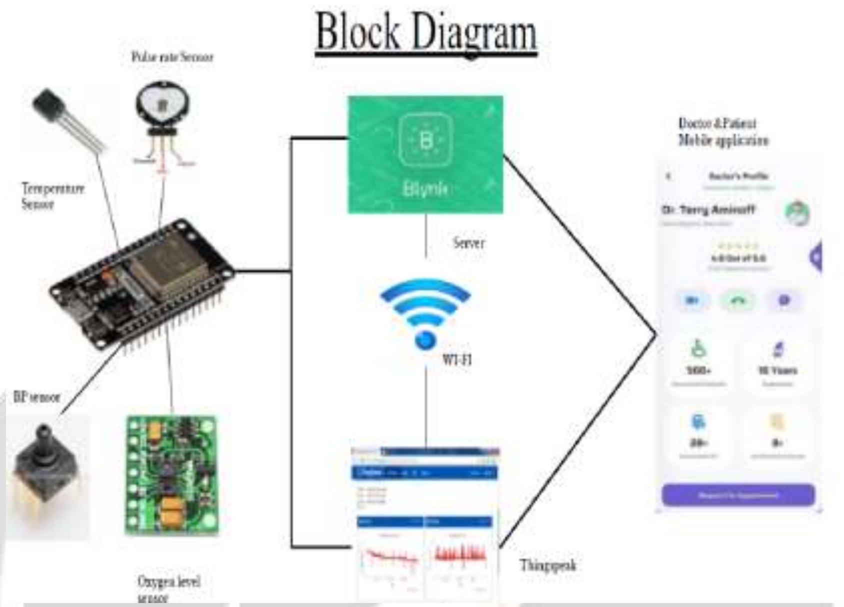

Fig-2: Concept design of proposed solutions

Succeeding are the obligatory modules of suggested finding:
(i).User Interface : The user is required to login with his/her login credentials in order to look into his/her estimated data via web application Thereby the user is redirected to his/her detailed estimated data page where one can find estimated data and predicted recovery rate of that specific user and the medications that are required to take by the user and an option to have a video chat with concerned doctor.
(ii). Connectivity from ESP32 to mobile application : In order to have efficient communication between mobile application created using BLYNK , an id is generated and pasted in the code for an id selector in Esp8266 wifi module code which in turn generates a hotspot region.
(iii).Storing Data in cloud, processing and retrieving the recovery prediction rate: using some Machine Learning Algorithm via PYTHON language in Anaconda Jupyter Notebook, we in turn retrieve the recovery rate in mobile applications created via BLYNK.

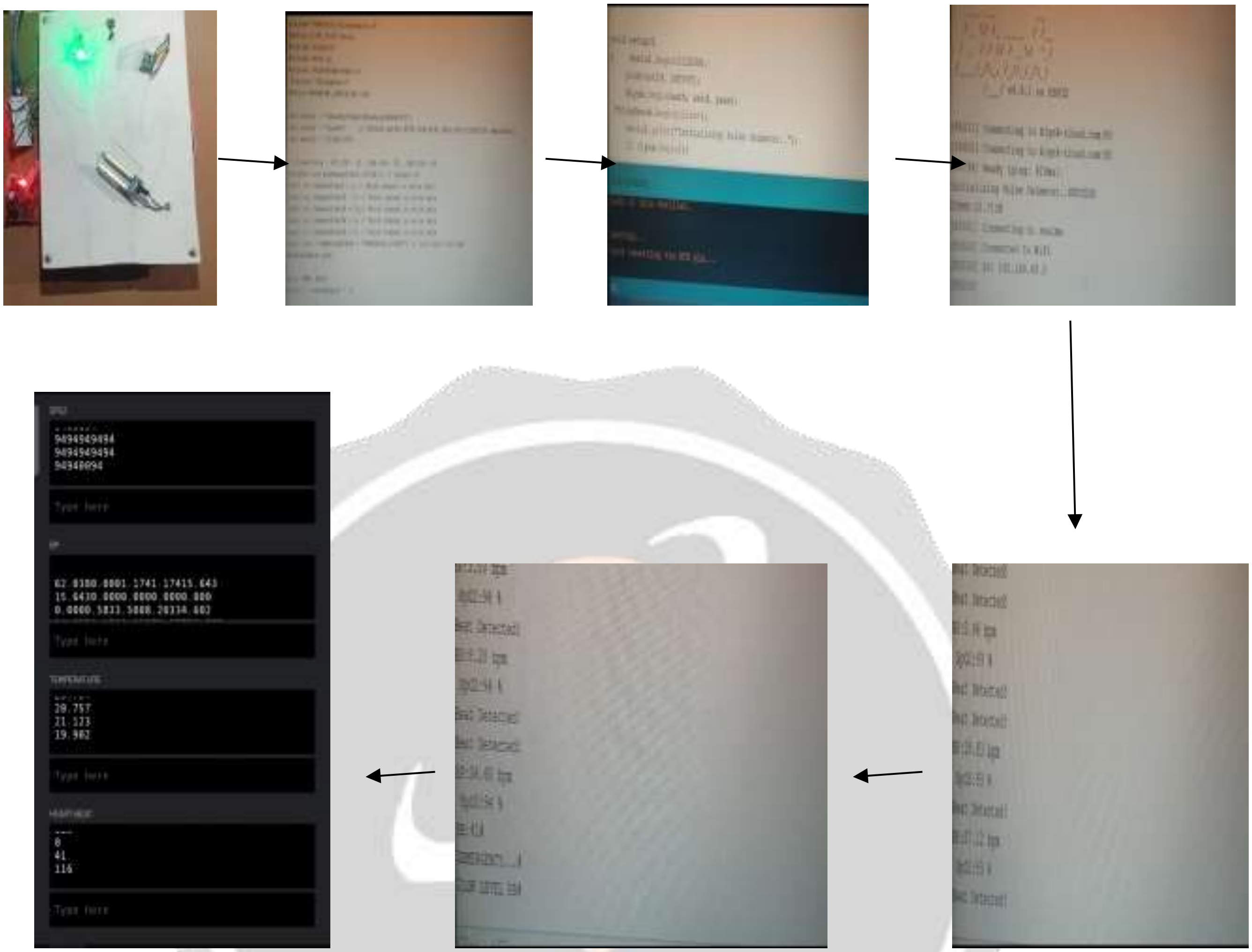

Fig-3: Implementation of Hardware

In the Software, we created a web application for monitoring the patients remotely. Here we have two user logins,

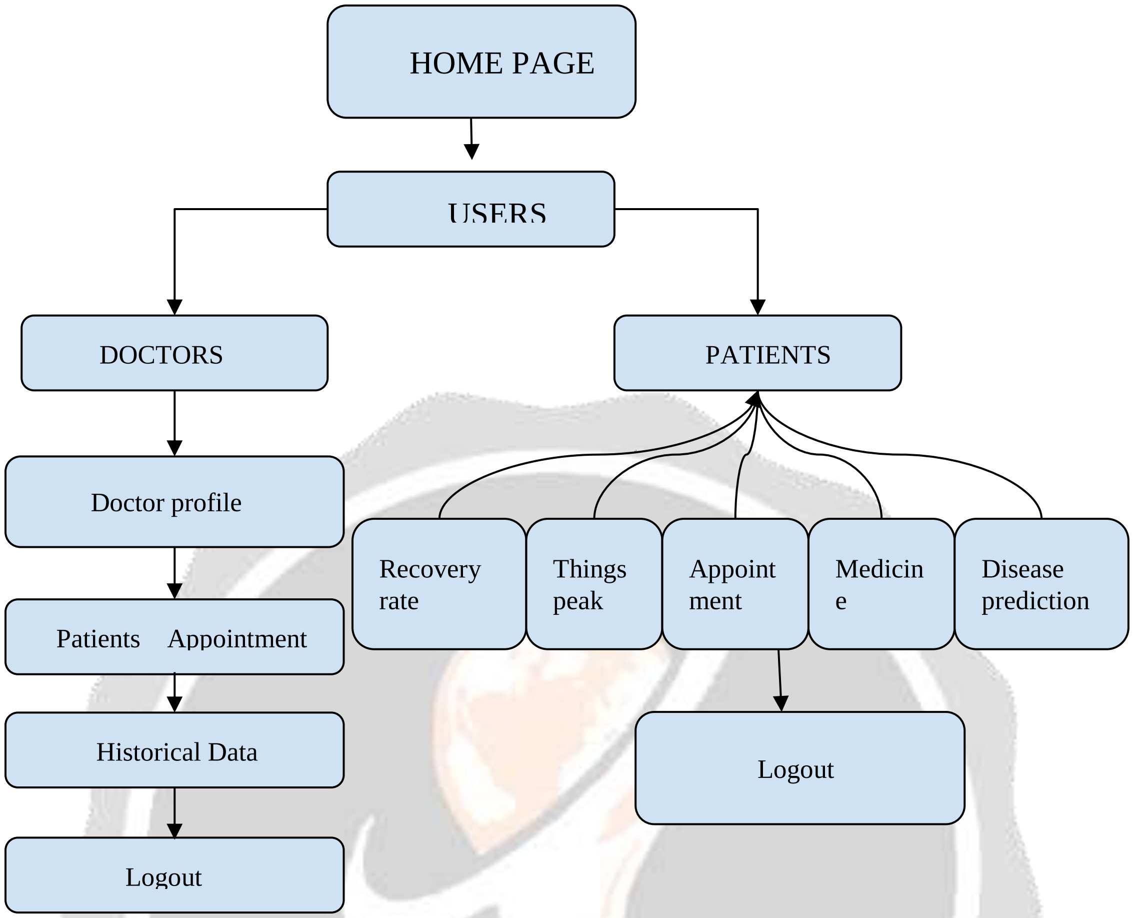

Fig-4: Block Diagram of Software part

i.User interface: In the user interface, the user will login with the login credentials such that the user is able to look into an estimated data, taking appointment, viewing the data, disease predicted, medicine predicted, predicted recovery rate of the corresponding user.

- In patient recovery rate, to predict whether the patient is able to recover or not by what percentage, here to predict the recovery rate we will be using real time data that we have collected from the sensors by using the ID3 algorithm.
- In thingspeak, the user will be logged in using login credentials to view the graphical data
- In an appointment, the user can make an appointment by filling in the necessary details. Then the details will be sent into the doctor page such that the doctor can schedule the appointment for the patients.
- In medicine, the user is able to predict the medicine using decision tree classifier with respect to the symptoms by filling 1 or 0
- In disease, the user is able to predict the disease by providing the symptoms.Here we have predicted the disease using two algorithms namely Decision tree and Naive Bayes classifier and accuracy of 85% and 88% respectively.

ii. Doctor interface: In the doctor interface, the doctor will login using the login credentials, then the appointments for the specific doctor will be displayed. If the value given is green then it is normal if red then it is out of the normal, and the patient is able to view the historical data.

Snapshots of UI Design :

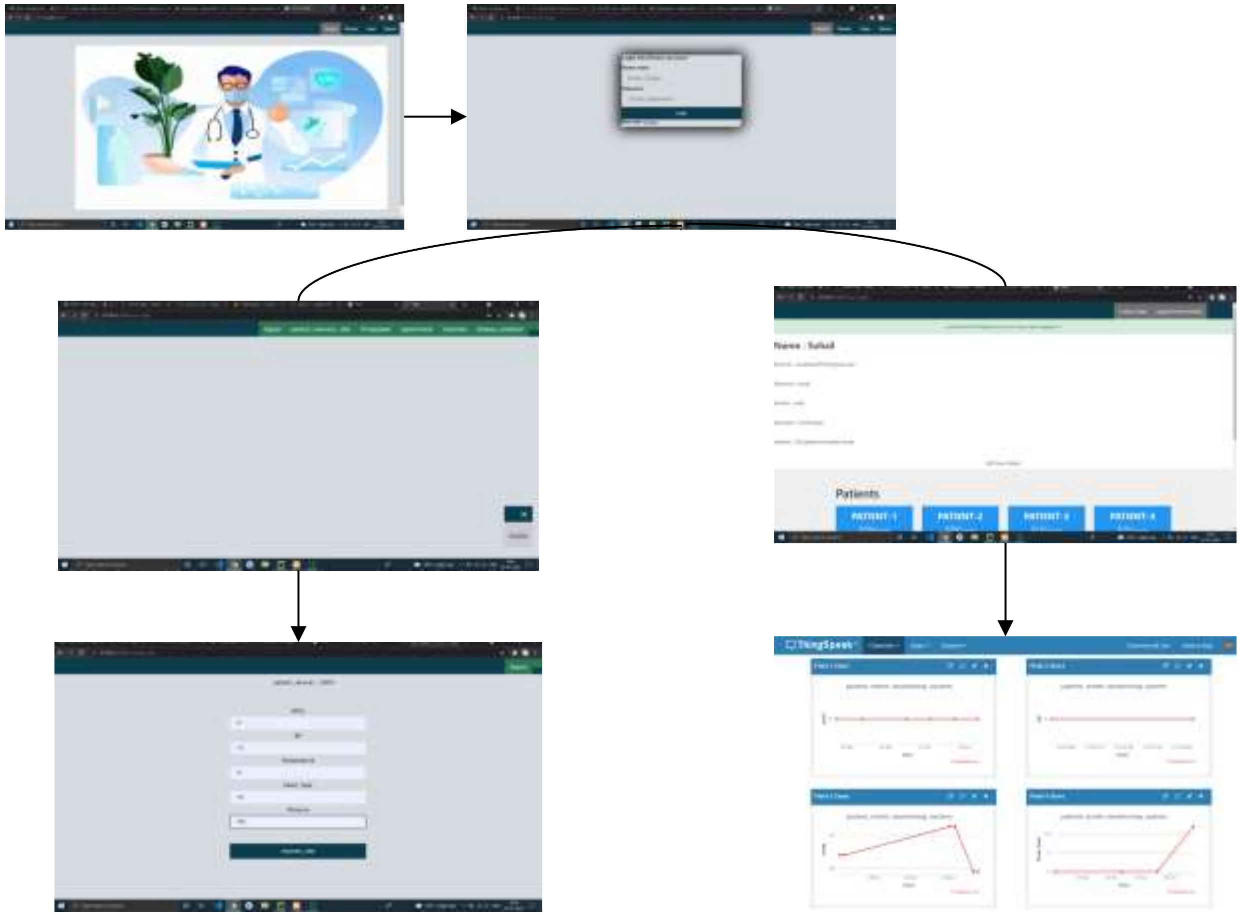

Fig-5: Implementation of Software

4. CONCLUSIONS

We presented the design and implementation of a Remote patient monitoring system based on IoT, wireless automation using a cellular phone, Patient data can be retrieved on mobile phones as well as recovery rate of patients. As the existing system requires many separate components, we had overcome it by integrating the components into a single unit and even with monitoring the patient remotely for 24 hours in turn it had affected the staff limit. And also we had given the solution for the recovery rate. Confidentiality and data security could be achieved. The proposed model is extremely useful for the patients as well as wellness programmers.

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