IoT based Automatic Patient monitoring System

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Abstract - *Health is one of the most important factors that affect a country's economy. In pandemic where the disease is highly contagious it is essential that a proper medical medium is provided so that the doctors do not catch a disease which the patient is suffering from. Some deadly pandemics like corona virus spreads very quickly. So, to avoid the spread of these diseases, I have come up with a solution wherein doctors can monitor the patient without the need of admitting the patient in a hospital. The patient can stay at his own house or a quarantine centre and the doctor can monitor the patient regardless of the distance. For instance, if the doctor is in Australia and the patient is in India the doctor can get all the health details of the patient such as (Body temperature, heartbeat etc.). All this data will be received in a customized app APMS which stands for Automatic patient monitoring system. The doctor can also see the personal details of the patient (Such as name, address etc.) and the condition in a systematic manner. All this data is saved and is completely secure. The doctor can also give a medicine to the patient with the help of the app and the medibox. All this works with the help of Internet. (IoT)*

Key Words: *Medical, IoT (Internet of Things), Patient Monitoring, medibox, APMS, PH scanner.*

1. INTRODUCTION

It is very important to have a proper medical system which can help to cure some diseases. Through my idea patients can be cured even if he stays at home. The patients live condition is recorded in the mobile application APMS and also gives warning signals if any of the patient's health deteriorates. The best part of this project is that even if the doctor cannot come to the hospital maybe because of the long distance or some other reasons he can at least get the patients live details and can also provide him with the appropriate medicine which will be required at that point of time. If no such system like APMS is implemented soon then there will be a need of building more and more hospitals especially in the time of pandemic. An important part of the project is that it can only help in curing specific diseases. Diseases that have a symptom of fever or maybe high blood pressure can be cured through this system. Anyways advancements will be made to make more and more diseases curable through this life saving project.
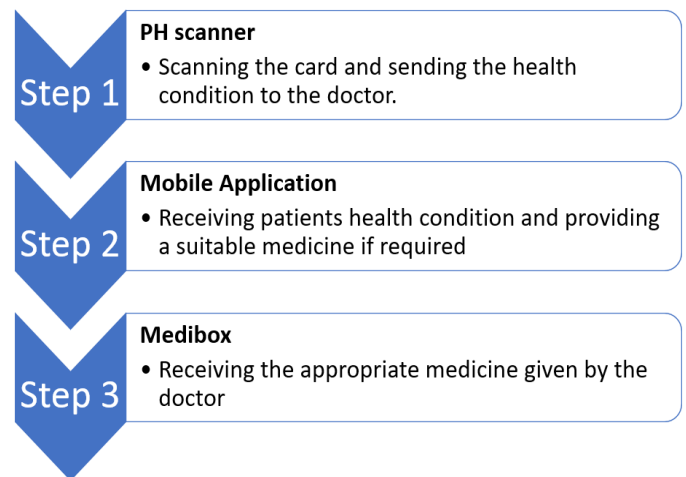
1.1 APMS steps

Fig -1: Steps involved in APMS

Above figure gives an overview of basic steps involved in the whole process. Some of the problems faced by people because of the absence of such an advanced medical system:

a) The disease spreads from patients to doctors because of close contact.
b) Lack of hospital beds
c) Lack of personal timely approach of the doctor.
d) Sometimes the doctor is unable to reach to the patient because of far distances which can be fatal.
e) The doctor cannot have a regular checkup of the patients.
f) The patient has to travel long distances for regular checkup.
g) The doctor cannot view the condition of many patients at a time.
h) A nurse or a doctor has to be present all the time to personally monitor the patient.
i) The doctor can monitor fewer patients in more time.
j) Treatment from doctors of distant countries becomes tedious and expensive.
k) In situation of a pandemic there is hustle and bustle of the people getting infected with the disease because of lack of doctors, hospital beds and proper medical facility.

2. Proposed solution

The idea with which we can resolve all these issues is APMS. APMS is an internet enabled system and can allow the doctor to get all the information of the patient. So, let's see the whole process of APMS in details. First of all, when the patient falls sick, he will call a doctor. The doctor will come to the patient's house or the patient will come to the doctor (any one option). The doctor will check the patient and will add all the personal details of the patient such as, His name, address, contact no, etc in his mobile app APMS. After the doctor is able to diagnose the disease through which the patient is suffering from, the doctor will give him the list of medicines and three most important things. The three important things that the doctor gives the patient is a medibox, a PH scanner, and a PH card. The patient has to buy the medicines and has to take rest at home. Now starts the process of APMS. The PH scanner has many sensors attached to it such as Oximeter and pulse rate sensor, Temperature sensor etc. These sensors will monitor the patient's health. The patient has to scan the PH card on the PH scanner after every one hour (except when the patient is asleep). As soon as the patient scans the card all the sensor data i.e., the patients' health details like oxygen level, heartbeat, and body temperature will be displayed in the doctor's mobile app APMS. When the doctor receives the patient's health condition, he automatically gets a notification. The doctor then has to access the app with a three-step verification process. Finally, the doctor can see all the details of the patient. In case the doctor feels to increase or decrease the medicine dosage of the patient or give an emergency medicine he can do that from his mobile application. He can simply click the button on which the name of the medicine is printed and the patient will receive the medicine from the medibox. The medicine was already there in the medibox. The patient will just get an indication as to what medicine he should take. A person who will be the in charge of the APMS will also send one of his men and insert a camera in the room where the patient will be there so that the doctor can also monitor the patient live on his mobile app. In case there is any sought of emergency where the patient requires immediate attention there is an emergency system in APMS. The doctor will automatically get a phone call and a SMS stating that Patient and his (His serial no of PH card) requires immediate attention. The doctor can then accommodate the patient in any nearby hospital. In this way the APMS system works and can save the lives of many people. The best part is that the patient gets treated even though he is at home and is far from the doctor. This will also decrease the risk of doctor getting infected with any contagious disease such as Covid - 19, swine flu, bird flu etc.
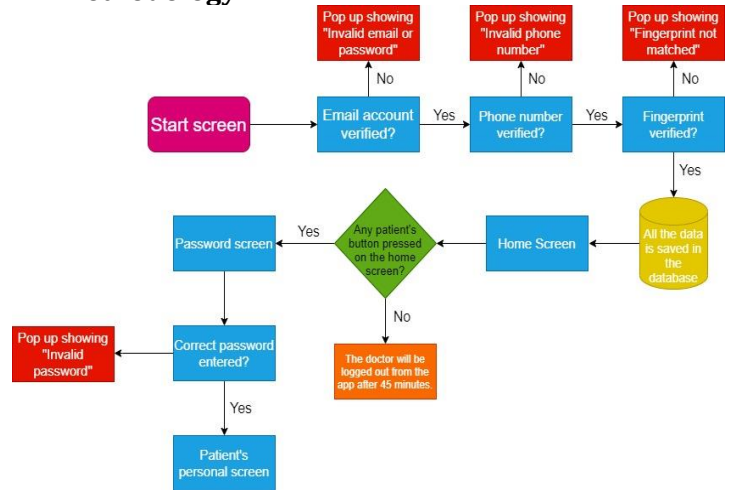
2.1 Methodology

Fig - 2: App flow chart

Components used:

Node MCU – NodeMCU is an IoT platform which is open source and can be implemented at low cost. It has a high processing speed and has inbuilt WiFi and Bluetooth connection. It supports UART, SPI, and I2C interface. Here the NodeMCU helps us to connect to the Internet and helps to transmit and receive the data.
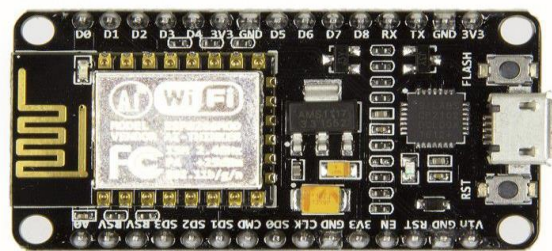

Fig - 3: NodeMCU

RFID – RFID stands for Radio Frequency Identification. Information is stored in Tags/Cards. The communication between the RFID sensor and the NodeMCU is established by Serial Peripheral Interface (SPI) protocol. Here RFID is used in the scanner for the card scanning facility.
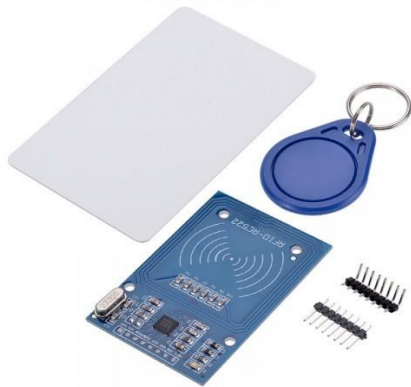
Fig - 4: RFID

DS18B20 – The DS18B20 is a 1m long temperature sensor. It can measure a wide range of temperature from -55°C to +125° with a decent accuracy of ±5°C. Here we are using this sensor to measure the body temperature of the patient.

Fig - 5: DS18B20

Pulse rate and oximeter sensor – The MAX30100 is an integrated pulse oximetry and heart- rate   monitor sensor. It has two LEDs, a photodetector, optimized optics, and low-noise analog signal processing. Here we are using this sensor helps to measure pulse rate and oxygen level of the patient's body.

Fig - 6: MAX30100

ESP32 camera module – The ESP32-CAM is a small size, low power consumption camera module based on ESP32. It has a slot for connecting an OV2640 camera module. Esp32 cam helps to click photographs and store it in the SD card and can be connected with

Telegram and blynk applications. We can also show live video streaming on a specific IP address. Here we are live streaming the Esp32 cam view on the APMS app.

Fig - 7: ESP32 CAM

GSM – GSM stands for Global System for Mobile Communications. It has a slot for connecting SIM card. GSM provides SMS and calling feature. Here SIM800l GSM module is used. Here we are using GSM so that we can make an automatic phone call and send an SMS when the patient's health deteriorates and whenever the patient requires immediate medical attention.
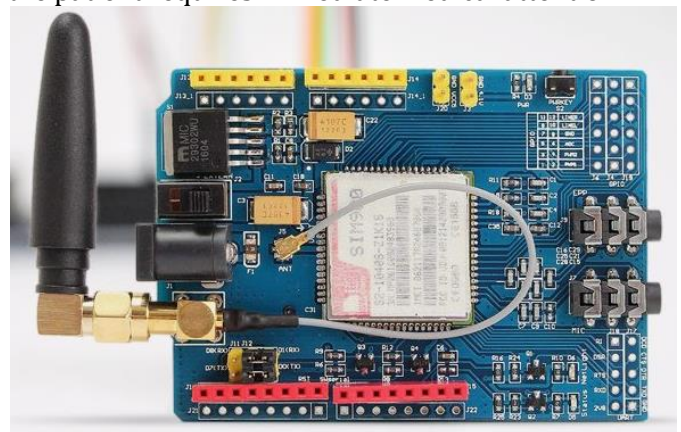

Fig - 8: GSM

DS3231 RTC – The DS3231 RTC module is a Precise Real-Time Clock Module. At the back of the sensor there is a coin cell battery holder which helps the RTC module to maintain time record even when the main power goes off. Here real time clock tells us the actual time and prints the time in the APMS app when the card is scanned. This helps the doctor to know the condition of the patient at that time.
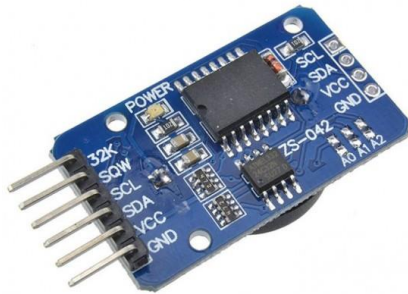
Fig - 9: Real Time Clock

3. IMPLEMENTATION AND RESULTS

Let's see how all the models will work in real life. The working of three different things is shown. The PH scanner, medibox and the APMS app are the three main things of the project. So further you can see the step by step working of all these things.

a) PH scanner:

• The image of the PH scanner is given in figure 10.

• Two sensors that are DS18B20 and MAX30100 are also attached with the scanner.

• These sensors will continuously give their input to the micro controller.

• Once the PH card is scanned on the mentioned area in the scanner then the input given by the sensors will be sent to the doctor's app via internet.

• Once the card is scanned and the data is sent a confirmation message is printed on the I2C LCD display.
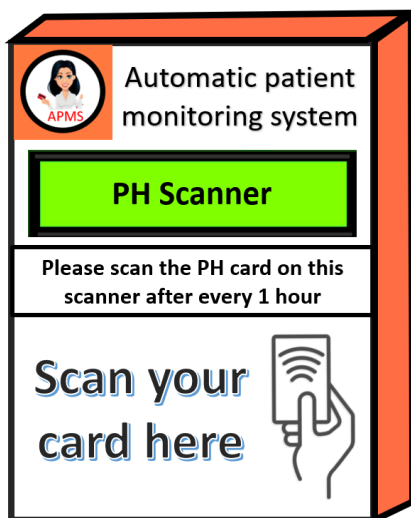

Fig - 10: PH Scanner

b) App

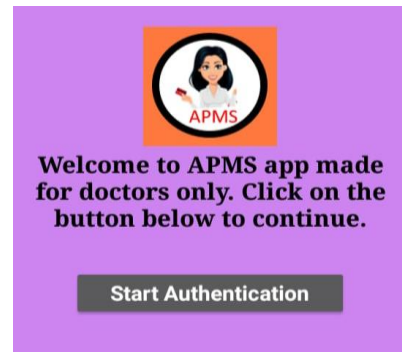i) In the app first of all there comes a verification screen.

Fig -1: Welcome screen

This is how the screen will look. The doctor has to press the start authentication button and proceed.

ii) Email verification

The next screen is where the doctor has to enter his email id and password of any of his APMS account.
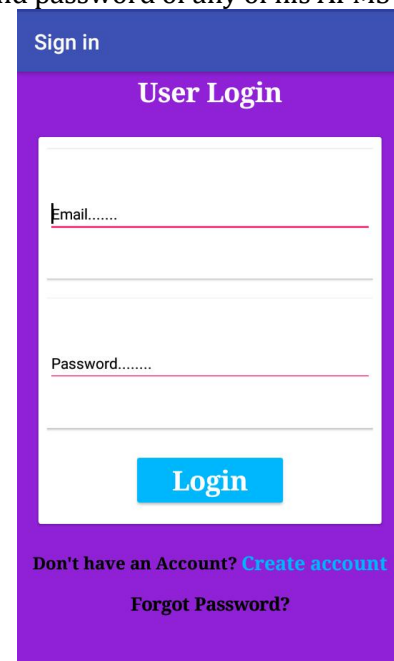

Fig - 12: Email login screen

If the doctor has an APMS account, he can just enter the email and the password of his account and he can proceed. If the doctor forgets the password, he has to click on the 'forgot password' option at the bottom of the screen and then he will get a mail from APMS. In the mail a link will be provided. The doctor has to click on the link and has to enter his new password and the password will be reset.
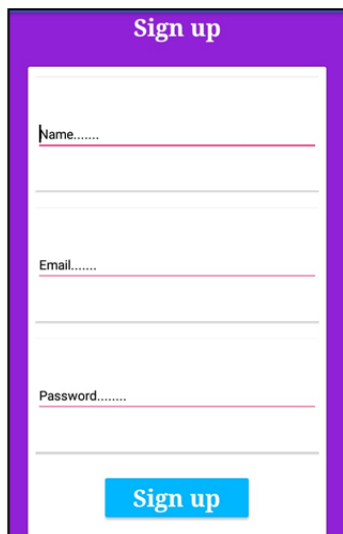
Fig - 13: Sign Up Screen

If the doctor does not have any APMS account, he can click on create account option and then he can create his APMS account. The doctor has to fill the necessary details and then he will have his APMS account. The APMS account is so safe that even if one doctor gets the credentials of the other doctor, he cannot get the information of the other doctor. Though he will be able to proceed but he will not be able to access the data of any other doctor. If someone enters with an account which already belongs to someone else the person will get an email from APMS that another device has entered your account. And the user can change or reset the password.

iii) Phone number verification
Once the doctor enters the correct email id and password, he will then have to verify his phone number.
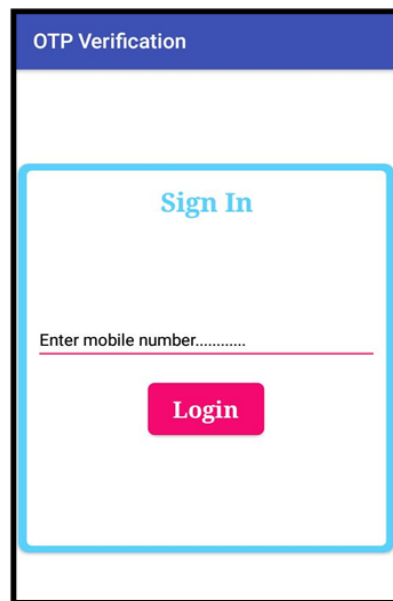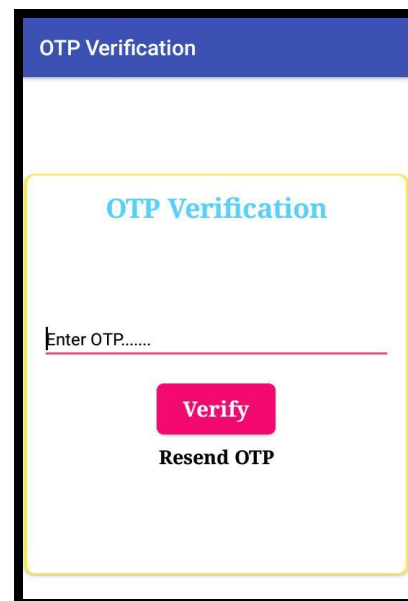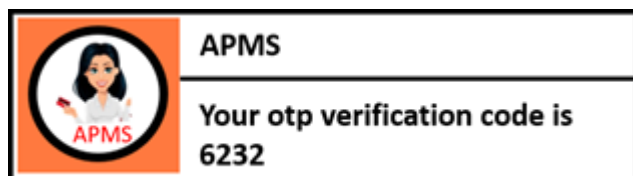

Fig - 16: OTP Received by APMS

Here the patient has to enter his mobile number. After entering the mobile number, the doctor gets an OTP on the number which he provided. After entering that OTP, the doctor can proceed forward.

Fig - 14: Phone number screen

Fig - 15: OTP Verification Screen

iv) Fingerprint verification
Once the phone number verification is successful the doctor has to place the finger on the fingerprint sensor of the mobile and then his fingerprint will be checked. He will be allowed to proceed if the verification is successful.

v) Home screen
The doctor finally reaches the home screen after a three-step verification process. In the home screen the doctor can see the overall view where he can access any patient he wants.
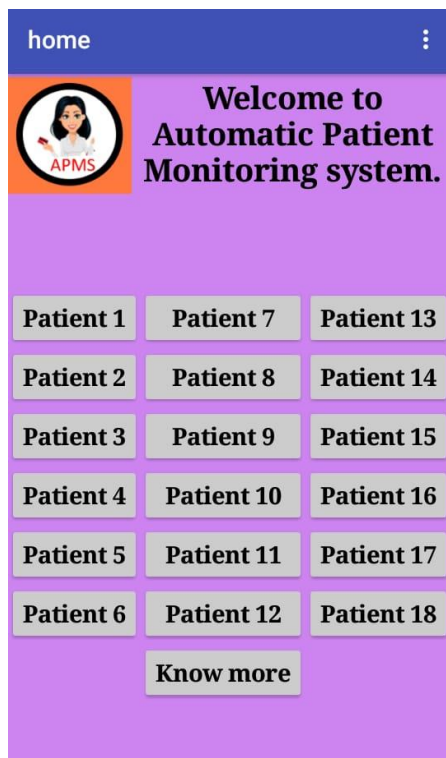
Fig - 17: Home Screen

When someone clicks on the know more button the doctor will get a whole well explained pdf which tells all the instructions of how to use the app and whom to contact in case of technical issues.

vi) Password screen
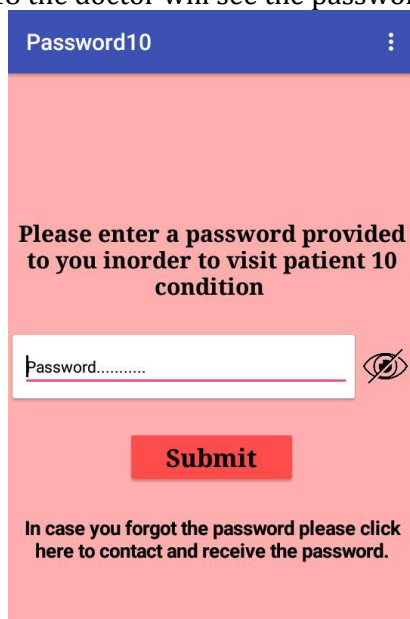Once the doctor clicks on any of the patient button from 1 – 18 the doctor will see the password screen.

Fig - 18: Password screen

The password here is common for all the doctors. All the doctors have to enter the same password for all patients.
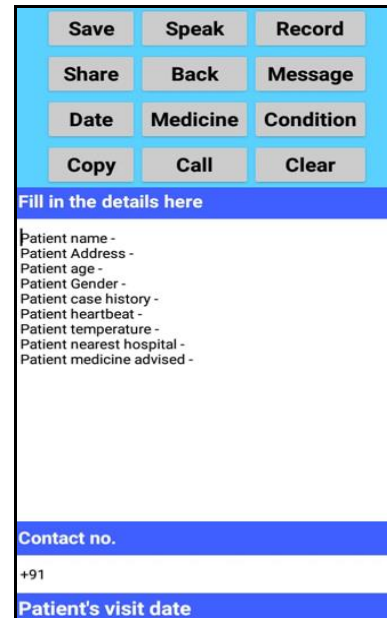
vii) Patient screen

Fig - 19: Patient's Screen

This is the personal patient screen where the doctor will enter all the details of the patient such as name, address, Heartbeat, Temperature, Age, Gender etc. All these details are mandatory to be filled. The details will be entered when the doctor personally meets the patient for the first time. A separate block is provided for the contact number where the doctor has to enter and save the contact number of the patient so that he can contact or message the doctor and they can communicate with each other.
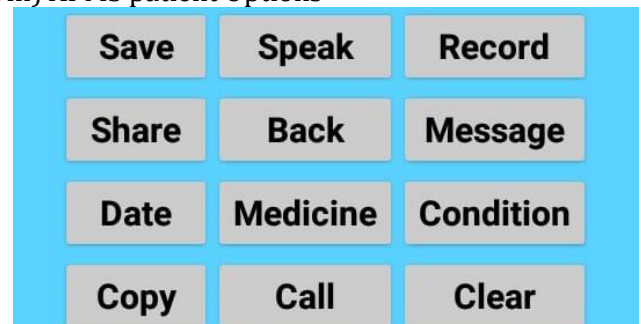
viii) APMS patient Options

Fig - 20: Editing Tools on Patient's Screen

Save – It is used if we want to save the text which we have inserted or we have edited.

Share – It is used if we want to mail the details of the patient to a higher authority.

Date – The doctor can set the date by using this component instead of typing it in order to make it easier and much more efficient. The patients visit date is also saved at the bottom of the screen.

Back – This component is used if the doctor wishes to go back to the previous slides either to close the app or to visit the condition of the other patients. As soon as the doctor chooses this option a notifier appears giving him three options

Fig - 21: Notifier

Record – In case the text is too huge this component is used wherein the doctor can record his voice and the app will convert it into text.

Message – An option of contact no is provided wherein the doctor has to type the contact number of the patient and whenever he clicks on the message button automatically WhatsApp will open the contact with that number. In case it is not found he can SMS the patient.

Copy – In case the text is important the doctor can click here and all the text will be copied to clipboard.

Call – A phone call is dialed to the person whose number is typed in the contact info part.

Clear – If the doctor feels that the text is not important, he can simply click here and delete all the text from the text areas.

Speak – The device will speak the details which the doctor would have entered.

Medicine – When this option is clicked a separate screen is opened.
The doctor has to click on the medicine which he wants to give the patient and with the help of the medibox the

patient will automatically come to know which medicine to take. This feature can be used in case of emergency.
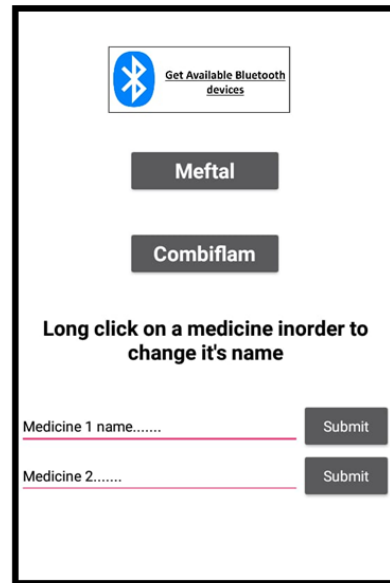

Fig - 22: Medicine Screen

The doctor can also set the number of medicines the patient has to take through the dropdown provided. The number selected will be displayed on the LCD screen of the medibox.

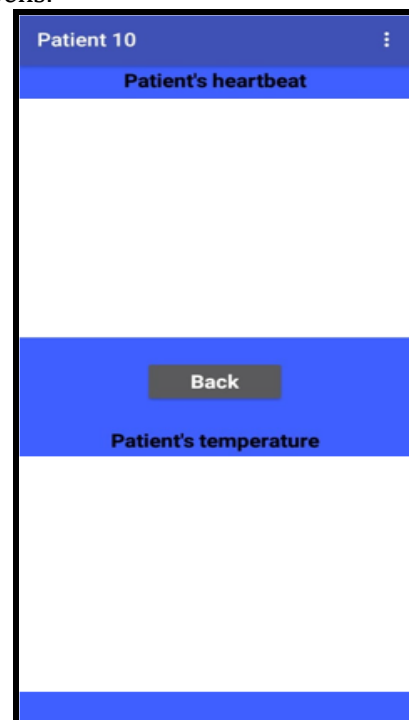Condition- When the doctor clicks on this button a new screen opens.

Fig - 23: Patient condition screen

In the condition screen the doctor will get all the details or information from the scanner. The doctor will get to know about the current health condition of the patient.

c) Medibox:

Fig - 24: Medibox

i) The medibox is created in a box type structure so that we can even keep our medicines in that box. There is an inbuilt light inside it so that the patient can clearly look in the box when it is too dark.

ii) There is an LCD on the medibox which displays the number of medicines to be taken at a time.

iii) There is an alarm on the medibox which beeps when it is time to take the medicine.

iv) There are two LED on the medibox below which the name of the medicine is written. Which medicine is to be taken is decided by the two LED present above the medicine name.

v) For example, if the doctor clicks on the combiflame button in the APMS app then the alarm will beep for 3 seconds and the LED that is situated above the label combiflame in the medibox will start glowing. In this way the patient comes to know which medicine is to be taken at what time. There is a button on the side corner of the medibox which the patient has to press when he/she has taken the medicine as told by the doctor. When the switch is pressed the doctor gets an instant notification from APMS app that the patient (along with the serial number) has taken the medicine.

4. Future enhancements

More advancement will be made in this project so that more and more diseases or problems can be cured through this system. We will also try to monitor more and more things about the patient other than his temperature, heartbeat and oxygen level. We will also look forward to reduce the power and the cost of this system as much as possible so that it can be affordable to everyone.

5. Conclusion

The main target of creating this system was to ensure that everyone gets good and proper treatment. No one must be deprived of proper medical facility because of distance or maybe lack of hospital beds. This system will be really very helpful to the people as well as the doctors.

6. Reference links

1. How to make apps using MIT App Inventor https://thecodingbus.info/mit/
2. How to use the NodeMCU board: https://lastminuteengineers.com/esp8266-nodemcu-arduino-tutorial/
3. An animated video of how APMS works: https://bit.ly/apms-video
4. Link for NodeMCU board reference image: http://bit.ly/NodeMCU_board
5. Link for RFID sensor image: http://bit.ly/RFID_sensor
6. Link for DS18B20 sensor image: http://bit.ly/DS18B20_sensor
7. Link for MAX30100 sensor image: http://bit.ly/MAX30100_sensor
8. Link for ESP32 Cam module image: http://bit.ly/ESP32_CAM
9. Link for GSM module image: http://bit.ly/GSM_module
10. Link for DS3231 RTC module: http://bit.ly/DS3231_RTC

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