IoT based Smart Patient Health Monitoring System using Arduino MKR 1000

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Abstract: **In today's medical services health structure where patients stay at home after operations are monitored by a medical caretaker or a family member. People who work full time, face the problem of monitoring their loved ones particularly the aged patients. So, to overcome this difficulty we are using this patient health monitoring system using IoT. This will make use of sensor technology in combination with micro-controller and Wi-Fi module to help the user monitor their loved ones. For monitoring the health of a patient, a new project is developed to reduce the sudden death rates by using patient health monitoring which makes use of bio sensors and internet to communicate to the doctor or family member in critical condition. Our system uses Pulse oximeter sensor, Heart rate sensor, body temperature sensor and Indoor Air Quality Sensor which are connected to Arduino MKR 1000 board, Thingspeak cloud and IoT Data Explorer Matlab App for analysis. To display the health condition to the patient, an LCD is interfaced with the microcontroller and to send the data to the cloud web server, the Wi-Fi connection in the Arduino MKR 1000 is used. In case of any sudden changes in the health condition are observed in patient's Heart beat rate or Systolic Blood Pressure or Diastolic Blood Pressure or in Body temperature or Indoor Air Quality, immediately an alert message about the situation is sent to the doctor or family member using IoT technology. Based on the alert message, the doctor will contact the caretaker at the patient's place for the preventive measures.**

I. INTRODUCTION

Many people nowadays who work full time are facing a problem of monitoring their loved ones especially old age patients. Because of the nonexistence of good medical treatment on needed time, many patients are facing critical problem or death due to heart attack. So, to monitor the health of a patient, a new internet based sensing technology has been developed. This project is specially for old aged people to inform about their health condition to the doctor or to their family members. So, we are proposing a new system to reduce the sudden death rates by using patient health monitoring which uses bio sensors and internet to communicate to the doctor or family member in critical condition. Our system uses Pulse oximeter sensor, Heart rate sensor, Body temperature sensor and Indoor Air Quality Sensor which are connected to Arduino MKR 1000 board.

II. LITERATURE SURVEY

Many assessments on sending sensor data through wireless were done before as projects or research papers on IOT based patient health monitoring system.

In the paper presented by Jin et al [1] design the effective system for smart cities by using loT. The loT network presents in this is cloud based structure and it uses the data management. The system architecture presents in this uses the three strategies namely Data-based loT, Cloud-based loT and Network-based loT. These three strategies work under the different standards, protocols and plans. The Crossbow's XMesh, IRIS, Crossbow's iMote, QoS mechanism, TCP/IP architecture, IPv6 crowd sourcing, WSN , RFID.

Jara et al [2], in this paper has presented a separate formation to central supervised founded on loT. The loT presents in this paper integrates with different systems like environment integration platform, knowledge base systems, context management framework, services provider system and hospital information system. This structural design uses a new protocol called YOAPY, HOP, wireless personal devices, 6LoWPAN, embedded systems, marital hardware and RFID. But the protocol YOAPY manifests hopeful, though, this system not give details treatment of extremity conditions.

An intelligent home-based healthcare IoT system is presented in [3]. For the home-based healthcare system, the Medical Box(iMedBox) is used which is health loT system and iGATE way which acts as a home healthcare gateway. Wearable sensors and intelligent medicine packaging (iMedPack)] are successfully coupled to the iMedBox via a diverse network, which is well-matched with several presented wireless principles. The iMedPack is joined with the iMedBox via an RFID link to support the users with their arranged prescription.

III. PROPOSED SYSTEM

This paper reports a constant healthcare monitoring system that will be a devoted deferral. We utilize Arduino MKR 1000 as the small-scale controller unit. It gets the information or the required parameters like body temperature, systolic blood pressure, diastolic

blood pressure, heartbeat rate and air quality from GY-906, Pulse express optical PP sensor with MAX 30102 & MAX 32664 and Laser PM2.5 Dust Sensor (HM3301) sensors respectively.

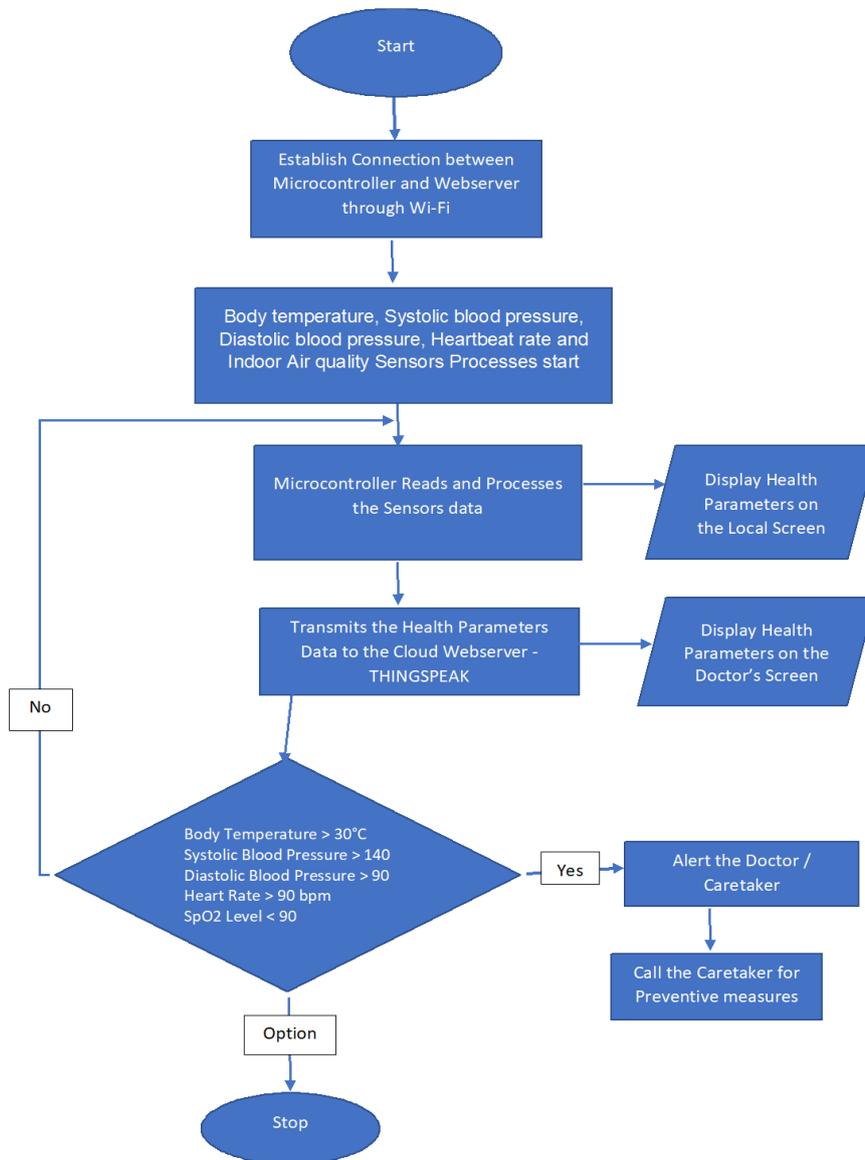The Flowchart representation of this framework is as shown in Figure 3.1.

Figure 3.1: Flowchart representation of patient monitoring system

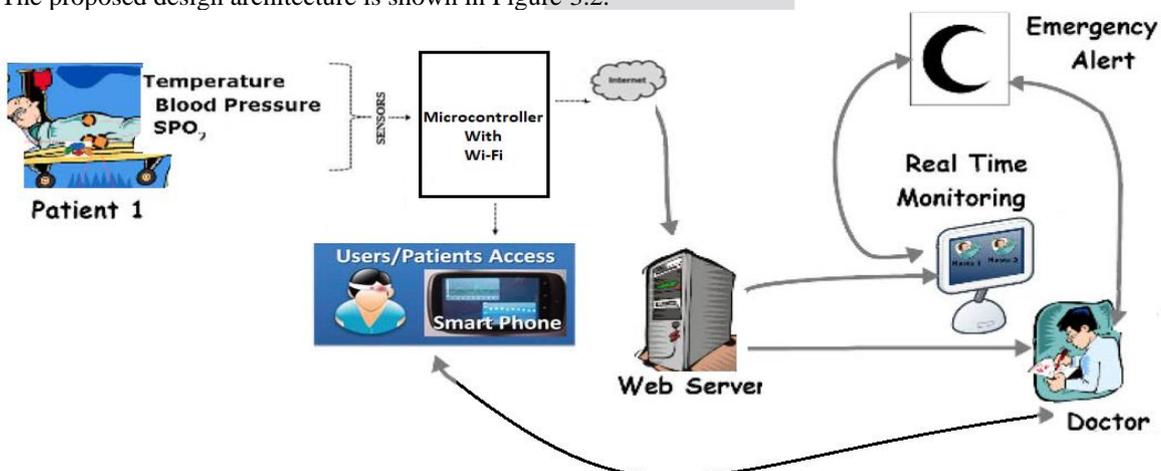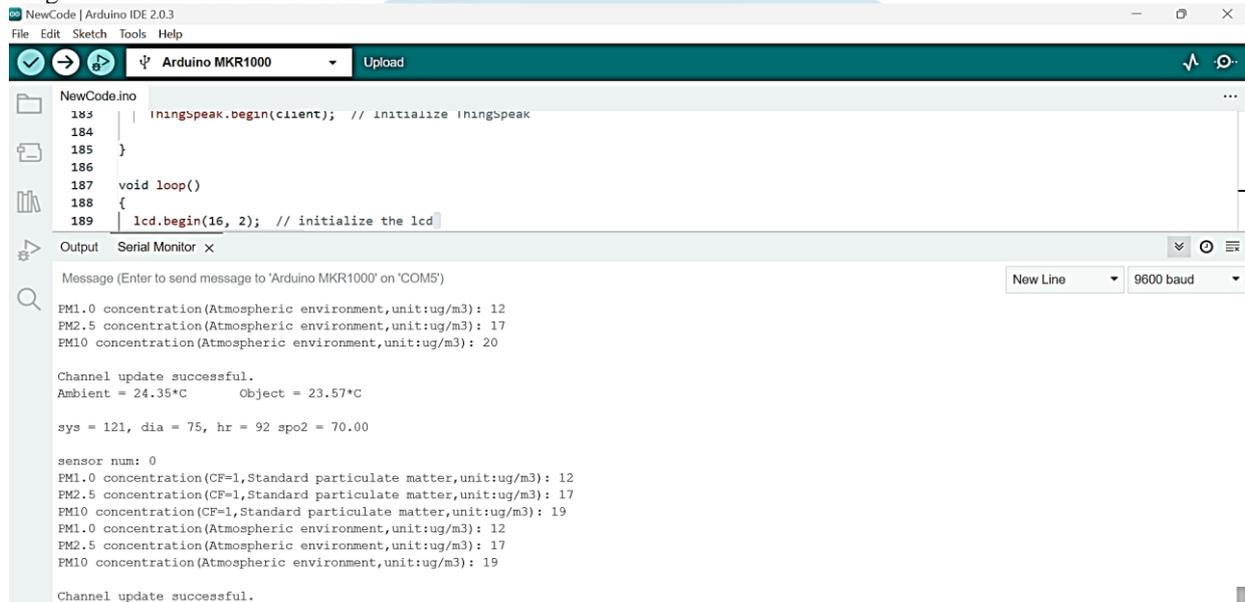The proposed design architecture is shown in Figure 3.2.

Figure 3.2: Proposed Architecture for IoT based smart patient health monitoring system

Parameters like body temperature, systolic blood pressure, diastolic blood pressure, heartbeat rate and air quality are consistently checked. At the small-scale controller these parameters are given as contributions through sensors like GY-906, Pulse Express optical PP sensor with MAX 30102 & MAX 32664 and Laser PM2.5 Dust Sensor (HM3301) respectively. The signals generated from these sensors are forwarded to microcontroller. Microcontroller transmits these signals to the Wi-Fi module for the transmission of data through internet to the specific destination i.e., THINGSPEAK Cloud Web server. By utilizing "React" feature in THINGSPEAK, an alert message will be sent to alert the doctor or to the caretaker when any one of the parameters crosses the limit.

IV. IMPLEMENTATION

By placing the temperature sensor in close proximity with the body of the patient and connecting the pulse oximeter to the finger of the patient, the signals i.e., the Body Temperature, Systolic Blood Pressure, Diastolic Blood Pressure and Heart rate are given as input to the Arduino MKR 1000. The Air Quality sensor will sense the surrounding environment and sends the signals to the Arduino MKR 1000. The Arduino MKR 1000 will process these values and displays it on to the LCD Display. The figure 4.1 shows few readings on the serial monitor of Arduino IDE.

Figure 4.1: Health Parameters on the Serial Monitor of Arduino IDE

The Arduino MKR 1000 will also transmit these values to the Thingspeak cloud by making use of the available Wi-Fi connection. By utilizing "React" feature in THINGSPEAK, an alert message will be sent to alert the doctor or to the caretaker when any one of the parameters crosses the limit.

The Doctor can see the recorded health data of many patients at a time from his work place by properly entering the Patient's Id. Past health history of any patient can be observed by the doctor at any time from the database in web server by properly selecting the Date and Time Range.

V. RESULTS

A total of 1490 readings were recorded from 7.02.2023 till 18.2.2023 from each sensor. These readings were transmitted by the Arduino MKR 1000 to the Thingspeak cloud. The Figure 5.1 to Figure 5.3 shows few readings from the Thingspeak cloud.
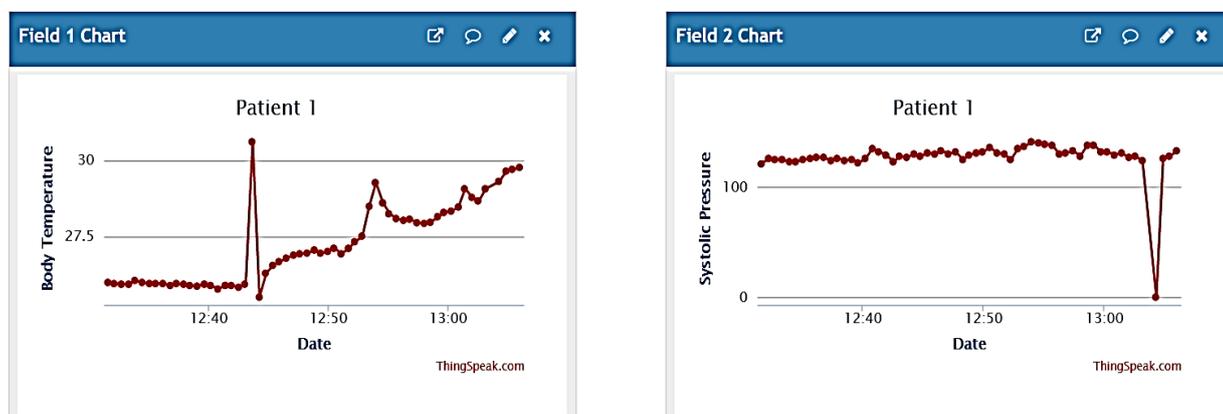

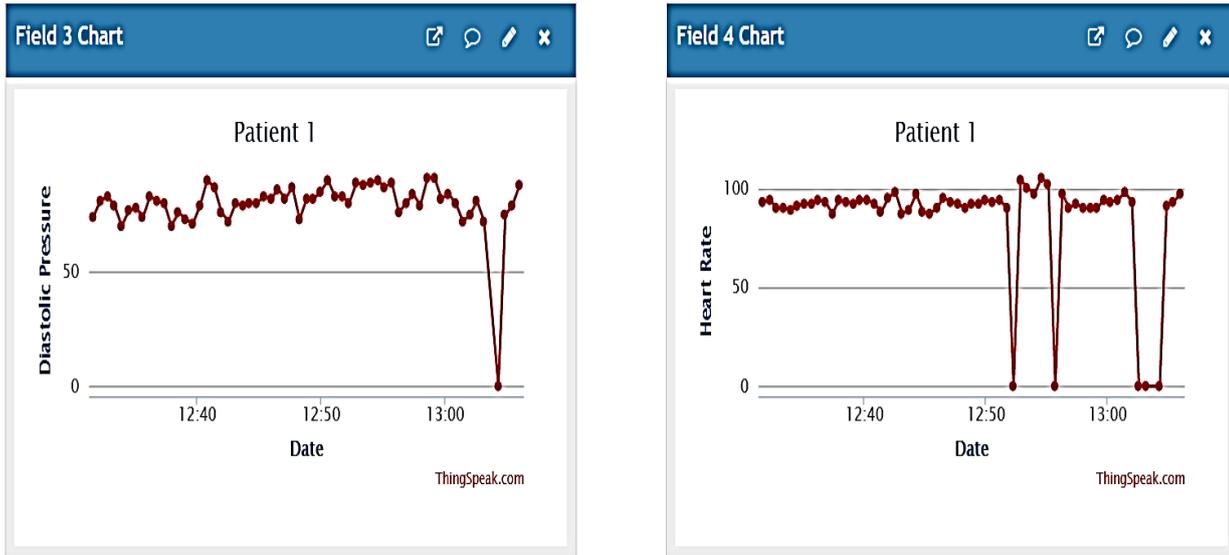Figure 5.1: Thingspeak Readings – Body Temperature & Systolic Blood Pressure

Figure 1.2: Thingspeak Readings – Diastolic Blood Pressure and Heart Rate
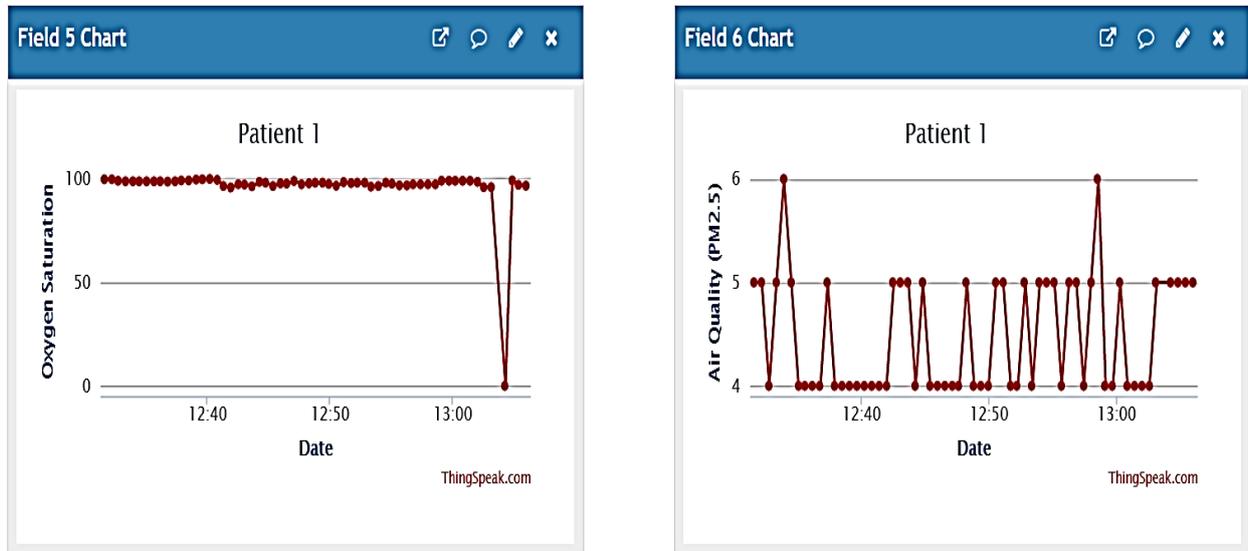
Figure 5.3: Thingspeak Readings – Oxygen Level and Air Quality

Whenever the sensor readings cross the threshold values, alert messages will be sent to the twitter account of the concerned person i.e., the doctor or the care taker. Figure 5.4 shows the alert messages sample.
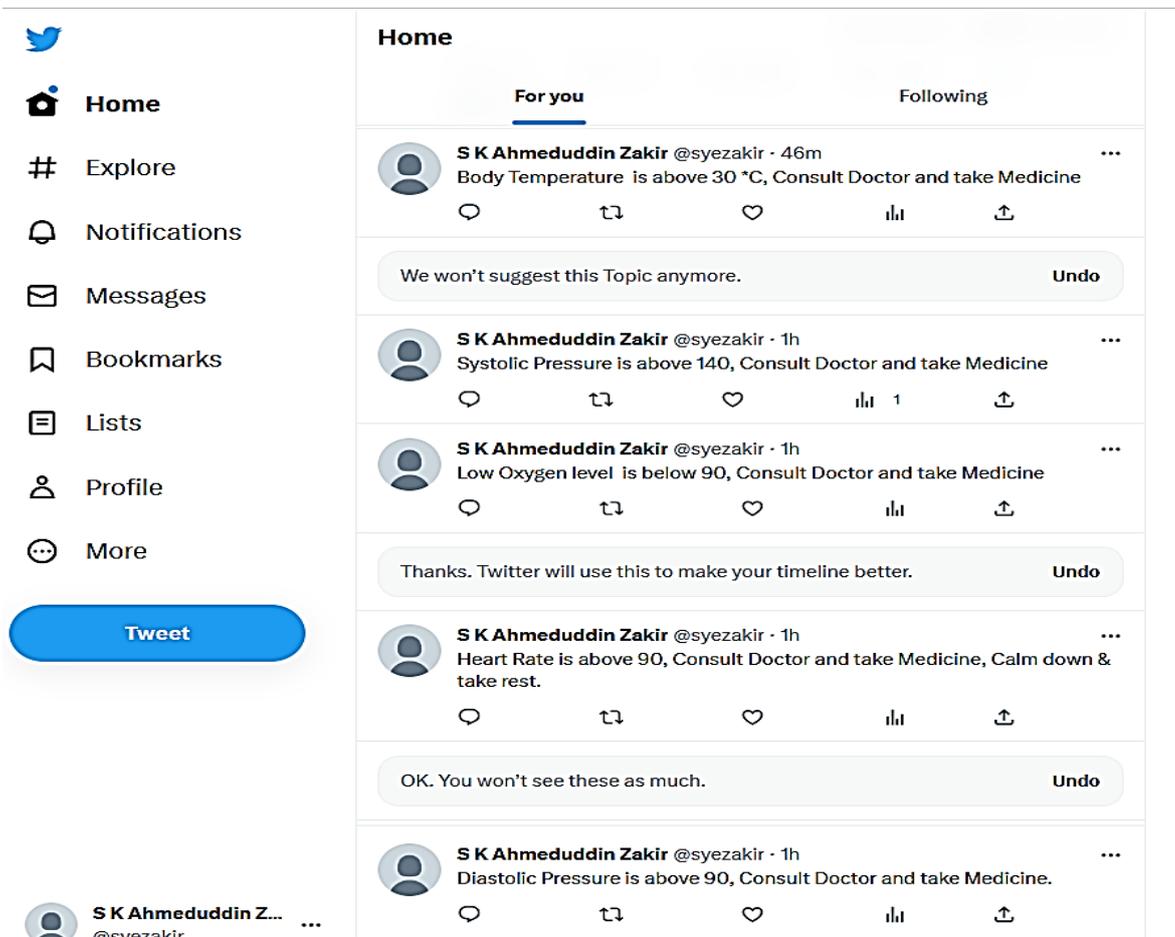
Figure 5.4: Alert Messages sample

The doctor can monitor the health parameters of the patient from his work place by making use of the IoT Data Explorer for the Thingspeak [6]. The figure 5.5 shows the sample of Body Temperature and Systolic Pressure data of the patient.
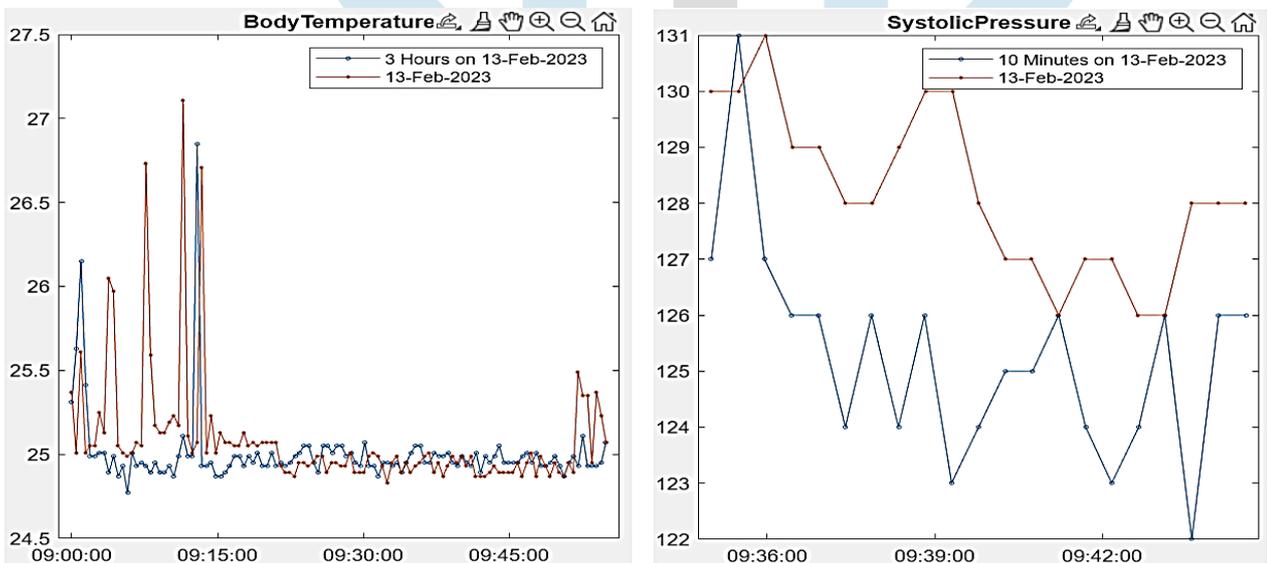
Figure 5.5: Sample Data of patient – Body Temperature & Systolic Pressure

The figure 5.6 shows the sample of Diastolic Pressure and Heart Rate data of the patient.
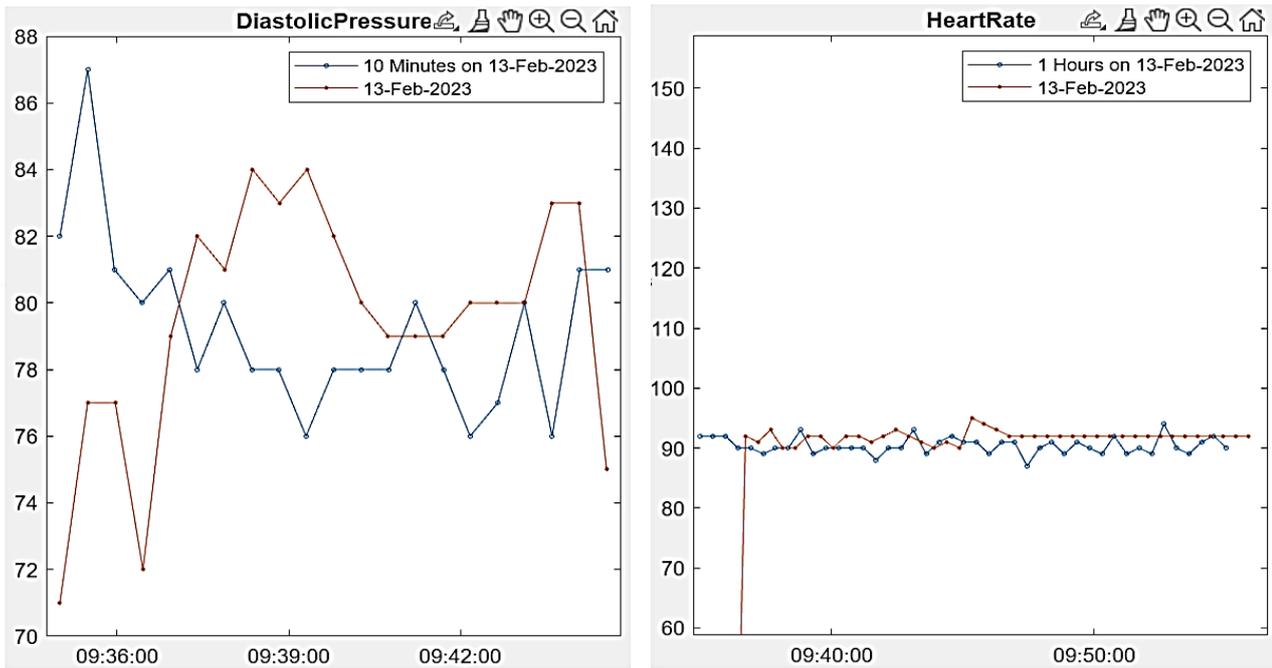
Figure 5.6: Sample Data of Patient – Diastolic Pressure & Heart Rate

The figure 5.7 shows the sample of Oxygen Saturation data of the patient and Indoor Air Quality.

Figure 5.7: Sample Data of Patient – Oxygen Saturation Level & Air Quality

The figure 5.8 and figure 5.9 shows the developed system and the patients parameters readings on LCD respectively.

Figure 5.8: Commissioning of the Developed System with Patient end display

Figure 5.9: patient's Health parameters readings on LCD

The Table 1 shows the sample of Data on 7th February 2023 from 9.58 PM to 10.24 PM.

Table 1. Sample of Data on 7th February from 9. 58 PM to 10. 24 PM

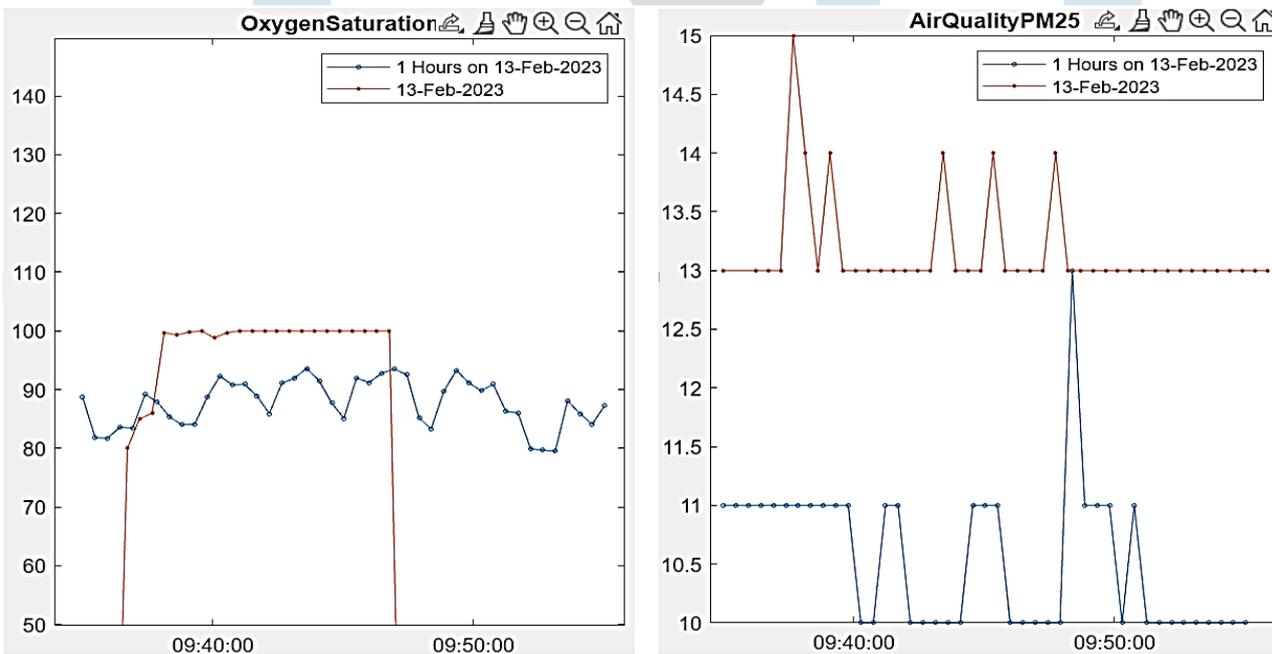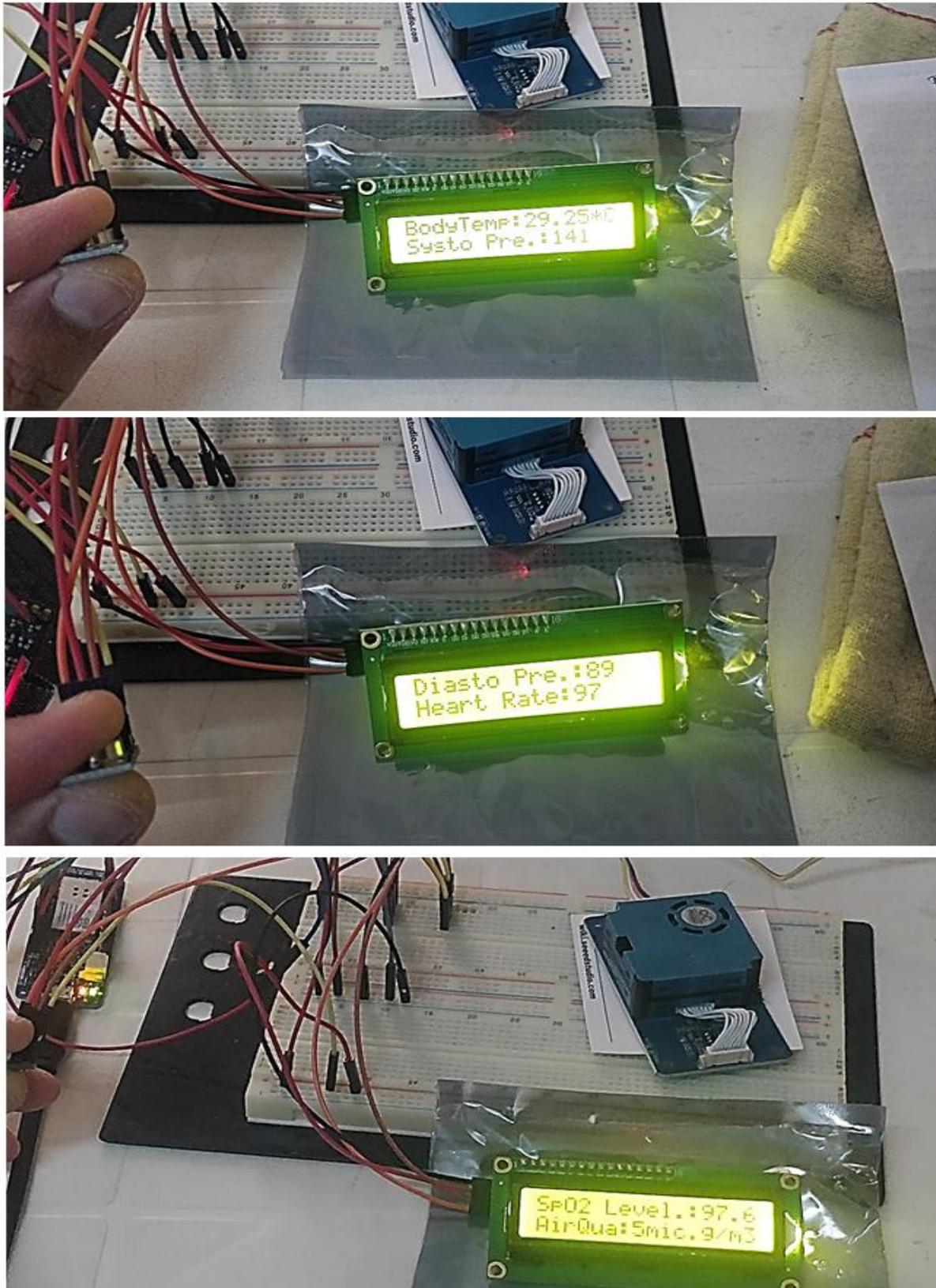| The Table 1	BodyTemperat	SystolicPressu	DiastolicPressu	HeartRa	OxygenSaturati	AirQualityPM
'07-Feb-2023	23.63	0	0	0	0	10
'07-Feb-2023	23.58999	124	73	84	98.4	10
'07-Feb-2023	23.57	126	80	86	98.1	10
'07-Feb-2023	23.58999	125	75	84	98.1	11
'07-Feb-2023	23.63	129	71	88	98.1	11
'07-Feb-2023	23.58999	125	84	85	97.7	11
'07-Feb-2023	23.64999	125	75	86	96.7	11
'07-Feb-2023	23.63	123	71	86	97.5	10
'07-Feb-2023	23.57	129	80	86	97	10
'07-Feb-2023	23.63	129	78	86	97.7	13
'07-Feb-2023	23.58999	123	73	84	98.3	11
'07-Feb-2023	23.63	127	83	87	97.5	10
'07-Feb-2023	23.63	128	79	88	97.8	11
'07-Feb-2023	23.69	125	74	86	98.4	11
'07-Feb-2023	23.63	126	82	87	98.3	11
'07-Feb-2023	23.63	125	70	88	99.6	11
'07-Feb-2023	23.64999	126	80	87	98.4	11
'07-Feb-2023	23.64999	123	70	85	99.2	11
'07-Feb-2023	23.58999	126	78	88	99.8	11
'07-Feb-2023	23.58999	128	76	91	99.3	11
'07-Feb-2023	23.63	128	78	90	100	11
'07-Feb-2023	23.57	128	84	0	99.7	11
'07-Feb-2023	23.63	123	78	0	97.3	11
'07-Feb-2023	23.69	126	82	0	97.4	11
'07-Feb-2023	23.69	121	73	149	97.3	11
'07-Feb-2023	23.70999	127	80	90	98.7	11
'07-Feb-2023	23.64999	123	74	84	97.1	11
'07-Feb-2023	23.69	125	79	85	97.9	11
'07-Feb-2023	23.69	126	81	92	97.6	11
'07-Feb-2023	23.69	120	74	86	97.2	10
'07-Feb-2023	23.74999	124	76	86	98.2	10
'07-Feb-2023	23.69	125	82	85	98	10
'07-Feb-2023	23.70999	127	77	90	98.3	10
'07-Feb-2023	23.69	124	77	85	98.7	11
'07-Feb-2023	23.64999	125	77	89	97.2	11
'07-Feb-2023	23.74999	126	81	86	98.1	11
'07-Feb-2023	23.79	127	82	86	97.1	11
'07-Feb-2023	23.74999	128	80	88	96.8	11
'07-Feb-2023	23.63	123	78	84	97.2	11
'07-Feb-2023	23.64999	122	79	87	97.3	10
'07-Feb-2023	23.70999	126	82	87	98.8	10
'07-Feb-2023	23.74999	125	70	85	98.7	11
'07-Feb-2023	23.63	127	77	90	98	11
'07-Feb-2023	23.63	127	77	85	97.7	11
'07-Feb-2023	23.63	125	72	83	98.1	11
'07-Feb-2023	23.63	124	77	85	98.7	11
'07-Feb-2023	23.64999	124	76	87	98.7	11
'07-Feb-2023	23.64999	120	69	89	98.9	11
'07-Feb-2023	23.64999	124	73	87	99.3	10
'07-Feb-2023	23.64999	127	75	89	98.4	11
'07-Feb-2023	23.69	127	72	91	98.5	10
'07-Feb-2023	23.69	122	68	86	98.7	11
'07-Feb-2023	23.69	127	84	87	98.7	11
'07-Feb-2023	23.69	124	77	87	99	11
'07-Feb-2023	23.74999	124	76	87	99.6	11

VI CONCLUSION

In this work, we have designed and demonstrated IoT-based patient health monitoring system, consisting of Various Sensors, microcontroller, a Wi-Fi network and Thingspeak web server. The proposed system has been developed, tested and analysed using Thingspeak Data Explorer which is a MATLAB App. The measurement of Body temperature, Systolic blood pressure, Diastolic blood Pressure, Heart Rate, SpO2 level and Indoor Air Quality parameters were recorded and transmitted to the web server. This improves accessibility to the doctor even from remote place thereby enhancing mobility and minimising the efforts for diagnosis of the patient condition.

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