Smart Health Monitoring System: Integrating Sensor-based Data Acquisition and IoT Connectivity for Real-time Analysis

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ABSTRACT

The progress in communication and information technology has contributed to the creation of the Internet of Thing (IoT). Internet of Things today plays a crucial role in tracking, documenting, storing, presentation and communication in variety of fields like healthcare, smart cities, engineering and others. The rapid advancement of technology in recent years has opened up new opportunities for revolutionizing the healthcare sector. Healthcare requests generally reflect close attention to IoT techniques due to cost savings, ease of interpretation, and recovery of patient personal satisfaction. Sensors enable continuous health monitoring and real-time data transmission via wireless connectivity, making the system highly portable. Key parameters such as heart rate, temperature, and vibration are seamlessly integrated into a parallel processing microprocessor. To facilitate remote monitoring from anywhere in the world, the paper also introduces a smart IoT gateway responsible for data processing, local web server hosting, and cloud connectivity.

Key words: Arduino UNO, ESP8266 IoT module, heartbeat sensor, temperature sensor, vibration sensor, health monitoring

1. INTRODUCTION

Specialists throughout the healthcare sector are increasingly leveraging the areas of concern that these developments carry in and can allow considerable improvement in and beyond the medical administrations. Similarly, the capabilities of Electronic Health apps and Health (therapeutic organizations managed by ICT) are utilized by countless regular consumers to develop, support and strengthen their healthcare network. The SMS is submitted to the specialist or to any family member in some fundamental situation. Health analysis slowly misuse the points of value these developments add to the social security market in the healthcare setting, thus creating a crucial change. Likewise, endless standard customers are helping and helping their health experts by using the M-Health (Mobile Health) applicants and Health. A dependable and rapidly persistent portion of this corresponding technique. Structure like look (PMS). One of the biggest issues for society is the lack of social security. As the World Health Organization (WHO) parliaments demonstrate, the most elevated feature of the Medical system is a great best thing for a person. In order to persuade and render people look, it is important to have a flash similar to the new mending machine. The system for social insurance will include stronger remedial connections for people wherever they are, in a sustainable and careful manner. Provided that such contraptions support the Internet, they boost the environment and ensure that organizations and social security become continually safe and logically drawn. The whole idea of IOT remains on sensors, portion as well as remote systems that allow customers to grant and access the application information. No place, however, is the IOT across all zones more apparent than it was in the areas of prosperity treatment. As a cliché states, 'Prosperity is money,' the movement towards greater results is phenomenally important. Therefore, it is necessary to connect to an IOT framework that provides secure and prosperous analysis. At present, the contraction of human institutions, the conventional way of coping with a technologically advanced personally driven oriented system, is being traded. As the age profile of many societies continues to increase, in addition to the increasing population of people affected by chronic diseases, including diabetes, cardiovascular disease, obesity, and so on, supporting health, both mentally and physically, is of increasing importance if independent living is to be maintained. Sensing, remote health monitoring, and ultimately, recognising activities of daily living have been an promising solution. From a technical perspective, the Internet of Things (IoT) is gaining a rapidly growing attention in many disciplines, especially in personalised health

body area sensor network (BASN) under the IoT framework has been widely applied for ubiquitous health monitoring, for example. ECG monitoring has been commonly adopted as vital approach for diagnosing heart disease. The main contribution of this paper include the following: firstly, this paper presents a novel system, the WISE (Wearable IoT-cloud-baSed health monitoring system), for real-time personal health monitoring. WISE adopts the BASN (body area sensor network) framework in the support of real-time health monitoring. Several wearable sensors have been embedded, including the heartbeat, body temperature sensors.

The size and composition of the world population has changed over the last couple of decades, and these trends are projected to continue. Such demographic trends have significant implications for almost all areas of the society, particularly in health and healthcare. Life expectancy has increased dramatically, especially in the more affluent nations, which is set to be celebrated and should be viewed as an opportunity for people to live longer and better. However, this requires substantial improvement in both the healthcare service and the living environment, as older people generally require more healthcare than their younger counterparts. Additionally, older people are more likely to suffer from chronic disease as part of the natural ageing process. In parallel to this demographic time bomb, the cost of healthcare provision is increasing rapidly in all the nations across the world.

In this paper, we present an idea of a service model in technological and economic views for the comfort of patients and also the open challenges in implementing IoT in real world medical field.

2. LITERATURE SURVEY

The IoT Based Emergency Health Monitoring System utilizes IoT technology to continuously monitor patients' physiological parameters such as pulse, body temperature, and heart rate. This system collects and transmits patient data to a cloud platform, enabling medical specialists and authorized individuals to monitor the patient's health remotely. The system aims to provide efficient and effective health facilities to patients, particularly those suffering from chronic conditions like Chronic Heart Failure (CHF). As a cost-effective and user-friendly solution, it has the potential to revolutionize healthcare by enabling virtual consultations and introducing cloud-based innovation in the medical field. In future developments, additional sensors such as respiratory, and glucose sensors could be integrated to create a comprehensive health monitoring system.[1] The objective is to develop a device which helps to monitor a patient's health. It is used to detect parameters like temperature, heart rate, saline water level, etc. It also displays messages regarding patient’s health.[2]

This paper discusses the potential of IoT-based health monitoring systems in early detection, real-time monitoring, and tracking of pandemic diseases, with a specific focus on COVID-19. It includes a special issue containing sixteen papers that cover various aspects of IoT-based health monitoring systems and related areas, such as machine learning-based diffusion models and smart healthcare frameworks. The document provides valuable insights into the potential of IoT-based health monitoring systems in combating pandemics and improving public health.[3] The IoT based Health Monitoring & Automated Predictive System proposed in this paper works by collecting real-time biological data from patients using physical sensors and processors. These data are then passed to a Raspberry Pi, which uploads them to a cloud network using a WiFi module. The benefits of combining IoT and machine learning in combating COVID-19 include more efficient monitoring of the health status of patients, early detection of the severity of coronavirus, and providing proper treatment to the patient and suspected cases. This system can be implemented in different healthcare settings, and it has a great promise to combat the coronavirus by responding to critical health situations and providing proper treatment to patients.[4]

The paper discusses an IoT-based system for monitoring the health of paralysis patients, focusing on vital signs such as heart rate, and body temperature. It utilizes technologies such as Bluetooth, heart rate sensors, and Arduino microcontroller boards. The system aims to provide continuous monitoring and real-time data transmission to healthcare providers, enabling timely intervention and improved patient care. Additionally, it incorporates an alarm system to alert healthcare providers of any abnormalities in the patient's vital signs.[5] The paper titled "Health Monitoring System Using IOT Sensor" discusses the integration of IoT and cloud technologies to monitor and track human wellbeing. The system uses sensors to collect data on body temperature, breathing oximetry, and

environment humidity and temperature, which is then transmitted wirelessly to healthcare providers for diagnosis and treatment. The document also covers the benefits of using IoT technology for health monitoring and provides technical details on the system's design and implementation.[6] The paper "ai.pdf" discusses the use of IoT in monitoring and controlling the spread of COVID-19. It proposes a framework for real-time data collection of infected persons using IoT-based sensors. The study employed machine learning models to predict the severity level of COVID-19 patients. The proposed IoT-based architecture includes components for data collection of disease symptoms, health centers/quarantine centers, data warehouse, and health professionals. The study aims to provide a comprehensive understanding of the potential of IoT in combating the global burden of the COVID-19 pandemic.[8]

3. EXISTING SYSTEM

In existing system of health monitoring system many sensors are used to measure the health parameters temperature, body motion, pulse rate all are measured and displays in LCD only. In existing model we don't have data transfer through longer distance using any wireless communication. To secure the patient health the proposed model implemented with IOT setup automatically sends alerts to doctor and relative in case of emergency. Before this project was introduced, Bluetooth was used in its place. Also few parameters like Fall detection is not available. Bluetooth can range upto 10 meters (30 feet). So it would be within the hospital or nearby distances. Where caretakers or family members can access it only from short range of distances.

4. PROPOSED SYSTEM

In the proposed system of health monitoring system, we used SpO2, vibration sensor and heartbeat sensor for monitoring the human body health parameters and display in LCD and IOT server. If the heart rate fluctuates then buzzer module automatically alerts and same thing will update in server. This methodology is intended to build a structured remote observation system for wellbeing. The goal is to track the patient's heart rate that the NRF innovation specialist will be faced with. The care services in medical centers are consistent with the assessment of the wellbeing of the patients. The body of the patient is continuously monitored for heart rate and pulse and registered. This interface is simple, illustrating the usage of ESP8266 and Arduino IoT Patient Safety Monitoring Program. The Arduino designs the application and shows an LCD panel with 16 * 2. Starts sending the data to the IoT application server via WLAN ESP8266 unit partners with both the WiFi. Thing speaks is the IoT server used in this. Finally, data from anywhere in the world can only be verified by identifying the channel Thing speak. Hardware modules used in this proposed system is explained in below.

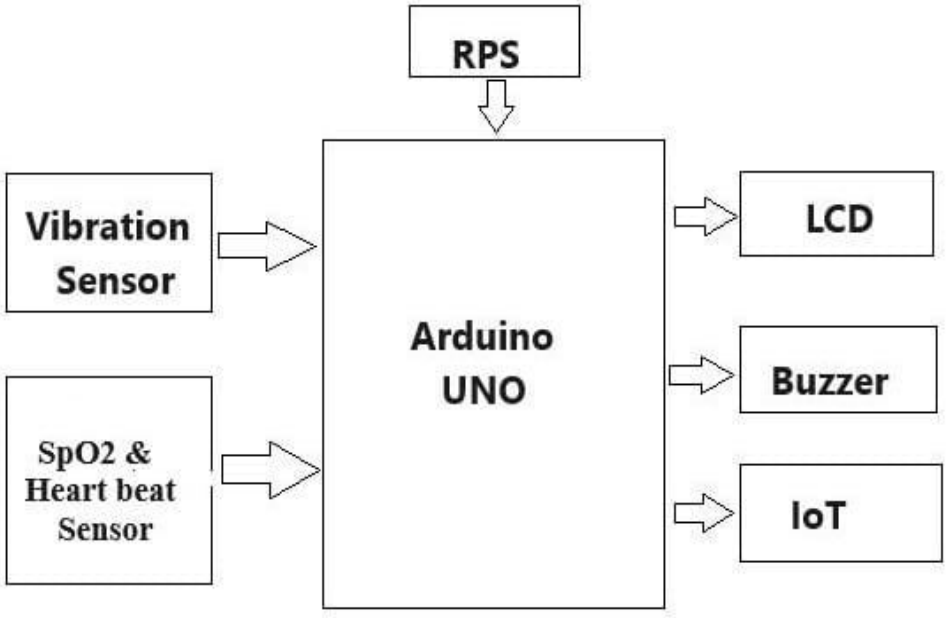

Fig. 1: Block diagram

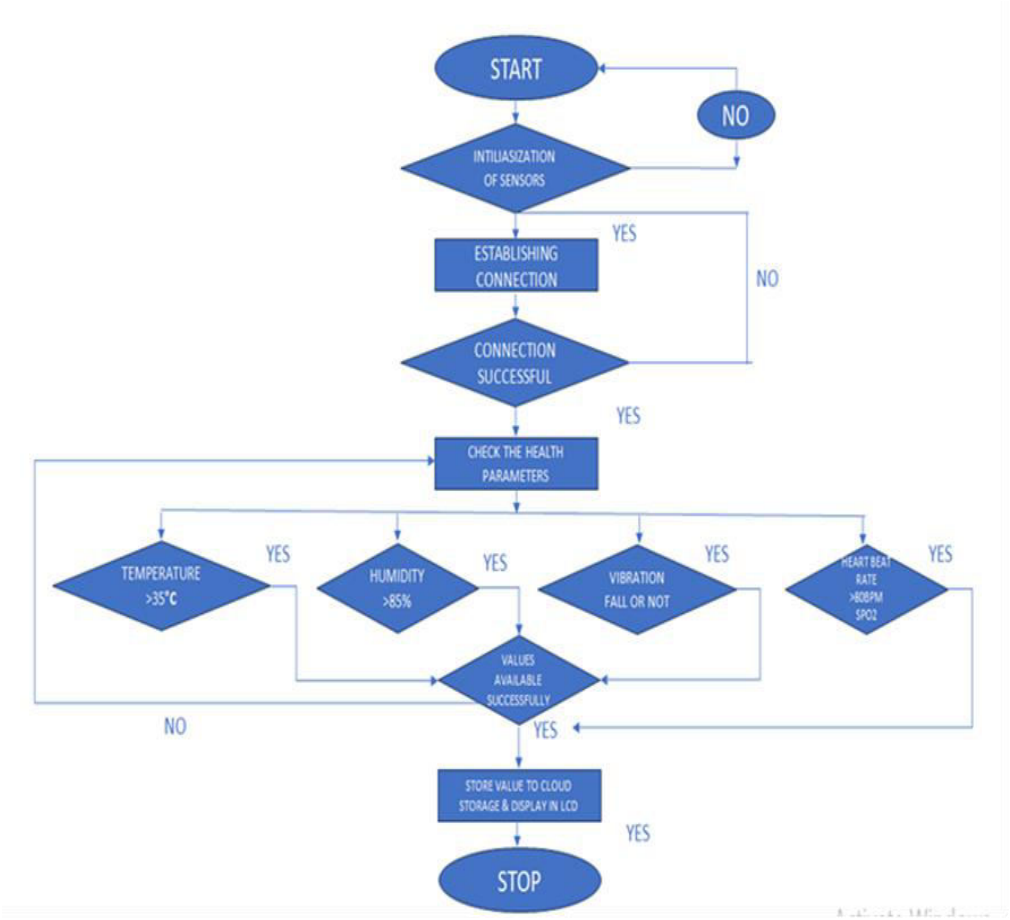

Fig. 2: Flow Diagram

Logic Explanation:

The code starts by importing necessary libraries and defining pin connections for various components. An instance of the Liquid Crystal class (lcd) is created. In the setup() function, pins are set up for output (buzzer) and input (vibration sensor). The buzzer is initially turned off. Serial communication is initialized for the built-in serial port and the Software Serial instance (mySerial). The LCD is initialized and displays a startup message. WiFi is initialized using the wifiinit() function, and the LCD is cleared. The loop() function contains the main logic for monitoring different sensors and uploading data to the server. It performs the following steps:

- Reads temperature and humidity from the DHT sensor and displays them on the LCD.
- Checks temperature and humidity thresholds, producing an alert with the buzzer and uploading data if thresholds are exceeded.
- Monitors the vibration sensor, updating its status on the LCD and uploading data if vibration is detected.
- Obtains heartbeat and SPO2 readings, handling potential value limits.
- Displays heartbeat and SPO2 on the LCD.
- Periodically checks if it's time to upload data to the server and does so with an alert.

SCHEMATIC DIAGRAM

Below is the pin diagram where all the hardware components are been connected components. this ARDUINO microcontroller having 28 pins. In which 14 GPIO pins as digital pins and 6 GPIO pins.

16MHz crystal oscillator connected internally. The step down transformer, Bridge rectifier capacitor with 1000f Resisters and led are connected in Regulated power supply which provide the 5v to the Arduino and all input/output modules.

Schematic

- 16*2 LCD Monitor has connected with the Digital pins 2, 3, 4,5,6,7.
- WIFI has connected to Digital Pins D0, D1 internal Transmitter and receiver pins.
- DHT11 connected to 10 pin of the Arduino micro controller.
- Vibration sensor connected to digital pin 9
- Spo2 connected to Analog pin of A0.
- Buzzer alarm connected to digital pin 13

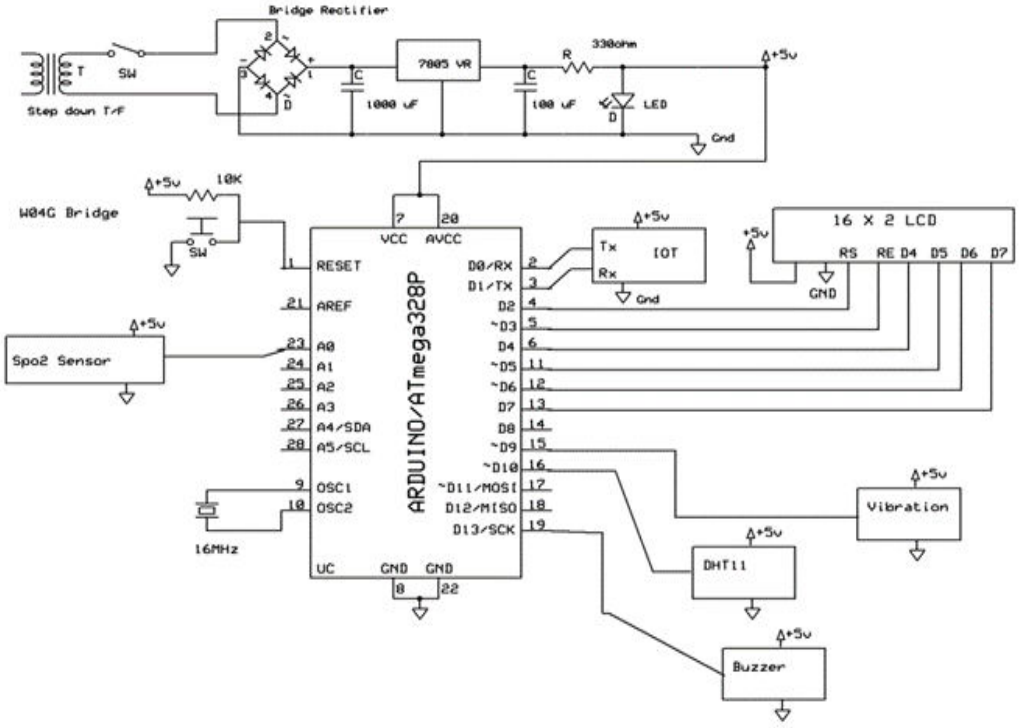

Fig. 3: Schematic diagram

WORKING

IOT Based Health Monitoring is to utilise Various sensors, including vibration sensor, SpO2 sensor, Heartbeat sensor. these Sensors are equipped and connected to patients Heaob. The vibration sensor is used from if there is any problem with patient, alerting doctors to respond. SpO2 sensor here used to measure the oxygen saturation in the blood. Heat beat sensor used to detect and measure the heart rate. The sensor measures the pressure of blood in the arteries, identifies health problems. This sensor is connected with RPS (Regulated Power Supply) which provides constant Voltage output, and to display data we use LCD (Liquid crystal display). If there is any problem with patient heartbeat then the buzzer gets and doctor will take necessary actions.

6. HARDWARE IMPLEMENTATION

The body temperature sensor, pulse rate sensor, room temperature and humidity sensor values are calibrated using the microcontroller. The complete prototype of the health monitoring system with the sensors are shown in Fig.4. Where it shows the output values of the sensors calculated and displayed in a LCD display, so that these values are visible even to the patient. These sensor values are then sent to the database server. These data can be accessed from the cloud by the authorized users using the IoT application platform. The sensor values of the patient are displayed on the app as shown in Figure 6.

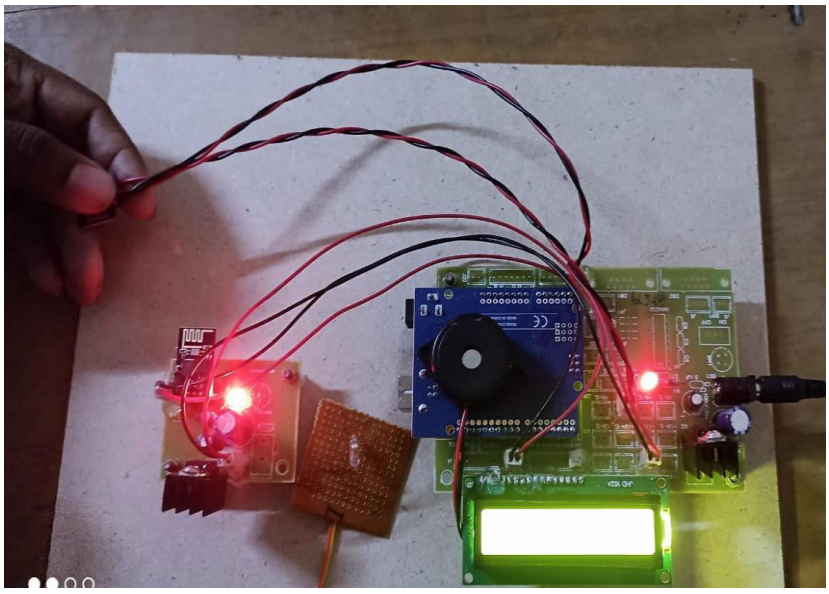

Fig. 4: IoT Based Health Monitoring.

Fig. 5: Sensor Readings in LCD.

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S.No	Vib	HB	SPO2	Date
1	ON	0	0	2023-12-09 14:02:13
2	OFF	0	0	2023-12-09 14:01:54
3	OFF	79	100	2023-12-09 14:00:53
4	OFF	0	0	2023-12-09 13:59:25
5	OFF	0	0	2023-12-09 13:58:24
6	OFF	0	0	2023-12-09 13:57:22
7	OFF	0	0	2023-12-09 13:56:21
8	ON	0	0	2023-12-09 13:55:59
9	OFF	75	97	2023-12-09 13:55:01
10	ON	0	0	2023-12-09 13:54:06
11	ON	0	0	2023-12-09 13:51:39
12	OFF	79	100	2023-12-09 13:51:04
13	OFF	81	93	2023-12-09 13:50:03
14	ON	0	0	2023-12-09 13:49:16
15	ON	0	0	2023-12-09 13:48:46
16	OFF	0	0	2023-12-09 13:45:33
17	OFF	0	0	2023-12-09 13:44:32
18	ON	71	96	2023-12-08 18:30:22
19	OFF	0	0	2023-12-08 18:27:18
20	OFF	0	0	2023-12-08 18:26:17

Fig. 6: Heart Beat & SpO2 Readings

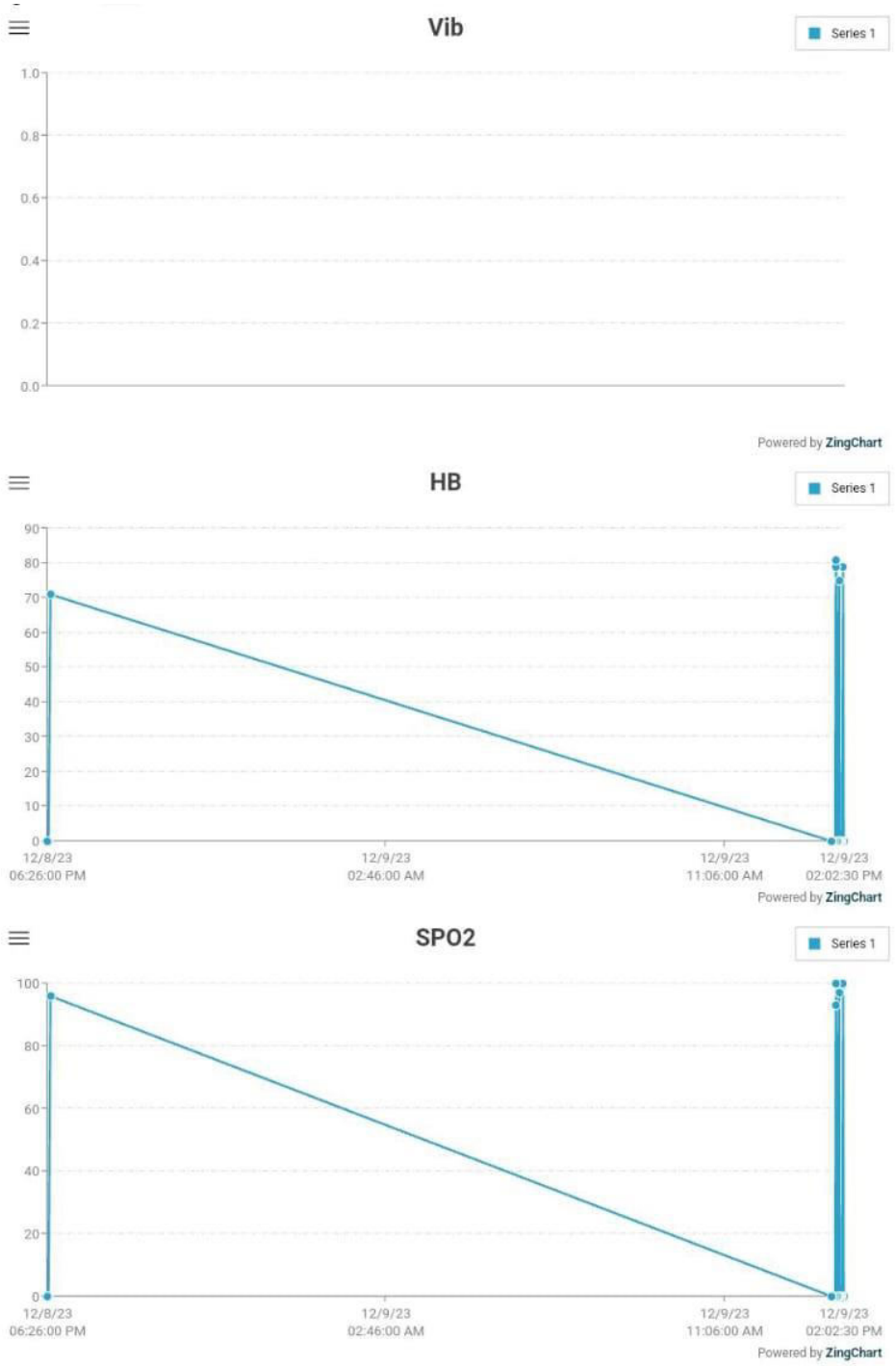

Figure 7: Graphical representation of sensors data.

6. CONCLUSION

We designed and implemented Arduino Based TELE – Health System over Internet of Things with integrating of all input modules like temperature, humidity, position motions, heart rate and oxygen monitoring sensors, output modules LCD, buzzer and wireless communication system called internet of things through Arduino processor. In this proposed system, the various health parameters such as pulse rate, temperature, angle movement of patient were monitored and recorded in the IoT server platform. The values of these parameters were analyzed and alerted in this the proposed system. In

future we will add some other sensors which enhance the health monitoring system like gluecometer and body fat device measurement we can add.

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