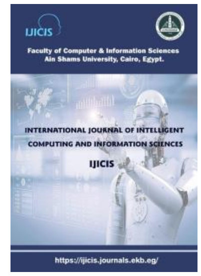
IJICIS, Vol.22, No.4, 86-99
DOI: 10.21608/ijicis.2022.139226.1182

International Journal of Intelligent Computing and Information Sciences
https://ijicis.journals.ekb.eg/



INTERNET OF THINGS (IOT) BASED SMART DEVICE FOR CARDIAC PATIENTS MONITORING USING BLYNK APP

Salma Mostafa A. Helmy*
Software Engineering Department, Faculty of Computer and Information science, Ain shams University, Cairo, Egypt
salma.mostafa@cis.asu.edu.eg

Ayman Mahmoud Amar
Cardiac Surgery Department, Faculty of Medicine, Ain shams University, Cairo, Egypt
ayman.ammar@med.asu.edu.eg

El-Sayed M. El-Horbaty
Computer Science Department, Faculty of Computer and Information science, Ain shams University, Cairo, Egypt,
shorbaty@cis.asu.edu.eg

Received 2022-05-18; Revised 2022-05-18; Accepted 2022-11-28

Abstract: *The health support of everybody should be considered as a highly significant, due to the huge increases in various health concerns. Meanwhile, heart attacks and cardiovascular disorders caused a public issue with high mortality ratios and cardiac patients, thereby increasing the open-heart surgery cases, limiting the available number of doctors, and most importantly generating an inefficient environment for caring patients, particularly with severe and fragile health problems. Hence, healthcare systems have begun to connect with IoT to keep each patient's digital identification. We, therefore, aimed at designing a smart device for cardiac patient's monitoring to save time and effort for both caregivers and patients. Our design also could prevent crowding in health care places, provide a link between a person's hectic lifestyle and regular, and continuous the health checkups via remote access. The results from our prototype device can be employed for cardiac patient monitoring using IoT-technique which will monitor several health signs, i.e., blood oxygen ratios, heart rate, and body temperature. These signs can be remotely retrieved and/or imagined via medical experts on a handheld device through blynk APP from any location at any time. They also can gather the data and provide the real-time information about the patient through the Bluetooth module. Several individuals were put through a series of tests based on a variety of parameters. In conclusion, IoT could be recommended as a smart tool in the health care for monitoring the cardiac patients quickly and efficiently.*

Keywords: *Internet of things*, *Cardiac patients*, *Blynk Mobile application*, *Arduino UNO*, *Real time monitoring.*

***Corresponding Author:** Salma Mostafa A. Helmy

Software Engineering Department, Faculty of Computer and Information science, Ain shams University, Cairo, Egypt

Email address: salma.mostafa@cis.asu.edu.eg

1. Introduction

The utilization of the communication facilities in combination with the fast-evolving technology, including machine learning, Internet of things (IoT), mobile & cloud computing, wireless sensing, and huge data analysis, increased the accessibility of healthcare facility. IoT also amended the human self-sufficiency and expanded their capability to cooperate with the external world. IoT has become a substantial provider to worldwide interaction, especially with the aid of futuristic protocols and algorithms. It unites a vast number of internet items, such as home purposes, electronic tools, and wireless sensors [1]. IoT is achieving the reputation, mostly owing to its merits in term of accuracy improving, cost reducing, and the ability to well-estimate the future outcomes. Additionally, the instant IoT-upheaval has been simplified by the improved of both software and apps knowledge, evolutions in mobile and computer tools, extensive accessibility of wireless technology, and extension of the numerical economy [2]. Thus, IoT is currently widely utilized in several applications, like smart homes & cities, wearables, and linked health. IoT, which is a platform, allows the network's devices, sensors, and items to link with another one or with other things in the same network.

It also mails data over the internet without required the human meddling [3], thereby, lowering the system mistakes as well as improving its effectiveness and consistency. The usage of IoT in remote health observing systems is spotlighted [4]. Recently, the healthcare industry was grown, adding to income and jobs [5]. Only a limited years ago, disorders and irregularities in the human body could be identified only by undertaking a physical examination in a hospital. Most of the patients ought to wait in the hospital for the time needed of their therapy. This increased the healthcare costs and draining healthcare facilities in both rural and distant districts. The increases in technology lastly have conceded for the identification and checking of many diseases *via* miniature devices including smartwatches. Additionally, technology has altered the healthcare procedure from a hospital-centrical to a patient- centrical one [6,7]. Human contest the progresses in terms of technology every time, where health is often a massive concern.

Recently, Corona virus has destroyed the economies of numerous countries, showing the illustration of how the growing in the health is really demanded. It is often a good option to observe these individuals utilizing the remote health checking technologies on sites where the virus has distributed. Consequently, the current answer is the using of IoT-based health monitoring system [8]. This heart condition necessitates long-term surveillance and proper controls against him. IoT enables the transition from manual cardiac patient monitoring to remote cardiac one. A doctor may not always be available to treat or care for the patient, and a guardian may not always be available to transport the patient to the hospital. As a result, we designed a cardiac patient monitoring system that allows doctors to remotely monitor physical data, like heart ratio, temperature, and oxygen capacity. According to a June 2013 report in The Star, Malaysia's National Heart Institute, which has befitted the first hospital to introduce a remote patient checking system, which will improve transmission among doctors' patients *via* the internet [9]. The remnant of this paper is arranged as monitors: we also narrated in this paper Background and Related work (section 2), material & methods(methodology) of IoT based smart device for cardiac patients monitoring (section 3), Results and discussions (section 4), and the conclusion & future work (section 5).

2. Background and Related work

Herein, latest research in the IoT-field uses and functions in the arena of cardiac patients was described. "Apnea MedAssist "[10] is applied on Android functioning system (OS) established smartphones. It utilizes either the typical adult specialty-independent SVC or specialty-dependent SVC. The real-time ability derives from the utilize of 1-min sections of ECG epochs for piece isolation and cataloguing, and achieves a cataloguing F-measure of 90 % and a sensitivity of 96 % for the specialty-independent SVC, The condensed difficulty of "Apnea MedAssist " derives from effective optimization of the ECG administering, and utilize of systems to decline SVC model difficulty by dipping the measurement of characteristic fixed from ECG and ECG-resulting inhalation signs and by decreasing the number of sustenance vectors.

A Non-intrusive Wearable Neck-Cuff System for Real-Time Sleep Checking [11]. In this study, they industrialized a non-intrusive wearable neck cuff system which can achieve real-time checking and imagining of snooze data. The system is consisted of numerous physiological radars combined in a relaxed soft neck-cuff that is damaged by the patient in their domestic through sleep. Sleep data is wirelessly showed *via* Bluetooth to a neighboring cell phone for handling and storing. This data is valuable for sleep syndrome analysis, sickness candidate collection and construction a gathering of sleep data utilized for additional analysis and to create a wellbeing reference. They established the utilize of the neck-cuff system in the probable discovery of disruptive sleep apnea.

Uniyal D, et al [12] professed that pervasive healthcare targets to deliver round-the-clock checking of numerous dynamic signs of patients by numerous health sensors, specified contact protocols, and sensible context-aware requests. Current surveys on pervasive healthcare covering broad practices or a specific function, like fall discovery. the author performed a complete reporting of numerous general illnesses delivered by pervasive healthcare recently. The nearly categorize various infections by age groupings of patients and then consider several hardware and software instruments and techniques to identify or cure them.

Chao Lia, et al [13] projected an IoT-based heart syndrome checking system for pervasive healthcare facility. This approach screens the patients' physical signals i.e., as blood pressure, ECG, SpO2, and applicable environmental markers unceasingly, and delivers four dissimilar data transmission manners that surplus the healthcare necessity and request for transfer and figuring properties. They also realized an example to extant an indication of the system.

Adrian Brezulianu et al. [14] developed IoT-based heart action checking by inductive sensors. The author describes a system that monitors heart action considerations by innovative ElectroCardioGraphy (ECG) mobile methods and a Wearable Heart Monitoring Inductive Sensor (WHMIS). The idea of incorporating a "wear and forget" device onto fashion is useful for checking data ratio and respiration as crucial markers. The data rate and exhalation indications are calculated using the similar output signal from the inductance-to-number evangelist. The body action through data challenging has a considerable influence on the inductive symbol, causing act artefacts, and this method is not suitable for everyday use.

Sani Abba and Abubakar M. Garba [15] presented an IoT-based smart framework for monitoring and controlling human heartbeat rates, it was designed to be used on a breadboard with a variety of system components that are met, secured, and tasted. The system's components are mended on a breadboard and housed in a plastic container, with the heart pulse sensor protracted to be decrease onto the user's probing. For data collection, this device makes use of a cardiac pulse sensor. The microcontroller interprets a human heartbeat as data signals and processes them. The data is analyzed and sent to an IoT platform for further analysis and visualization. Because the system was able to observe and evaluate the pulse rate of its operators and connect the data over the internet, the prototype's investigational discoveries were proven to be accurate. A detailed of the heart ratio checking finding system employing IoT and a pulsation sensor with an Arduino Uno and a Bluetooth HC-05 element by Sahana S Khamitkar and Mohammed Rafi [16]. For data collection, this device makes use of a cardiac pulse sensor. The microcontroller interprets a human heartbeat as data signals and processes them. The processed data is sent to an IoT platform for further analysis and conception. The device was capable to feel and recite the heartbeat ratio of its operator and transmit the identified data through Bluetooth to an Android mobile app, resulting in exact outcomes (Blynk).

After presenting intensive literature surveys describes in this division & [17], the subsequent inadequacies have been highlighted in the IOT in heart diseases checking: Most of research use one or two radars like heartbeat sensors, Spo2sensor to detect heartbeat ratio in steady declaration and progress state only but not uses additional adjustable to display the heart health. The Internet of Things architecture is extremely multifaceted which wants a hybrid cloud situation to track. The number of wearable's, mobile devices and other associated things are rising meaningfully. This rises the opportunities of depleting novel kinds of applications which utilize several sensing and communication devices. Due to fast expansion of IoT, millions of substances related to the internet. These smart substances combine huge amount of data that demand to be handled, analyzed and store data for upcoming inspection. Hence scalability of IoT network is a key concern.

3. Methodology

The components of cardiac patient monitoring device architectures can be classified as sensors or actuators. They could be described as A device that detects changes in a patient's health characteristics and answers to some other output of the system. A sensor converts a physical singularity into a quantifiable equivalent voltage or a digital signal in some circumstances. Then, it is presented or transmitted for interpretation and/or additional managing on computing devices varying from wearables to PDAs, i.e., laptops, tablets, and smartphones. The data storage components, which contain any item with a memory portion affixed to it and networking elements like wireless components and routers will be used afterwards. The cardiac patients checking systems are created based on sensors including temperature, SpO2, and heart rate (Pulse Rate) ones.

Our proposed model objective:

- Managing the number of sensors.
- Performing real-time monitoring.
- Collecting and analyzing data.
- Setting up interoperability across devices.

Model component: NEEDS

1) Arduino Uno.
2) USB cable.
3) HC-05 Bluetooth.
4) Jumper wires.

5) Bread board.
6) Spo2 _ Heart-Rate Sensor (MAX30102).
7) Temperature Sensor (MLX90614 Contactless).
8) Blynk application.
9) Clip with standard dc male plug/holder with 9v battery.

1- The Arduino Uno as shown in Figure. 1 is a microcontroller panel that utilizes the ATmega328P microcontroller (datasheet). It includes fourteen digital input/output pins, six analogue inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB fixture, a power jack, ICSP-header, and a readjust button. It gets with all things you will entail to have begun with the microcontroller; easily socket it into a computer by a USB cable or power it with an AC-to-DC adapter or battery.

Figure. 1: The Arduino Uno.

2- USB cable as represented in Figure. 2 is also utilized to link the Arduino UNO board with the computer.

Figure. 2: The USB cables.

3- The HC-05 Bluetooth module as illustrated in Figure. 3 is a sequential Bluetooth module that can be utilized as an expert and/or a slice. Most roles are pre- fit, thus just serial port transmission is possible, but it is simpler to operate. This module also contains the base board, not just the core one. It is also compatible with Arduino and Microcontroller.

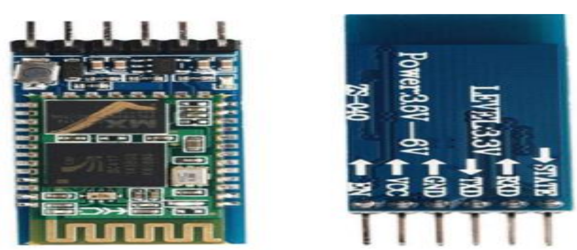


Figure. 3: The HC-05 Bluetooth module.

Features: It could benefit the widely used CSR Bluetooth chip and the Bluetooth V2.0 protocol standard. The 3.3V is the operating voltage for the serial port. The default baud rate is 9600, but it also can be altered with the AT command. The current operation, pairing at 30 MA, communication at 8 MA after pairing GPS navigation systems, remote data collection, and PDA devices are all examples of wireless data communication equipment. It is also compatible with a laptop, a laptop Bluetooth adaptor, PDAs, and Arduino.

4- Jumper wires as clarified in Figure. 4 are easily wires giving connecter pins on both edges which could be utilized to link up two spots without using the solder. The jumper wires are regularly utilized with breadboards and other prototyping devices to let for speedy circuit differences as required.

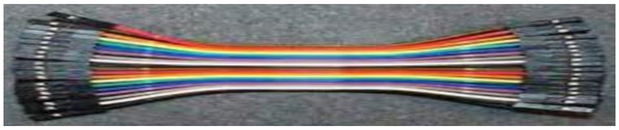


Figure. 4: The jumper wires.

5- A breadboard as shown in Figure. 5 is a solderless prototyping device for electronics and test circuit designs. The breadboard includes metal streaks below it that connect the openings on the board’s top.

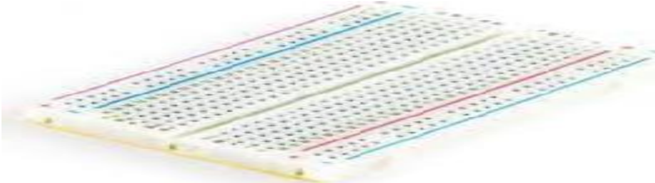


Figure. 5: The breadboard.

6- Pulse Oximeter SpO2 - Heart-Rate Sensor (MAX30102). The Sensor as represented in Figure. 6 has couple of LEDs, in which one releases red light and the other releases infrared light.

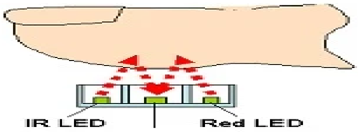


Figure. 6: The MAX30102 sensor.

How does the max 30102 pulse oximeter work?

1-By measuring the oxygen concentration in the blood (SpO2 %), it can be used as an oximeter.

2- The oxygenated blood amount in the blood amends due to having more blood after the heart pumps blood. The quantity of oxygenated blood decreases after the heart relaxing. The pulse ratio is expressed by calculating the time between the rise and decline of oxygenated blood, as supported in Figure. 7.

Deoxygenated blood grips red light and transmits more infrared light, whereas oxygenated blood absorbs red light and transmits more infrared light. This is the sensor's primary function. It reads both light sources' absorption levels and saves them in a buffer that can be read the I2C.

Figure. 7: The working method of MAX30102 sensor.

Features: Voltage range: 1.8-5.5V. Both a whole pulse oximeter and a heart ratio sensor are combined, including the optics. There is no need for a second probe. Easy-to-use I2C interface. The ultra-low-power operation extends battery life.

7- Infrared temperature sensor MLX90614, as illustrated in Figure. 8, is a contactless infrared sensor. All needed is a clear line of sight to the item we are aiming for. It is an infrared thermometer with non-communicate temperature detecting capabilities. The thermometer has a high accuracy and resolution, due to its integrated faint sound loudspeaker, 17-bit ADC, and potent DSP unit. With a 0.5 °C precision level, this well-known sensor offers a wide range of applications in healthcare and industrial control.

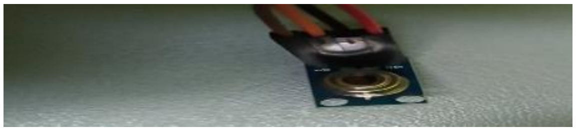


Figure. 8: The MLX90614 sensor.

Features:

- Functioning voltage: 3.3 ~ 5V.
- Thing temperature: -70 to +380 °C.
- High correctness of 0.5 °C, over a varied temperature variety.
- I2C interface.
- Power keeping mode.
- Automotive category.

8- Blynk, as represented in Figure. 9, is a platform which permit you to govern the Arduino, Raspberry Pi, and other tools *via* internet using IOS and Android apps. It is a numerical dashboard, where you may pull and droplet elements to build a graphic interface for your own design.

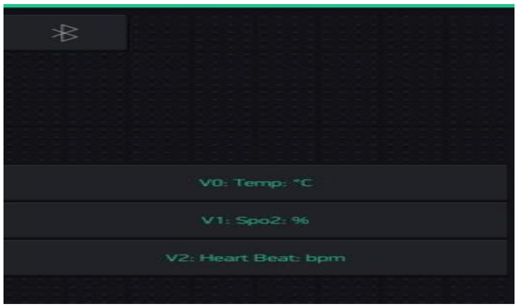


Figure. 9: The Blynk APP.

Features:

1) A popular API and customer interface for all established hardware and devices.
2) Cloud connectivity across WiFi, Bluetooth, and BLE (Bluetooth low energy).
3) Widgets that are simple to benefit.
4) No writing code, just an immediate pin strategy.

5) Using virtual pins, it is simple to integrate and add new functionality.
6) Data monitoring in the past with the Super Chart widget.
7) Bridge Widget-based device-to-device connectivity.
8) Sending emails, tweets, push notifications, and other electronic messages.
9) Clip with a standard dc male plug/holder with a 9v battery, as shown in Figure. 10, which used as a source of
10) power for Arduino UNO board as an alternative of USB cable.

Figure. 10: Battery 9V Holder with Standard DC Male Plug.

4. Results and discussions

The entire prototype of the cardiac patients examining system integrated with sensors are portrayed in Figures. 11 and 12.

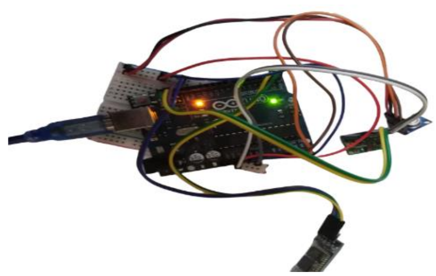


Figure. 11: The prototype of the cardiac patients monitoring device using USB cable.

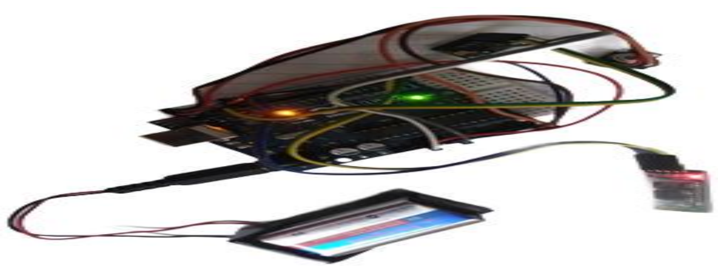


Figure. 12: The prototype of the cardiac patients monitoring device using Battery 9V Holder with Standard DC Male Plug.

Scheming of temperature, SpO2, and heartbeat sensors on Serial Monitor & Blynk App signifies the output which presented on the mobile monitor in the Blynk App, are exemplified in Figures. 13-17.

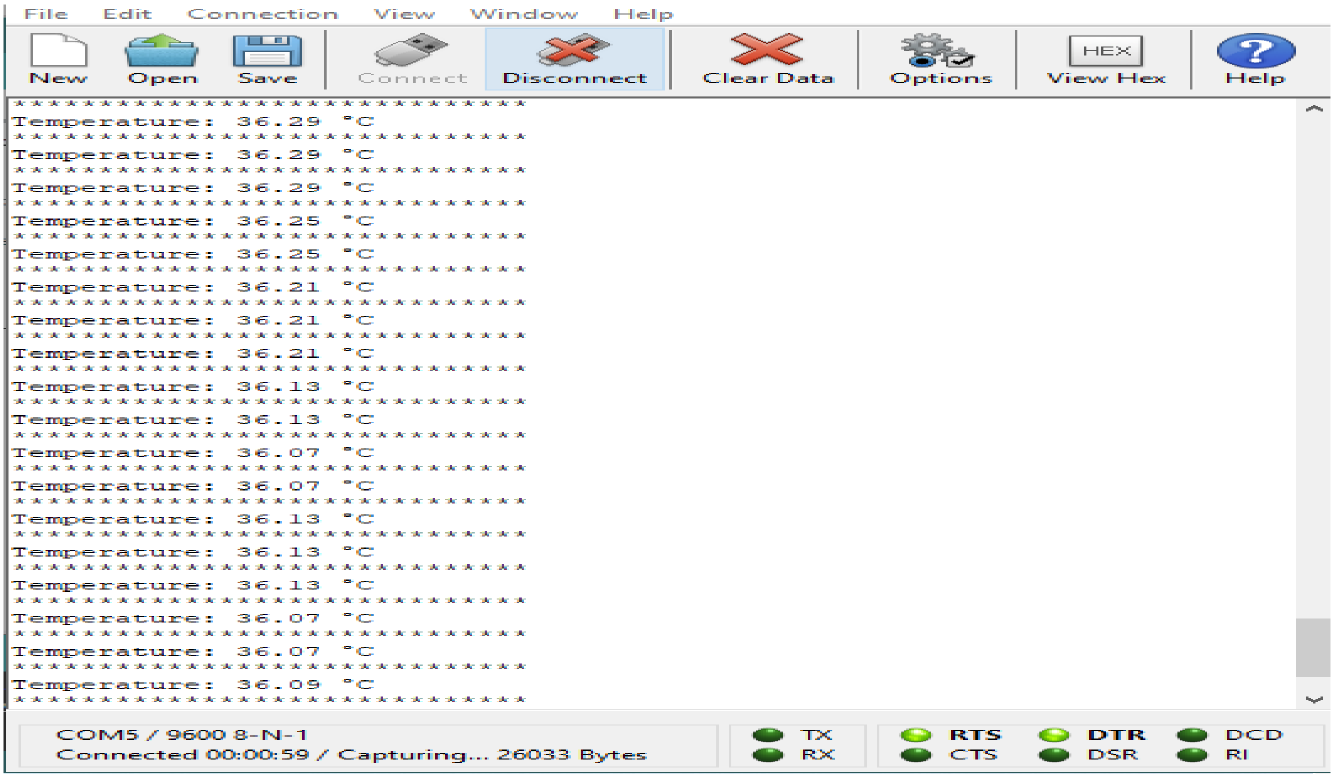


Figure. 13**:** Scheming of the temperature data.

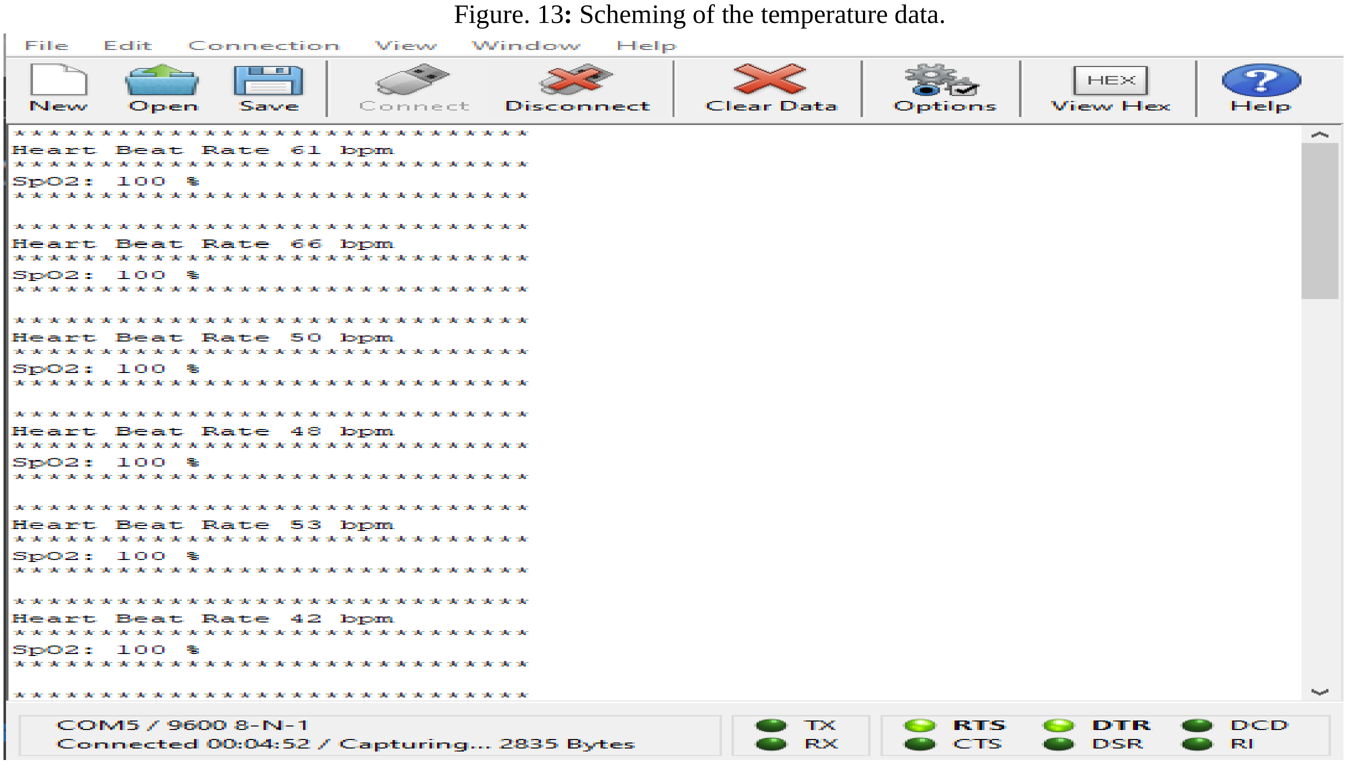


Figure. 14: The heart rate and SpO2 amount.

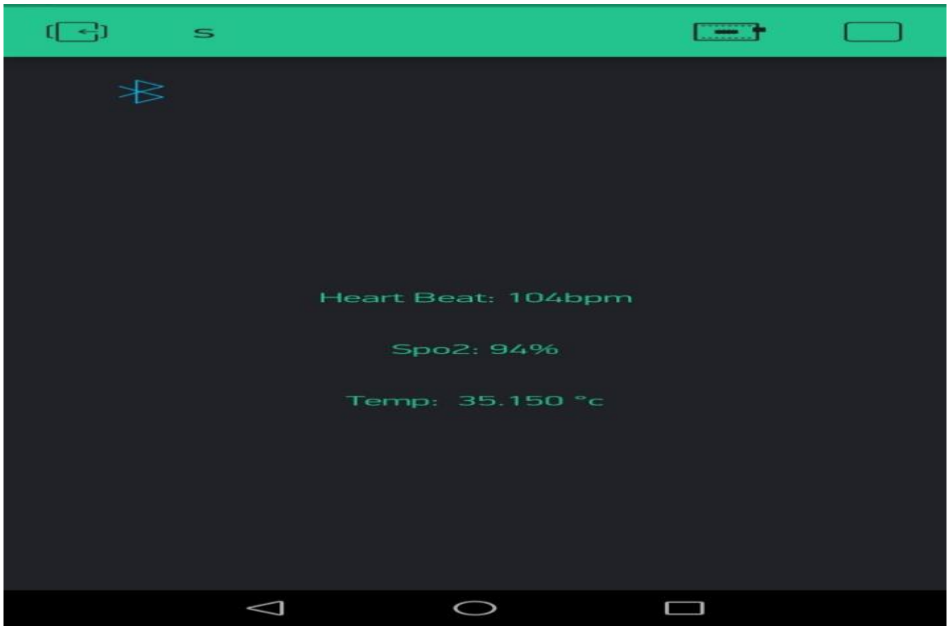


Figure.15: The mobile display of blynk app case.

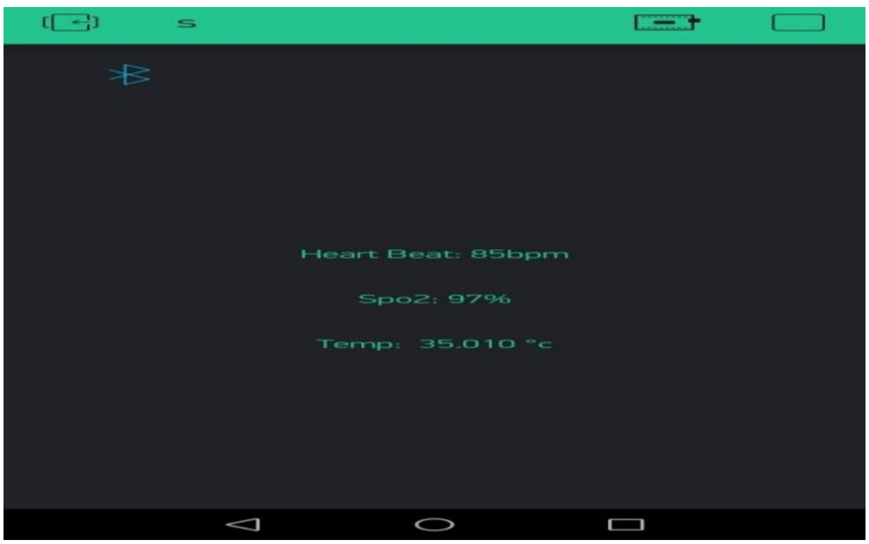


Figure. 16: The mobile display of blynk app case.

Figure.17: Mobile App Interface of another readin

True Facts:

Usually, the oxygen capacity amount collapses between 95 and 99%. When it <90%, the time we ought to pay consideration

- 95-100%: Normal.
- 91-~ 94%: Mild hypoxia (Oxygen losses).
- 86- ~ 90%: Moderate hypoxia.

The fact that heart rate is determined in a relative to age are represented in Table 1. The regulations for identifying the output health situation are as tabulated in Table 2.

Cases

Several volunteers were tested on several criteria as tabularized in Table 3.

Several people were subjected to a series of tests based on a range of factors to ensure that the data was dependable compared with the original numbers. The tested data of volunteers are being concurrently transmitted to doctors who sitting at a remote place to regularly evaluate the real-time data globally received of patients. Accordingly, the results are agreeable, with a very cost-efficient solution, implying that our current study on remote cardiac patient observing systems could be commercially utilized.

Table 1. The heart rate is determined in a relative to the age.

Age group	**Heart rate**
Preterm	120-180
Newborn (0 to 1 Month)	100-160
Infant (1 to 12 Months)	80-140
Toddler (1 to 3 Years)	80-130
Preschool (3 to 6 Years)	80-110
School age (6 to 12 Years)	70-100
Adolescents (12+ Years)	60-90

Table 2. Regulations for diagnosing disorder.

	Body Temperature		
Pulse rate	**Low**	**Normal**	**High**
Low	Health checkup	Unhealthy	Health checkup
Normal	Hypothermia	Healthy	Fever
High	Health checkup	Unhealthy	Health checkup

Table 3. Cases of Several volunteers

Case code	Sex &Age	Case history	Heart rate	Temperature	SPO2	Comparison with ordinary devices reader.
#01	Female 32 years.	Normal case with some intestinal disturbance.	101	36.5	98.3%	Comparison is semi-identical to ordinary devices.
#02	Male 13 years.	Normal case	104	37.6	99%	No difference.
#03	Female 16 years.	No complaints	93	36.9	98.4%	Show slight difference in Heart rate (90).
#04	Male 40 years.	No complaint	108	36.9	99%	Show slight difference in Spo2 (97.3%).
#05	Male 28 years.	Athletes after exercise	144	38	98%	Show high variation in Spo2 (90.6%).
#06	Female 24 years.	Athletes during exercise bilateral low back pain.	138	37.5	90.8%	No difference.
#07	Male 89 years.	• Coronary heart disease. • Stroke. • Diabetes.	110	38.2	90.8%	Show slight difference in Spo2 (87%)
#08	Female 72 years.	• Well-controlled hypertension. • Obstructive pulmonary disease (COPD).	105	37.7	95%	Show slight difference in heart rate (110).
#09	Female 58 years.	Open heart surgery	95	36.2	97%	Show slight difference in Temperature (37.1).
#010	Male 47 years.	• Atherosclerosis. • Hypertension. • Myocardial. infarction	89	37.2	96%	No difference.

5. Conclusion & future work

Based on IoT-technologies, we aimed at proposing an investigational concept for creating a wearable, portable, low-power, and real-time remote bio-signs checking system. This implementation produces bio-signals that may be trusted and validated. The confirmation is done by equating the results from this study to the readings from medical devices utilized by doctors and health suppliers. Those bio-signs have also been efficaciously uploaded to the Blynk smartphone application. This enables the health practitioners to concurrently observe and diagnose multiple health parameters. Additionally, this mobile application allows to supervise multiple cases at the same time. Eventually, this project may be acquired at a reasonable price.

Using an Android Blynk app, the upgraded version of this project will work on the security and encryption of the data gathered from the patient. Other health measures, i.e., cuffless blood pressure, non-invasive blood glucose, and respiration rate, could also be monitored. Furthermore, machine learning technology is an important adding to the healthcare checking system since it will help doctors diagnose disorders quicker and more precisely than the traditional diagnostic methods. Additionally, in the event of an emergency, when the patient's body produces an irregular signal, some ways can be incorporated to this project to address this demand.

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