IoT Based Patient's Smart Healthcare Monitoring and Recording Using GSM Module

Yuvaraj M[1*], *Naveen* R[2], *Gokul* N[2], *Gowtham* S[2], *Ramkumar* S[2]

[1] Electrical and Electronics Engineering, M.Kumarasamy College of Engineering, Karur, India
[2] Electronics and Instrumentation Engineering, M.Kumarasamy College of Engineering Karur, India

Abstract. An IoT based smart healthcare monitoring system is presented in this study. A local database, sensors, a microcontroller, and a GSM module make up the suggested system. Here, we're using an Arduino Uno to attach sensors, which then sense the environment and record data that is sent over the internet using the GSM protocol. The health of patients in isolated or rural locations without access to medical services can be tracked using this project. The importance of offering patients who were anticipated to decrease travel and direct contact with others remote patient monitoring services became even more clear when the epidemic struck. When there is an abnormal activity identified, healthcare team will get a message and they would make a call and prescribe the activities which need to be do for emergency and even it doesn't work ambulance is immediately depart to that particular patient's location since we have the patient's personal info about his location and his/her relative emergency mobile number.

1 Introduction

A remote monitoring and recording system for healthcare mostly depend on the Internet of Things is used to track important health parameters such as blood pressure rate, heartbeat rate, level of glucose, rate of respiration, room and body temperature etc. People's worry for their health is growing as technology develops. The COVID-19 leads every nation to take more responsibility about the healthcare of every citizen. All healthcare professionals struggle to provide their patients with the appropriate care because of the coronavirus. In this COVID-19, a sizable number of people who worked in the health sector also perished [1]. At the time, many serious patients skipped their scheduled visits because they were afraid of getting sick. Patients in both urban and rural areas struggle greatly throughout the outbreak. A healthcare system that uses an IoT-based GSM module for remote health care monitoring and recording enables patients to keep track of their essential health metrics and record their health status from any distance [2]. Patients can monitor from any location, including their homes, offices, rural locations, and metropolitan areas, thanks to the remote patient monitoring system[6s]. Healthcare personnel may follow and keep tabs on their patients' health issues thanks to the secure data transfer to a central server made possible by GSM technology. This approach also helps in giving patients with prompt assistance while there is a need of any medical emergency[3]. The importance of offering patients who were anticipated to decrease travel and direct contact with others remote patient monitoring services became even more clear when the epidemic struck. Because it addresses a crucial and delicate aspect of the current reality, as the epidemic has brought to light, our healthcare monitoring is especially important. showing off a few characteristics of earlier study. Yet, we have more solutions than the prior state of the art [4]. The next technological revolution will reportedly start with the IoT-based healthcare system, according to predictions. The development and implementation of a realistic model for an all-encompassing, Healthcare monitoring system of Internet of Things is used for both urban and rural areas are the main emergent goals of this key project. Any registered patient can use our system to update doctors on their physical problems at any time. This system will benefit more to the patient and also reduces the work pressure of doctors [5].

2 Existing System

A bigger number of sensors and human efforts are required when conventional sensor-based diagnostics is applied on a broad scale in the medical industry. Due to a dearth of medical experts and a mismatched system, the work is challenging. To overcome this problem, the research effort suggests an Internet of Things-based health care application. The suggested solution is based on continuous wireless patient monitoring and includes online and mobile applications [6]. The healthcare monitoring device's central processing unit is a PIC microcontroller.

* Corresponding author: yuvarajm.eee@mkce.ac.in

It processes the data it receives from the signals of numerous sensors that are affixed with the person i.e., patient's body. The processed data is then wirelessly sent to a monitoring station so that medical personnel can access it. When there is a considerable departure from the patient's typical health parameters, the healthcare monitoring device may be configured to notify the appropriate healthcare personnel [7]. Heart rate, blood pressure, sleep patterns, and activity levels may all be tracked using wearable technology like fitness trackers, smartwatches, and heart rate monitors. These devices can also send alerts to healthcare providers or caregivers if any abnormalities are detected. This early warning system enables medical practitioners to take the required steps to stop the patient's condition from getting worse. Vital signs are monitored by sensors across a wireless network for the patient. The data we got from the sensors is then gathered and delivered to the cloud's database for storage thanks to a Wi-Fi module connected to the controller [8]. By Using technology to collect and monitor health-related data in real-time is known as smart healthcare monitoring system. These systems use connected devices such as blood glucose meters, blood pressure cuffs, and weight scales to monitor patients' health remotely. Healthcare providers can track patients' health data and intervene if necessary. The system often collects the health data through wearables or sensors, which is then sent to a centralised system for analysis [9]. The data is analysed on the cloud, actions are made in response to the analysis, and the results may then be reviewed in more detail by a doctor remotely.

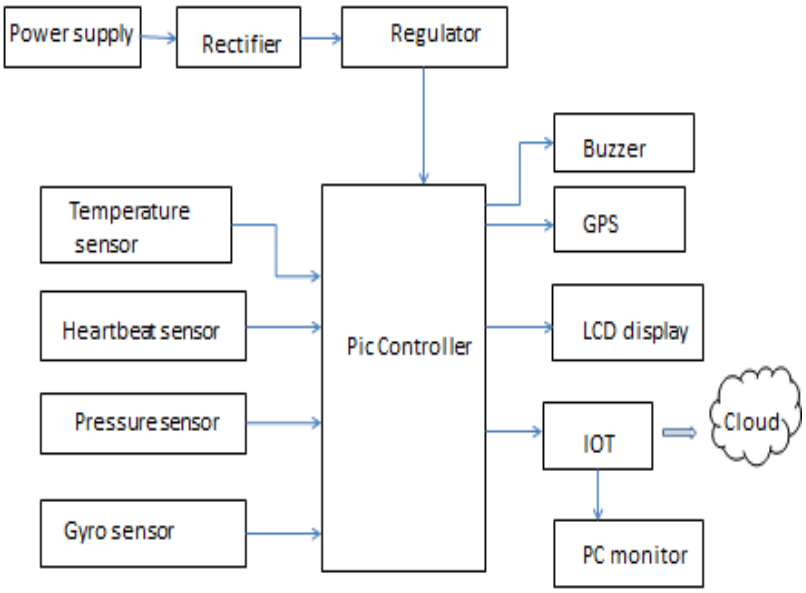

Fig. 1. Working model of existing system

Although offering patients exact information about their health state, remote viewing lessens the effort for doctors. If the patient needs emergency care, a notification is then sent to the doctor. Fig. 1. represented the block diagram of the existing system which used pic microcontroller instead of Arduino uno. Let us see the working process of the existing system. Here, the sensors are connected to pic microcontroller [10]. A GPS is used to immediately transmit data from sensors and GSM modules via microcontroller to the doctor's team via wireless technology. Healthcare monitoring using PIC microcontrollers involves the use of a small, low-power microcontroller to monitor various physiological parameters of patients [11-12]. The PIC microcontroller can be programmed to read and analyze data from different sensors, such as temperature sensors, heart rate sensors, blood pressure sensors, and oxygen saturation sensors. The microcontroller can then use this data to provide real-time information about the patient's health status. The sensors, the PIC microcontroller, and the display unit are the three essential parts of this existing system [13]. The microcontroller is wired to the sensors using analogue input pins, and it is configured to read the sensor data on a regular basis. The data is then analysed, and the microcontroller makes any calculations required, such as translating the sensor data to useful units or calculating trends over time. Some of the benefits of smart healthcare monitoring systems include early detection of health issues, improved management of chronic conditions, and reduced healthcare costs [14].

3 Proposed System

The proposed system of the IoT based patient's smart health care monitoring and recording using GSM module using Arduino, Heart Beat reader, Oxygen Saturation Sensor, Respiration rate reader, Pressure indicator, Level of glucose Sensor, Temperature measurement Sensor, and Room Humidity Sensor is an IoT based system that may be use to track and log important health information like the rate of heartbeat, rate of blood pressure, rate of oxygen saturation, rate of respiration , rate of glucose level, rate of temperature, and rate of humidity. The system comprises of a GSM module and Arduino controller, a set of sensors, and a mobile app or website that can be used to monitor and records the data. The wireless link between the sensors and the mobile application is created via the GSM module [15-16]. The mobile application receives the processed data from the Arduino controller after it has been sent from the sensors. The sensors will gather the important information about the health of a patient's and then transmits it to the Arduino controller. Users of the mobile application can view the data and take any necessary actions. Also, the information will keep on a cloud server database for later study and reference. Fig. 2. Representing the block diagram of the project's proposed system. The system will be made up of an Arduino microcontroller, a GSM module, a sensor of a temperature, a humidity, a blood pressure, an oxygen sensor, a respiration sensor, a blood glucose sensor, and a sensor for heartbeat. The connections between the parts will be made as shown in the diagram below. Fig.3.represents the circuit diagram of a proposed system of all power supply to the system. Data collected from the sensors will read by the Arduino uno and then transmitted to the GSM. The data will then be transmitted by the GSM module to a distant server where it can be watched and recorded. To store and process the data from the sensors, the server's software will need to be created. The proposed system flowchart is shown in the Fig. 4. This explains how the model operates: first, the sensors are read, and then it checks the parameters to see if they are within an acceptable range or not. If yes, it will continue to measure the readings of a patient. If not, readings are displayed in the monitor of the doctor's team or to the patient's mobile. Then the action will take by the doctor. In emergency cases, doctor's team will send an immediate ambulance to the patient's location and also informs the patient relative since they have relative info too.

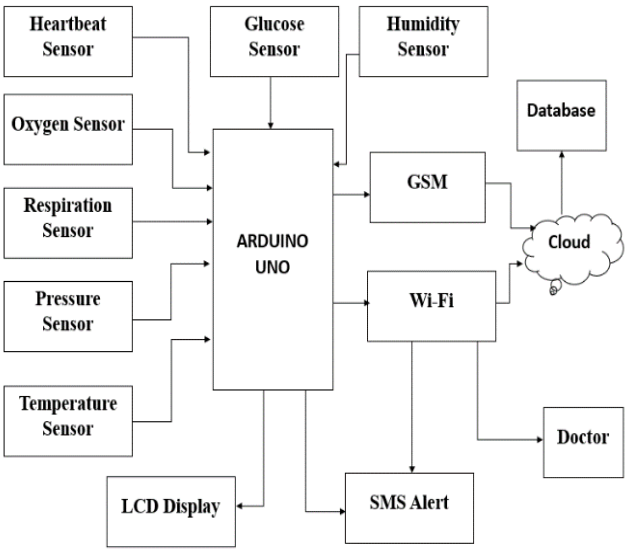

Fig. 2. Block diagram of a Proposed System

The steps needed to achieve the above described proposed system of smart healthcare system are the system will be made up of an Arduino microcontroller, a GSM module, a body and room temperature reader, a humidity reader, a blood pressure reader, an oxygen saturation reader, a respiration rate reader, a blood glucose reader, and a sensor for heartbeat. The connections between the parts will be made as shown in the picture below. The GSM module, the heartbeat reader, oxygen saturation reader, respiration rate reader, the blood pressure reader, glucose level identifier, temperature detector, and humidity reader will all be linked to the Arduino. Data from the sensors will be read from the Arduino, then sent to a GSM module via programming. The GSM module will then send the data into a remote server where it can be stored, monitored and recorded. The software for the server will need to be developed to save and process those data from the sensors. On basis of those data, it must also be able to provide reports and alarms. The system should be tested to ensure that all components are working properly or not and that the data is being accurately transmitted and stored on the database server. Whether the

alarm goes or not when parameter exceeds the range. The system can then be deployed to the intended users. The device will then allow the users to remotely monitor and record their health information.

Heart Beat sensor: An optical heart rate sensor measures the variations in blood vessel volume known as pulse waves, which occur when the heart pumps blood. By observing the volume change, pulse waves are found using an optical sensor and a green LED.

Oxygen sensor: With the use of a pulse oximeter, you may calculate the percentage of oxygen that your blood cells are transporting throughout your body. Your oxygen saturation level is indicated by that proportion (also called as SpO2 sensor).

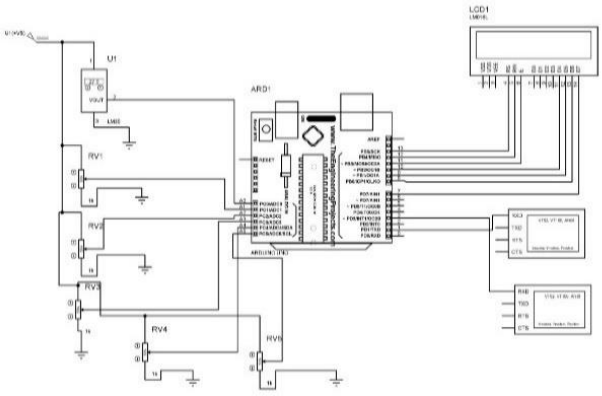

Fig. 3. Circuit Diagram of the Proposed System

Respiration sensor: The most typical kind of respiration sensor is called a piezoelectric transducer. Piezoelectric material is used to make two thin plates that make up the device. An electrical signal is produced when the chest wall or abdomen moves because the plates are pressed together. The signal processor subsequently converts the signal into a numerical output after receiving it.

Glucose sensor: A glucose sensor is a medical field device that can be used to measure the concentration of sugar level in the blood. It is used by people with diabetes to monitor their blood sugar levels and make informed decisions about their diet, exercise, and medication.

Temperature sensor**:** By monitoring the temperature of the skin, forehead, or ears, temperature sensors offer precise non-contact temperature assessment in medical applications.

Blood Pressure sensor: The sensor is a pressure sensor (MEMS pressure sensor) manufactured by the semiconductor process and is mostly employed in the oscillometric method. It monitors the pressure in the cuff utilising air as a medium for pressure transfer.

Humidity sensor**:** The relative humidity of the air is measured using a humidity sensor. The quantity of moisture or water vapor in the air relative to the maximum amount of moisture that the air can contain at a particular temperature is referred to as relative humidity.

GSM module**:** A GSM module is a hardware device that allows devices to communicate over the cellular network using GSM (Global System for Mobile Communications) technology. GSM modules are commonly used in devices that require wireless communication capabilities, such as mobile phones, tablets, GPS trackers, and IoT (Internet of Things) devices.

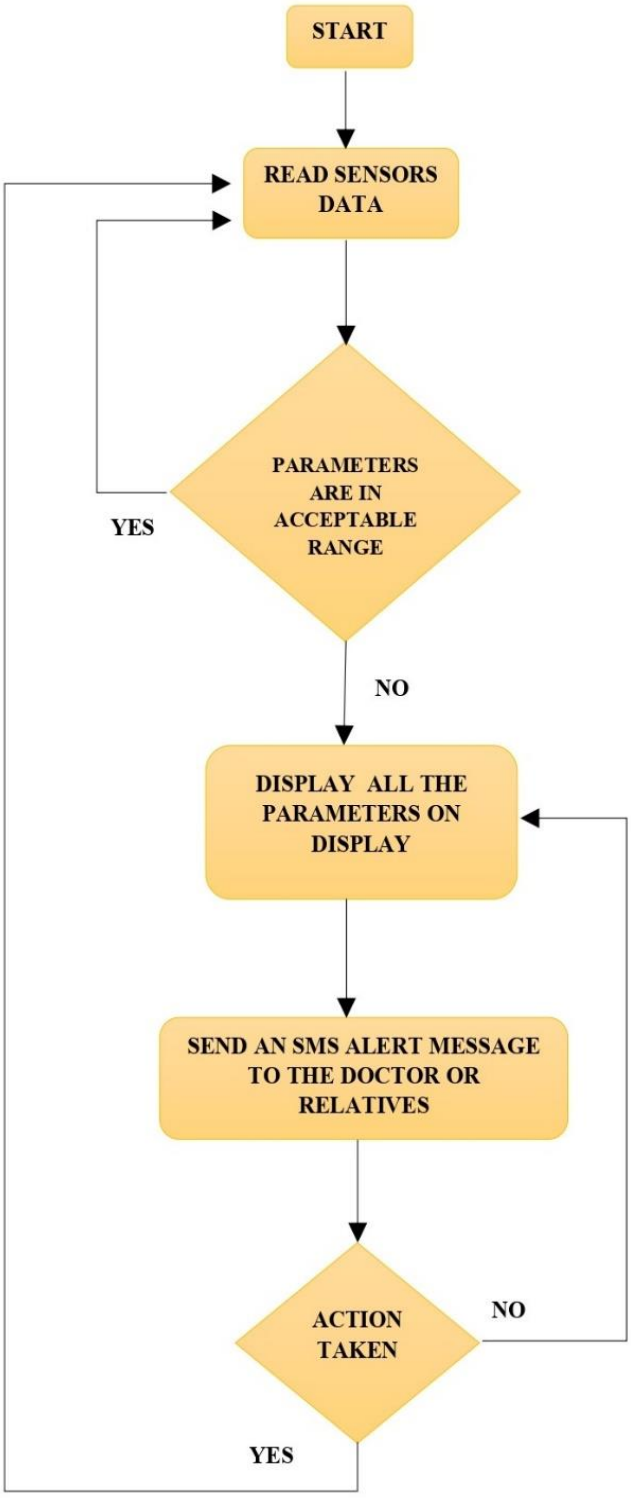

Fig. 4. Flow Chart of a Proposed System

***Wi-Fi module*:** A Wi-Fi module is a hardware device that allows devices to communicate wirelessly over a Wi-Fi network. Wi-Fi technology uses radio waves to transmit data between devices within a range of a few hundred feet. Wi-Fi modules typically contains a wireless radio transceiver, antenna, and firmware that allows for communication with a Wi-Fi network.

4 Result and Discussion

4.1 Hardware Implementation

According to the proposed model, vital signs are gathered by fastening to the patient's body. The module "Wi-Fi" transmits the data to the database(cloud). The Arduino processor and sensors are connected. If the patient chooses to, they are free to move around. IoT-based remote health care monitoring and recording using a GSM module is a technology that enables medical professionals to remotely monitor and record a patient's health status by connecting to a GSM network.

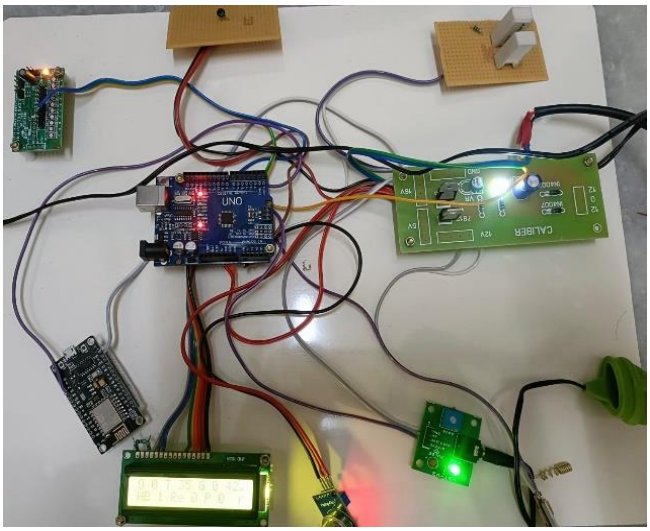

Fig. 5. Hardware implementation

Hardware kit is shown in the Fig.5. Smart healthcare monitoring can help detect early warning signs of potential health issues, allowing for early intervention and treatment, which can lead to improved patient outcomes. LCD displays the measured parameter of each sensor connected with Arduino.

4.2 Software Implementation

In this project, we also did a simulation and used a C programming to embedding into a Arduino. It provides a fast and most efficient way to monitor the health status. Proteus is a powerful software suite used to simulate and design electronic circuits, ranging from simple to complex. It is developed by Lab center Electronics and is used in various industries, including aerospace, automotive, and medical. With Proteus, users can design and simulate a variety of circuit components, such as resistors, capacitors, transistors, operational amplifiers, diodes, and logic gates. Proteus is a comprehensive electronic design suite that provides a wide range of tools for circuit design, simulation, and prototyping. The software also supports a variety of programming languages, including C, C++, VHDL, and Verilog. This allows users to create and compile circuit designs using their preferred language. It offers both graphical and command-line interfaces, allowing users to quickly and easily create complex circuit designs. Finally, the Proteus Suite offers a range of features to help users share and collaborate on their designs. It includes a built-in chat system and a library of example designs. In addition, users can export their designs in a variety of formats, including PDF, PNG, and SVG. The software supports the design of analog and digital circuits, as well as microcontroller-based systems.

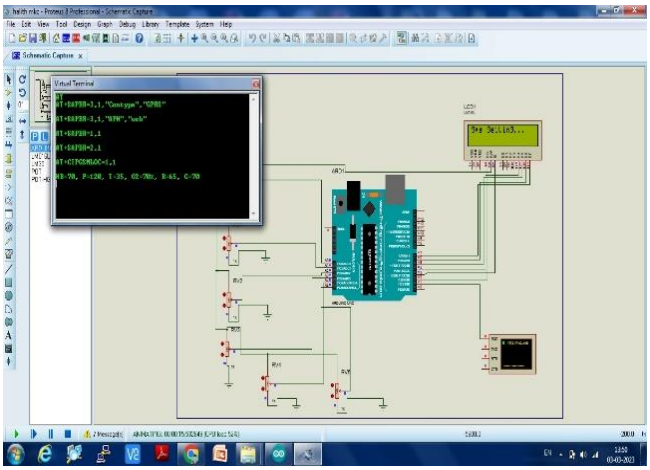

Fig. 6. Simulated output of a Proposed System

Finally, the Proteus Suite offers a range of features to help users share and collaborate on their designs.. When the program gets executed it will show the results in a virtual terminal of all parameters. Simulation of this project also done for the checking process and attained a great result in simulation. The data collected are stored in database and it works based on the flowchart. The output results are shown in the Fig. 6. Real-time monitoring of vital signs like temperature, pulse, and blood pressure is made possible by this technology, which also makes access to medical records and other data possible in Fig.7 & Fig.8.

Fig. 7. Temperature graph

Fig. 8. Oxygen saturation graph

Fig. 9. Respiration rate graph

Fig. 10. Heartbeat graph

With this technology, medical professionals can detect health issues before they become serious and help monitor a patient's health from a distance, allowing for improved patient care and better outcomes in Fig.9 & Fig.10.

Fig. 11. Blood Pressure graph

Fig. 12. Glucose level graph

In Fig.11 & Fig.12 graphs are the examples of particular result of a patient for about five continuous days. By allowing patients to get care from the comfortable places like of their homes, in-person appointments are need not necessary hereafter, enhancing access to healthcare for people living in distant or rural locations.

5 Conclusion

The suggested system is used to monitor patients' health wirelessly. Sensors including those for the heartbeat, glucose, blood pressure, respiration, oxygen, temperature, and SpO2 are used to measure the vital parameters. Doctors can remotely check on their patients' health thanks to the proposed concept. Anyone can consult specialists anywhere in the world thanks to the proposed system. The main advantages are the IoT-based remote health care monitoring helps in providing better patient care as it enables doctors and health care professionals to monitor patients remotely and take action promptly if needed. IoT-based remote health care monitoring provides access to real-time data which helps in making decisions quickly and accurately. IoT-based remote health care monitoring helps in reducing the costs associated with hospital visits and treatments. by providing doctors with access to real-time patient data.

References

1. Khan, Mohammad Monirujjaman and Mehnaz, Safia and Shaha, Antu and Nayem, Mohammed and Bourouis, Sami "IoT-Based Smart Health Monitoring System for COVID-19 Patients" In Computational and Mathematical Methods in Medicine, **2021**, (2016).
2. Banka, Shubham and Madan, Isha and Saranya, SS "Smart healthcare monitoring using IoT" In International Journal of Applied Engineering Research, **13**, 15 (2018).
3. Rahaman, Ashikur and Islam, Md Milon and Islam, Md Rashedul and Sadi, Muhammad Sheikh and Nooruddin, Sheikh "Developing IoT Based Smart Health Monitoring Systems: A Review" In Rev. d'Intelligence Artif, **13**, 6, (2019).
4. Srinivasan, P and Khan, A Ayub and Prabu, T and Manoj, M and Ranjan, M and Karthik, K "Heart beat sensor using fingertip through Arduino" In Journal of Critical Reviews, **7**, 7 (2020).
5. Tamilselvi, V and Sribalaji, S and Vigneshwaran, P and Vinu, P and GeethaRamani, J "*IoT based health monitoring system*" In 2020 6th International conference on advanced computing and communication systems (ICACCS), 06-07 March 2020, Coimbatore, India (2020).
6. S. H. Almotiri, M. A. Khan, and M. A. Alghamdi. Mobile health (m-health) system in the context of iot. In 2016 IEEE 4th International Conference on Future Internet of Things and Cloud Workshops (FiCloudW), 22-24 August 2016, Vienna, Austria (2016).
7. P. Gupta, D. Agrawal, J. Chhabra, and P. K. Dhir. Iot based smart healthcare kit. In 2016 International Conference on Computational Techniques in Information and Communication Technologies (ICCTICT), 11-13 March 2016, New Delhi, India (2016).
8. Sankar Kumar S, Gayathri N, Nivedhitha D, Priyanka A S "A Cost effective Arduino Module for Bedridden patient's Respiratory Monitor and Control" International Journal of advanced research trends in engineering and technology (IJARTET) VOL. II, SPECIAL ISSUE XXI, MARCH 2016.
9. V.Akhila et al, International Journal of Research in Information Technology, **1**, 1 (2017).
10. S.Kiruthika, P.Sakthi, M.Kaviya, S.Vishnupriya, "Blood Bank Monitoring and Blood Identification System Using Iot Device", Annals of R.S.C.B., **25**, 6, (2021).
11. S.Kiruthika, P.Sakthi, N.Gokul, G. Praveen Kumar, S.Praveenkumar, R.Prem, Monitoring Soil Quality and Fertigation System Using Iot, Turkish Journal of Computer and Mathematics Education (TURCOMAT), **12**, 9, (2021).
12. A Manjunathan, ED Kanmani Ruby, W Edwin Santhkumar, A Vanathi, P Jenopaul, S Kannadhasan, "Wireless HART stack using multiprocessor technique with laxity algorithm", Bulletin of Electrical Engineering and Informatics, **10**, 6 (2021)
13. M.Mathan, S.Kiruthika, G.Manoj Babu, Ramkumar "Smart Glucose Drip Bottle With Patient Monitoring System" in Journal Bioscience Biotechnolgy Research Communications, **13**, 5, (2020).
14. C Jeyalakshmi, A Manjunathan, A Karthikram, T Dineshkumar, W Edwin Santhkumar, S Kannadhasan, "Automatic Wireless Health Instructor for Schools and Colleges", Bulletin of Electrical Engineering and Informatics, **11**, 1 (2022)
15. Manjunathan Alagarsamy, Karthikram Anbalagan, Yuvaraja Thangavel, Jeevitha Sakkarai, Jenopaul Pauliah, Kannadhasan Suriyan, "Classification of covid patient image dataset using modified deep convolutional neural network system", Bulletin of Electrical Engineering and Informatics, 11, 4 (2022).
16. Selvaraj, V. et al. "Classification of COVID-19 patient based on multilayer perceptron neural networks optimized with garra rufa fish optimization using CT scan images", International Journal of Pattern Recognition and Artificial Intelligence, **37**, 6 (2023).