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IoT Based Nurse Activities Monitoring and Controlling System

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Abstract

IoT technology has emerged as a valuable tool in modern healthcare, providing real-time monitoring of patients, effective management of healthcare, and proper administration of patient information. The proposed system aims to develop a system that can prevent backward blood flow from stopping saline fluid, as well as monitor the temperature, heart rate, and oxygen level of patients by using multiple sensors like weight, temperature and heart rate, etc. Additionally, the proposed system can monitor the room temperature and humidity for contributing to the patient's overall comfort. In emergency situations, it includes an emergency push button for quick alert medical staff and initiates timely interventions. It is designed to support nurses and doctors in monitoring patients and providing timely interventions to prevent complications.

Keywords

IoT, Nursing Activities, Patient Monitoring, IV Saline Bag, Arduino UNO, NodeMCU (ESP8266), LM35, DHT11, MAX30102

1. Introduction

The rise of IoT technology has revolutionized the way we interact with devices and the world around us. The potential for IoT to streamline and optimize daily life is vast, with applications in healthcare, transportation, and manufacturing, among many others. As technology continues to evolve and become more accessible, it is sure to have a profound impact on society in the years to come. It enables us to monitor and control these objects remotely. It has been used in a variety of industries, from healthcare to manufacturing. With the help of IoT,

businesses can increase efficiency and reduce costs by automating processes. Additionally, IoT can be used for predictive maintenance, which allows companies to detect potential problems before they occur. As such, it is becoming increasingly important in today's digital world.

Nurses are life-savers, they have many duties including caring for patients, communicating with doctors, administering medicine and checking vital signs. It is a profession that requires a great deal of dedication and hard work. Nurses are responsible for providing compassionate care to patients, monitoring their health, and helping them to manage chronic conditions. As such, nurses play an important role in the healthcare system. While doctors often specialize in one area, nurses are able to coordinate the care for all aspects of a patient's overall health. They provide vital care and support to patients and their families in a variety of settings, from hospitals to private homes. Nurses perform a wide range of duties, from administering medication and monitoring patient health to providing emotional support and educating patients on how to manage their conditions. They are too responsible for the exact keeping of records. Accurate records are all perspectives that are taken and might include medical history, side effects, what the patient has eaten or inebriated, pharmaceutical, beat, temperature, blood pressure, bowel movements and any visits by specialists, etc. In a few communities where doctors are few, the nurse will analyze and treat essential sicknesses, endorse medication and conduct minor surgery. They are also responsible for turning off the IV bag when it will be empty. In addition, nurses often serve as advocates for their patients, ensuring that they receive the best possible care. With their knowledge, skills, and compassion, nurses play an essential role in helping people stay healthy and recover from illness or injury.

The use of IoT in nursing is revolutionizing the way healthcare professionals work and deliver care. IoT devices allow nurses to monitor patient health in real-time, track vital signs, and provide remote care. The use of IoT technology also helps nurses to be more efficient and accurate when it comes to providing patient care. This technology can be used for a variety of purposes such as monitoring medication levels, tracking patient activity, and even providing remote access to medical records. With the help of IoT-enabled devices, nurses are able to provide better quality care for their patients while reducing costs and increasing efficiency. We proposed a system for a Nurse Activities Monitoring and Controlling System over the internet. Saline is nourished to any patient; they have to be always checked by a nurse or any relatives. Most regularly due to carelessness, inattentiveness, busy plan and a more noteworthy number of patients, the nurse may disregard to alter the saline bottle as before long because it is completely consumed. Just after the saline finishes, blood surges back to the saline bottle due to the difference in blood pressure and pressure interior the purge saline bottle. This may cause a reverse stream of blood to saline bottles from their vein.

Smart IoT devices, such as those connected over the internet, create an inno-

vative new environment where outpatient and long-term care are delivered remotely by doctors to patients right in their homes or hospital. The more connected patients are to their doctors and families, the better their experience with healthcare. Using the proposed system patients can consult any doctor or medical staff from within the country or outside the country. Besides, patient's family members or relatives can monitor the patient's real-time conditions.

The proposed system provides remote care for patients' symptoms by using different sensors. Data will instantly transmit over the internet to the hospital staff or doctor. Remote observing of crucial signs and side effects make physical spaces more brilliant, progressing proficiency of operations and clinical errands and contributing to a more personalized involvement. Real-time data was provided from personal monitoring devices such as patient's Temperature. Heart-Rate, Oxygen-Lebel and Room-Humidity help doctors make more informed decisions. They provide data to analyze past treatments, diagnose symptoms, reduce errors, and improve ongoing disease management. So, it is no matter where a patient is due to the surrounding conditions, they can receive services through this device from anywhere.

Since the Covid-19 pandemic started, there has been a sensational ramp-up of innovation within the healthcare space. Healthcare suppliers ought to interface routinely with patients by means of video chat, and the utilization of different remote checking IoT devices contributes to real-time care without a patient requiring to see a doctor in person. IoT devices are helping hospitals and clinics to analyze patients afar from and prescribe remote treatment. The remote strategy is critical during emergencies just like the pandemic when hospitals have to be optimized the time went through in person with patients that need immediate treatment. It was having a growing impact on how doctors and authorities were monitoring the Covid-19 pandemic.

In the proposed system whenever the saline in the bottle completes, automatically the tube is compressed and additionally it also gives a buzzer alerting the nurse about the completion of saline in the bottle. In the proposed system, a nurse can also monitor room temperature, room humidity, patient's temperature, heart rate and oxygen level after medicine or before medicine and take necessary steps.

In our country, People have been suffering from a lacking number of nurses, one of the vital frontline well-being workforces. According to a recent report, 76 percent of nurses are short of Bangladesh, so we need to hire more nurses to manage hospitals. In this project, we develop the proposed system for nurse activities monitoring and controlling system. When nurses need to service multiple patients at a time, they can monitor patients' health conditions. And it will provide better results in the field of nursing duties.

The project we describe has the potential to be very useful for hospitals and healthcare providers, as it could help improve patient care and safety. By stopping saline fluid to prevent backward blood flow and monitoring vital signs such

as temperature, heart rate, and oxygen level, the proposed system can help medical staff identify and respond to any potential health issues in a timely manner, potentially improving patient outcomes. Additionally, by monitoring room temperature and humidity, the proposed system can create a more comfortable and safer environment for patients, which can also contribute to our recovery.

The emergency push button provides an added layer of safety, allowing patients or medical staff to quickly call for assistance in emergency situations. This can help to prevent or minimize adverse events and improve patient safety. It also provides a way for patients or medical professionals to alert others in case of an emergency, which can be crucial in critical situations.

The proposed system could be extremely useful in hospitals as it allows doctors and nurses to monitor patients more closely, which can lead to better care and potentially even save lives. The proposed system's ability to prevent backward blood flow can be especially crucial in preventing complications that can arise from certain medical procedures or conditions.

In terms of the future of this type of project, there is certainly a lot of potential. As technology advances, patient monitoring systems will likely become more sophisticated and offer even more features and functionality. This could include the integration of artificial intelligence and machine learning algorithms that can help detect early warning signs of potential medical issues.

The number of hospitals and diagnostic centers is increasing day by day in Bangladesh. The number of nurses is not sufficient for those hospitals and diagnostic centers. In this manner, we have chosen to plan an IoT-based nurse activities monitoring and controlling system. Hospitals and Diagnostic Centre can be used this device for monitoring and controlling nursing activities. Besides it will be beneficial for the patient health care system.

Additionally, the proposed system could be integrated with other healthcare technologies, such as electronic health records, to create a more comprehensive and seamless healthcare experience for patients and healthcare providers alike. Overall, the future of patient monitoring systems looks bright, and we have the potential to revolutionize healthcare by improving patient outcomes and reducing healthcare costs.

2. Objective

To develop IoT devices for monitoring and controlling nursing activities and provide greater result in the field of patient health care system.

2.1. Background Study

This area reports on the conducted literature study, displaying past works adjusted with our work. In a recent situation, hospitals and clinics have a large number of nurses in crisis. Of this people don't get proper treatment from the hospital. Keeping this view, the different device has been made to reduce this issue. Several systems have been proposed for this problem.

2.2. Literature Review

We have considered different websites, articles, and reports approximately nurse activities monitoring and controlling devices. To the most excellent of our knowledge, the nurse activities monitoring and controlling system has not exhausted Bangladesh however. But numerous strategies have been created to annihilate this issue.

The use of IoT technology has paved the way for innovative solutions in the healthcare industry, and one such solution is the development of a nurse call system using RFID. This system allows patients to call for a nurse's assistance by simply pressing a button on an RFID tag. The nurse can receive the call on their device and respond to it promptly, without the need for the patient or their family to visit the nurse station. This system also provides hospital executives with valuable data on the quality of nursing services, including the number of calls, the time taken by the nurse to respond to each call, and which nurse responds to each patient's call. By analyzing this data, the hospital can identify areas for improvement and enhance the quality of care provided to patients. Overall, an IoT-based nurse call system using RFID can revolutionize the way healthcare services are delivered and help hospitals provide better patient care. The reviewed system works for nurses to respond to every call from the patient, whereas the proposed system for nurse activities such as patient's temperature, heart rate, oxygen level monitoring and automatic IV bag controlling. The proposed system also includes an emergency push button to quickly alert the nurse [1].

This system utilizes an infrared sensor to detect the fluid level in an IV bag, and the output voltage level of the sensor changes when the IV fluid level is at a minimum. When the output voltage level is low, the system automatically alerts the nurses by sounding a buzzer alarm. Additionally, when the saline drops to a specific minimum level, an alert signal is generated to notify the caregivers that the IV fluid given to the patient is over. This automated system can help ensure that patients receive the necessary IV fluids without interruption, and healthcare providers can respond promptly to any potential issues that may arise. Overall, an IoT-based fluid level monitoring system can enhance patient care and improve the efficiency of healthcare delivery [2].

In this proposed system, sensors are utilized to detect and transmit vital health data to a central Node MCU. A PPG sensor is employed to detect the heartbeat data, and in case of any abnormalities in the pulse rate, an LED display is used to alert healthcare providers. The data collected from the Node MCU is monitored using the cloud-based platform Thinkspeak.com, providing secure access to the data for healthcare providers. Additionally, an LCD display is used to continuously monitor the patient's heartbeat. This system offers a reliable and efficient method of continuous monitoring of the patient's vital health data, allowing healthcare providers to detect and respond to any potential health issues promptly. Overall, an IoT-based system for continuous monitoring of vital health data can significantly improve the quality of patient care and enhance the

efficiency of the healthcare system. The reviewed paper works only for heartbeat monitoring, whereas the proposed system works for nurse activities such as patient temperature, heart rate, oxygen level monitoring and automatic IV bag controlling [3].

In this reviewed system, sensors are utilized to monitor the critical level of saline in a saline bottle and control the infusion drop rate using a motor mechanism to increase or decrease the saline drop rate. The system provides real-time updates on the status of the saline droplets, saline drop rate, and remaining time through a mobile application developed for the convenience of healthcare providers. This system can be used efficiently not only in hospitals but also in homes, allowing patients to receive the necessary infusion therapy under the guidance of a healthcare professional. The ability to monitor and control the infusion therapy in real-time can significantly improve patient outcomes and reduce the risk of complications. Overall, an IoT-based system for continuous monitoring of infusion therapy can enhance the quality of patient care and improve the efficiency of healthcare delivery in both hospital and home settings. The reviewed paper works with an IR sensor to detect saline level, whereas the proposed system works with a weight sensor for measuring the IV bag and whenever the saline in the bottle completes, automatically the tube is compressed. The proposed system also gives an alert to the nurse about the completion of saline [4].

The proposed IoT-based health monitoring system is designed to monitor patients remotely and store their data in a server using Wi-Fi module-based remote communication. The system is particularly useful in areas where pandemics are prevalent, as it allows for remote monitoring of patients, reducing the need for physical contact between patients and healthcare providers. The system is designed to reduce healthcare costs by eliminating the need for SMS-based patient monitoring and providing real-time monitoring of patients' health parameters, such as heart rate and body temperature. The system can detect sudden changes in a patient's health status and alert authorized personnel immediately. The use of IoT in healthcare not only improves the efficiency of healthcare delivery but also enhances the quality of care provided to patients. The reviewed paper works for the patient's body temperature, pulse rate and room humidity and temperature whereas the proposed system works for nurse activities such as patient's temperature, heart rate, oxygen level monitoring, room humidity, room temperature and automatic IV bag controlling. For emergency situations, the proposed system also includes an emergency push button to quickly call the nurse [5].

3. Methodology

3.1. Methodology

The methodology is basically the set of strategies, rules and a specific method or set of methods for gaining the proposed model's destinations. This project work has been completed by taking these steps.

Diagrammatic Representation of Some Steps Is Given below (Figure 1).

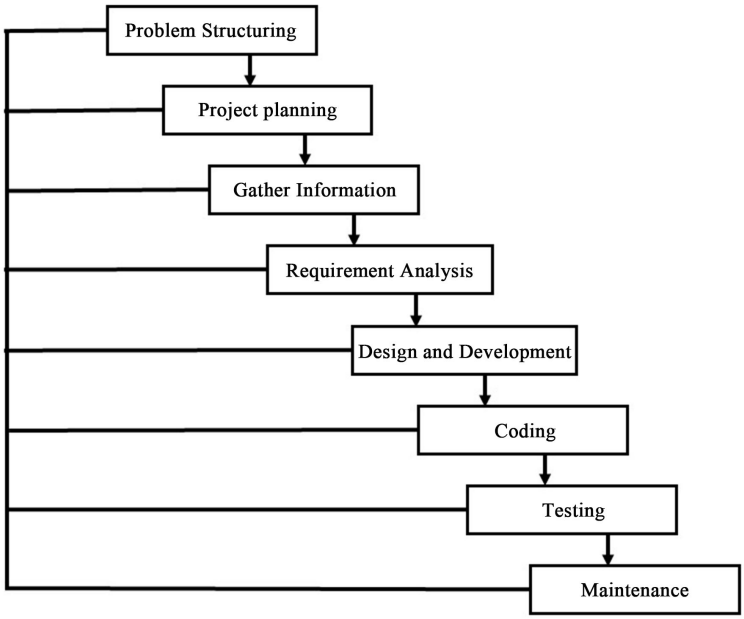

Figure 1. Proposed methodology.

3.2. Justification of Methodology

The total process of the proposed work is separated into different steps. We have chosen each step exceptionally earnestly to guarantee its accuracy and it drives efficiencies into each step of this process. We have collected all possible necessities of the proposed system to be created and are exceptionally great documents. There are no equivocal necessities, all necessities are clear and settled. There are parts of assets to support the proposed system.

3.3. Description of Methodology

The target of the proposed system is to plan and develop nurse activities monitoring & controlling systems to provide more noteworthy results within the field of patient well-being care systems in Bangladesh utilizing IoT. This proposed system is separated into a few steps.

The Sequential Steps Are

Problem Structuring: At to begin with, we have chosen to search for a particular issue based on the current city of Bangladesh which is ready to design and developed a perfect solution for the issue.

Project planning: Project planning may be a guideline to choose how to total a project inside a certain time period, with characterized stages. In this stage, the selection of how to do this project and make a choice around which project will be done. So, we have examined approximately the entire work of the proposed system.

Gather Information: By gathering data and knowledge can be recognized is-

sue which can be fathomed. In this step, we have investigated and collected knowledge from the web, books, papers, and the past related to this issue.

Design and Development: The objective of this step is to plan and develop a hardware device. In the design part, we have planned different graphs, for the illustration flow chart, system design, circuit diagram, block diagram, etc. In the development part, we have developed the devices which will nurse activities monitoring and controlling system. This device sends notifications to nurses for monitoring and controlling nurse activities. If the saline in the bottle completes, automatically the tube is compressed and additionally it also gives a buzzer alerting the nurse about the completion of saline in the bottle. Besides this, a nurse can also monitor room temperature, room humidity, patient's temperature and heart rate, after medicine or before medicine and take necessary steps.

Coding: For this proposed system we have to know approximately, Equipment connection, C++ language, and Arduino IDE.

Testing: Testing implies checkup the overall work. In this portion, tested this proposed system utilizing a few test modules. We have tested the proposed system on a gather of volunteers for want result.

Maintenance: This proposed project support represents the complete scope and the understanding of how the function ought to operate and manage in an implementation range. In some cases, issues might be made by clients. Maintenance is done to the changes within the proposed system to back clients and monitors system execution.

To develop the proposed system, we have outlined it in a few ways. The designs are given below.

4. Design and Development

4.1. System Architecture

The proposed system allows a nurse to attend to multiple patients simultaneously by utilizing IoT sensors to monitor their vital signs. (**Figure 2**) These sensors include a temperature sensor, a weight sensor, a heart-rate sensor, and a buzzer. The heart-rate sensor also measures the patient's oxygen levels, which are transmitted to the server. Nurses and doctors can access the server through a monitoring interface, such as a PC, laptop, or mobile device, to view the data of multiple patients. This enables them to monitor the patients' vital signs in real-time and respond quickly to any changes.

Moreover, the proposed system allows nurses and doctors to control the IoT sensors and the buzzer remotely. This feature helps them to take immediate action if any patient's vital signs show abnormal readings or if any patient requires urgent attention. In summary, the proposed system provides a comprehensive solution for monitoring and controlling the activities of multiple patients simultaneously, enabling healthcare professionals to provide efficient and effective care to their patients.

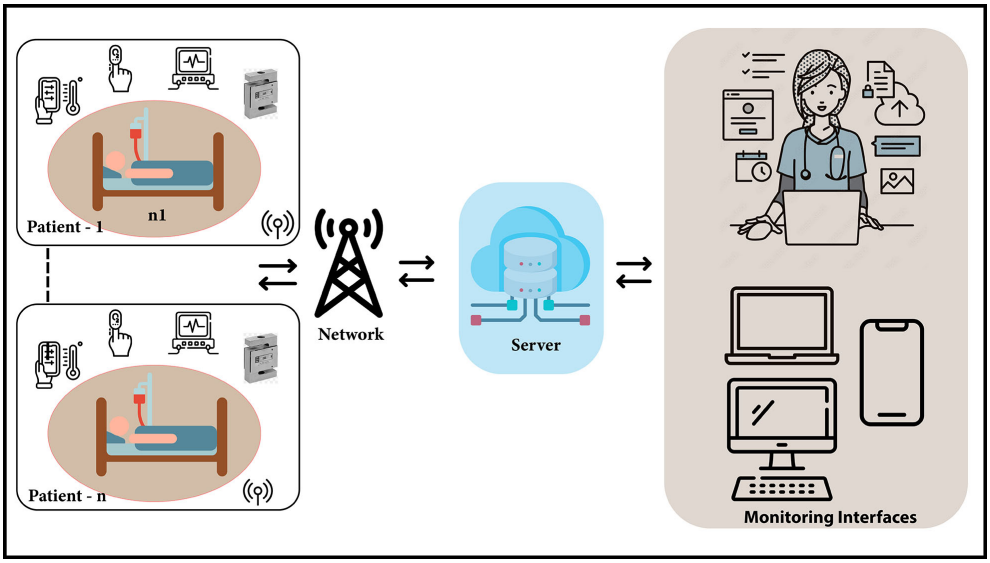

Figure 2. Proposed system architecture.

4.2. Block Diagram

A block diagram is a diagram of a framework in which the vital components are represented by blocks that appear as the connections of the blocks and are associated with lines. All the components are associated with the microcontroller and they are acting as input or output devices. (**Figure 3**)

Adapter: The purpose of the power supply for the proposed system is ON/OFF.

Micro-controller: Micro controller is a programmable device. Here, we can use this instrument to automatically control devices.

Weight Sensor: A weight Sensor is used to measure saline bags and it will be sent real-time data on the server.

Humidity Sensor: Humidity Sensors are used to the patient's room moisture monitor the environment of patient's room and they will be sent real-time data on the server.

Temperature Sensor: We used a temperature sensor in the proposed system for the patient's temperature and room temperature and it will be sent real-time data on the server.

Heart-Rate Sensor: Heart-rate sensor is used to measure the heart rate of a patient and it will be sent real-time data on the server.

Emergency Switch: It is for emergency calling nurses from a patient's room.

OLED Display: OLED Display is used for showing all sensor data on the screen.

Wi-Fi Module: By using the Wi-Fi module we can send data over the server to our proposed system. In the proposed system, we use a Wi-Fi module to provide information on smartphones, laptops and Desktop and also connect.

Micro-servo motor: It is used for ON/OFF saline bag flow.

Server: The Server is used to show real-time data over the internet.

Monitoring Devices: A PC/Laptop is used for monitoring all data.

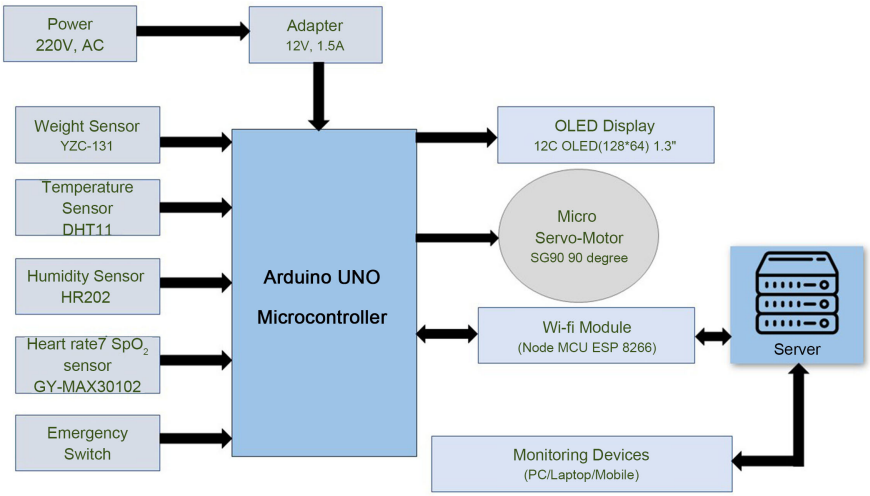

Figure 3. Block diagram of proposed system.

4.3. Flowchart

A flowchart could be a representation of a process. A flowchart is additionally a diagram of a problem-solving strategy step by step. (Figure 4)

Start: In this project, we use the start button for ON/OFF switching.

Power on IoT Device: In the proposed system, the adapter gives power to all IoT devices.

Check Patient Health Parameter: In this part, the proposed system checks all sensors to give data on the server.

Weight Sensor: A weight Sensor is used to measure the saline bag. When the weight of the saline bag is below 10g, the proposed system automatically is off the saline bag by servo motor and alerts the nurse. Otherwise, its data is displayed on the monitor and sent to the server.

Room Temperature & Humidity Sensor: It is used to patient's room moisture monitor the environment of the patient's room and it will be sent real-time data on the server.

Patient's Temperature Sensor: We used temperature sensors for the proposed system patient's temperature. When the temperature is 101 F or more than 101 F, then the proposed system shows on the server as fever. Otherwise, its data is displayed on the monitor and sent to the server.

Emergency Switch: It is for emergency calling nurses from a patient's room. When anyone presses the button, the nurse gets an alert and "You have a call" is displayed on the server.

Patient's Oxygen Level: It is used to measure the SpO2 level of the patient. When it is below 30%, the proposed system gives a notification as the SpO2 level is low. Otherwise, its data is displayed on the monitor and sent to the server.

Patient's Heart-Rate Sensor: A heart rate sensor may be used to measure the heart rate of the patient. When the heart rate is greater than 120 or less than 40, then the proposed system alerts the nurse and displayed high BPM or low BPM on the server. Otherwise, its data is displayed on the monitor and sent to the server.

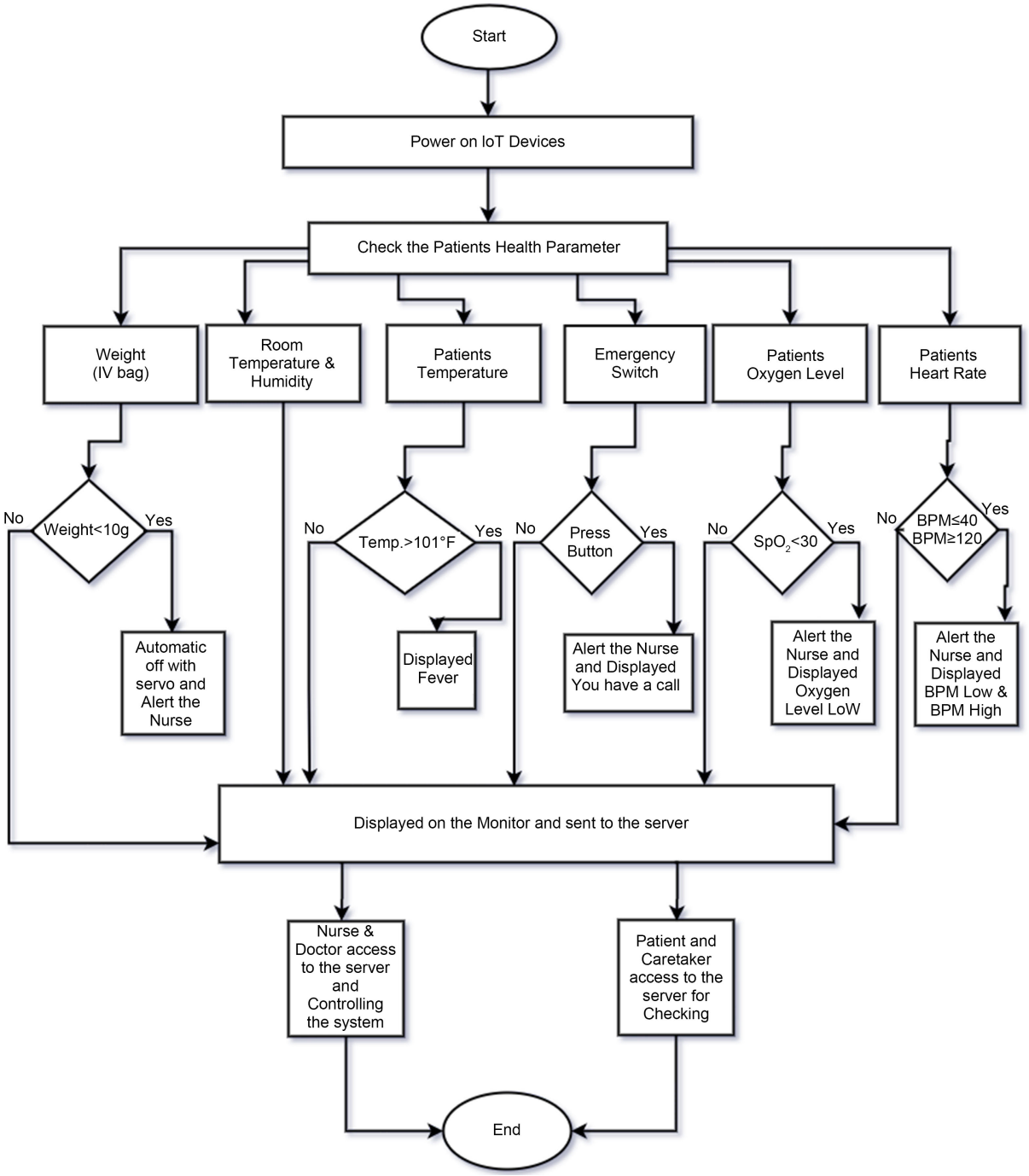

Figure 4. Flowchart of the proposed system.

Displayed on the monitor and send to the server: Our proposed system will be controlled by IoT. So, we need a smartphone with an Android app or a desktop web for getting alerts and monitoring. Nurses and doctors can see this.

Nurse & Doctor access to the server: Nurse and doctor access to the server for monitoring and controlling the proposed system.

Patient & caretaker access to the server: Patient and caretaker access to the server for checking.

End: The proposed system will stop working after Nurse can see the all notification.

4.4. Circuit Diagram

A circuit diagram could be a graphical representation of an electrical circuit diagram appear how electronic components are associated along. (Figure 5)

This is the proposed circuit diagram of IoT based Nurse Activities Monitoring and Controlling System. This project needs to establish a network connection and a power supply of 5 volts. We use Arduino UNO micro-controller to control our devices. Using the Node MCU Wi-Fi module (ESP 8266), we can also send data to the server over the internet. In this project, we use a Wi-Fi module to provide information on a laptop/smartphone and connect also. The weight sensor

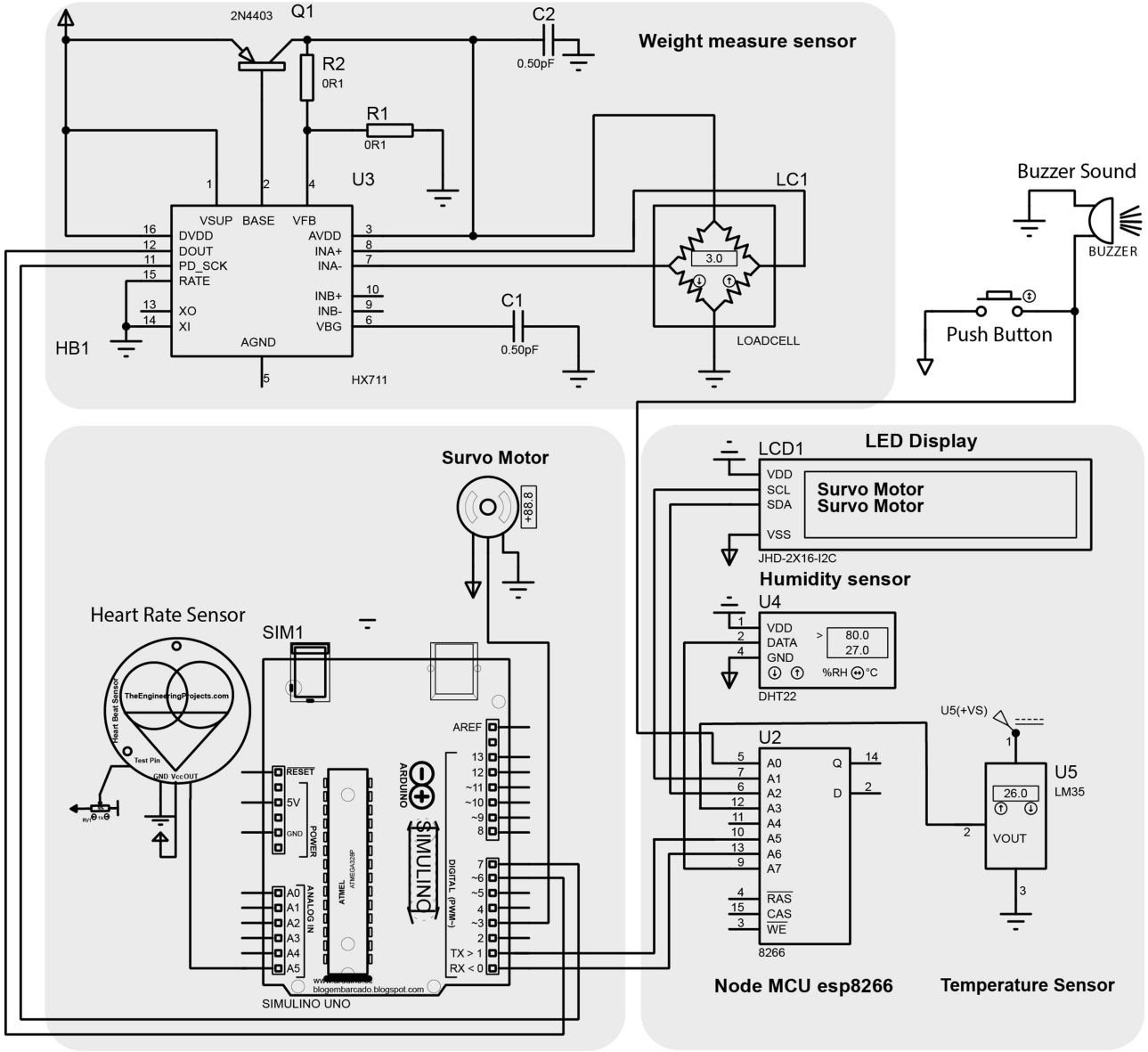

Figure 5. Proposed circuit diagram of nurse activities monitoring and controlling system.

measures the weight of the saline bag and connected with D7 send it micro-controller via D6. The Servo motor connects with D5. We use a DHT11 sensor to read temperature and humidity and send data over the internet using a Wi-Fi module which is connected to Node MCU with an A7 pin. The buzzer and push button give an emergency call which is connected to Node MCU with an A0 pin. We use a heart rate sensor to read heart rate and oxygen level and send data over the internet using a Wi-Fi module, which is connected to A5pin with UNO. D0 and D1 pin will pass data UNO to Node MCU via A5 and A6 pin. OLED display is connected with Node MCU via A1 and A2 pin and show all information of the system. All sensors' real-time data show in the server via a Wi-Fi module and show any internet browser.

5. Project Description

5.1. Device Prototype

Four sensors (temperature, humidity, heart-beat and weight sensor), Arduino and Node MCU Wi-Fi module, an OLED display, a buzzer, an emergency switch, a servo motor, and an IV bag are all shown in **Figure 6**. The system state will be restored once we give it power, and establish a network connection. It will log into the Web and any browser (mobile or desktop) to watch the system. (**Figure 7**)

5.2. Login

In the login interface, the user can install the Blynk IoT app (Desktop and mobile) themselves by filling in the email we provide Email (ahammedemtiaz07@gmail.com) and password (d9V3755DqhvWUB@cse). (**Figure 8**)

5.3. Dashboard Interface

In dashboard interface, the user can see all the data at Blynk IoT app (Desktop and mobile). (**Figure 9** & **Figure 10**)

5.4. Room Temperature and Humidity Monitoring

Real-time room's temperature and humidity monitoring has been implemented in the proposed system. (**Figure 11**)

5.5. IV Bag (Saline-Bag) Controlling Using Weight Sensor and Servo-Motor

In the proposed system, whenever the saline in the bottle completes or weight below 10 g, automatically the tube is compressed with servo-motor and additionally it also gives an alerting the nurse. (**Figure 12**)

5.6. Patient's Heart-Rate Monitoring with Graph Using Heart-Rate Sensor

In the proposed system, Real-time patient's heart-rate checking monitoring has been implemented. It also displays a graph. (**Figure 13**)

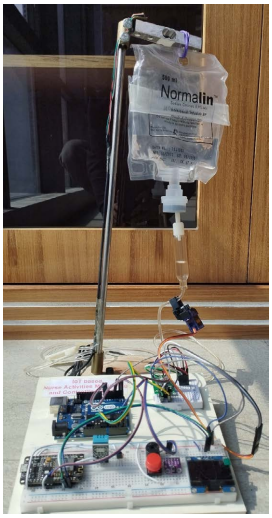

Figure 6. Device prototype.

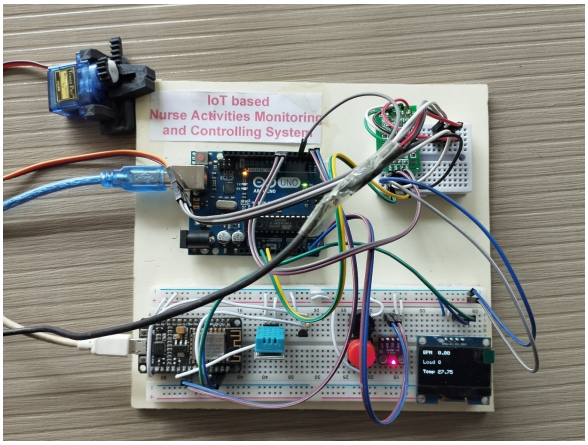

Figure 7. Device prototype.

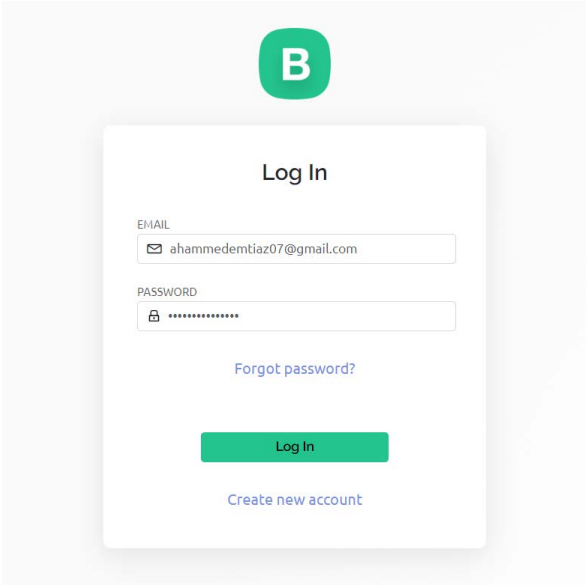

Figure 8. Login interface.

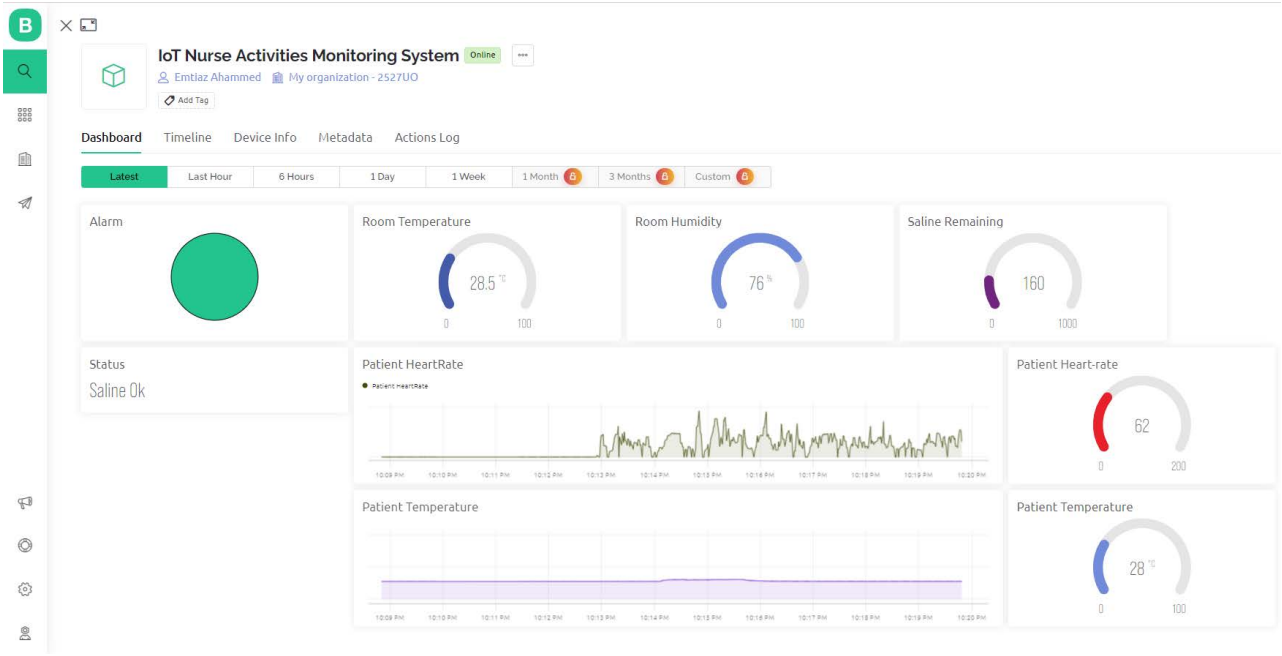

Figure 9. Dashboard interface (Desktop).

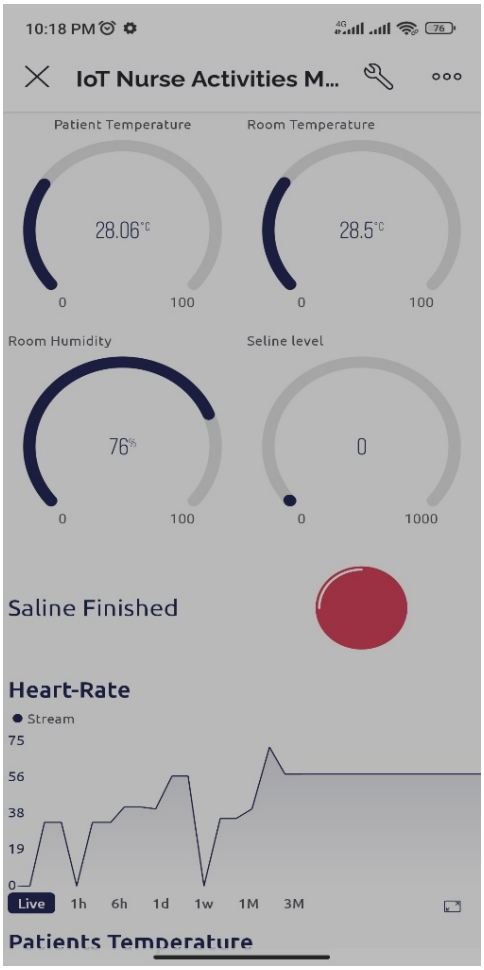

Figure 10. Dashboard interface (Mobile).

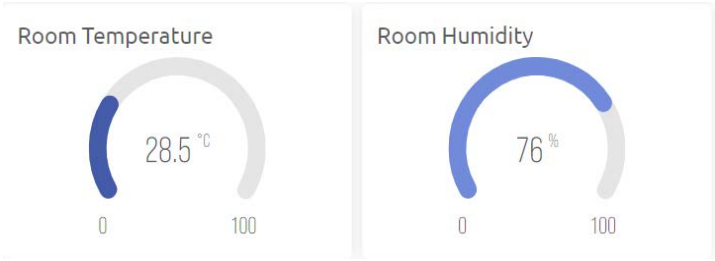

Figure 11. Room temperature and humidity monitoring.

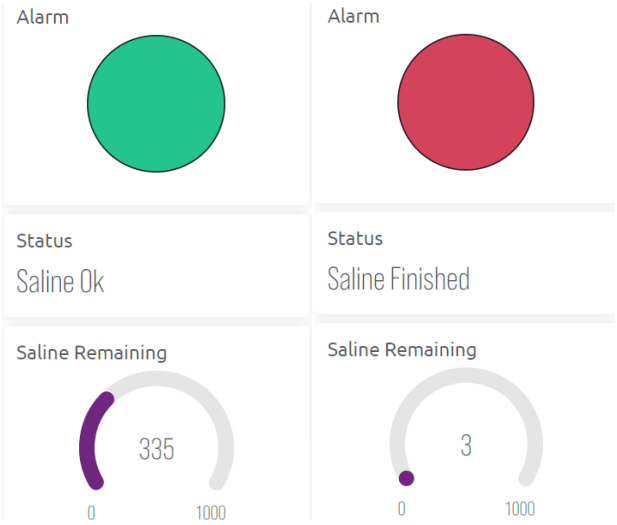

Figure 12. Automatic IV bag (Saline-bag) controlling.

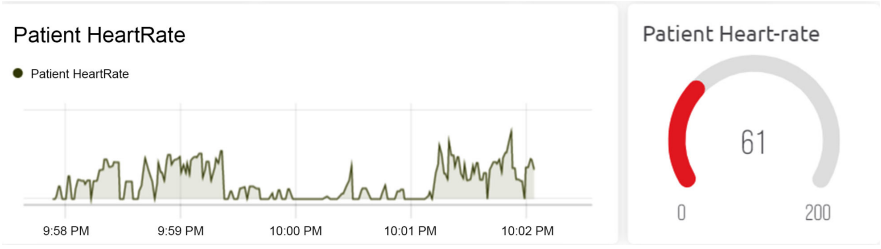

Figure 13. Monitoring Patient's Heart-Rate.

5.7. Patient's Temperature Monitoring with Graph Using Temperature Sensor

Real-time patient's temperature checking monitoring has been implemented in the proposed system. It also displays a graph. (**Figure 14**)

5.8. Patient's Oxygen Level Monitoring Using Sensor

Real-time patient's oxygen level checking monitoring has been implemented in this system. (**Figure 15**)

5.9. Emergency Switch Monitoring Using Buzzer

Emergency alert system has been implemented in this project. (**Figure 16**)

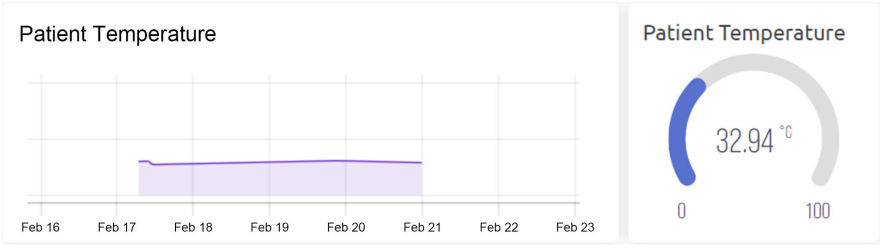

Figure 14. Monitoring patient's temperature.

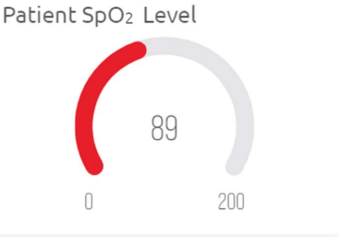

Figure 15. Monitoring patient's oxygen level.

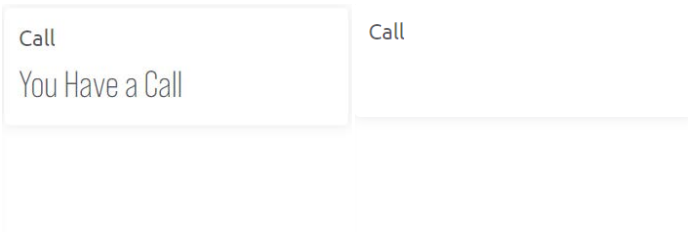

Figure 16. Monitoring emergency call.

5.10. Result & Device Accuracy

In order to evaluate the accuracy of our nurse activities monitoring and controlling device, we conducted tests on twenty patients while they were at rest. We used conventional tools such as a normal thermometer for measuring body temperature, a normal oximeter for measuring oxygen level, a normal heart rate scanner for measuring heart rate, and a normal temperature sensor for measuring room temperature. We then compared these measurements with the data obtained from our device. Through this comparative analysis, we were able to determine the accuracy of our device in measuring these vital signs. The comparison Table 1 is given.

5.11. Graphical Representation of Result

In this part, we give a graphical representation of our device's result with twenty patient's data. We use line chart for the graph. The graphs are given below:

Patient's Body Temperature: (Figure 17)
Patient's Oxygen Level: (Figure 18)
Patient's Heart-Rate: (Figure 19)
Room Temperature: (Figure 20)

Table 1. Result & device accuracy.

Patient	Body Temperature		Oxygen Level (SpO2)		Heart Rate		Room Temperature	
	Regular Result	Device Result	Regular Result	Device Result	Regular Result	Device Result	Regular Result	Device Result
Patient-1	97˚F	96˚F	98%	97%	81	84	21.3˚C	22.6˚C
Patient-2	98˚F	99.4˚F	98%	96%	86	87	20.2˚C	21.4˚C
Patient-3	96˚F	94˚F	96%	95%	87	82	20.6˚C	19.7˚C
Patient-4	98˚F	98˚F	92%	89%	94	86	24.6˚C	22.7˚C
Patient-5	99˚F	98.5˚F	93%	96%	88	85	21.9˚C	23.8˚C
Patient-6	98.2˚F	98˚F	90%	91%	90	88	19.6˚C	22.2˚C
Patient-7	95˚F	94˚F	97%	95%	88	83	20.2˚C	21.5˚C
Patient-8	97˚F	98˚F	95%	95%	88	84	21.6˚C	20.5˚C
Patient-9	99˚F	98.5˚F	92%	91%	91	89	25.6˚C	24.3˚C
Patient-10	99˚F	97˚F	93%	96%	88	85	21.9˚C	23.8˚C
Patient-11	98.1˚F	96˚F	96%	96%	82	86	20.6˚C	21.6˚C
Patient-12	95˚F	90˚F	91%	92%	89	84	20.2˚C	21.2˚C
Patient-13	97˚F	96.1˚F	99%	98%	74	79	21.6˚C	20.9˚C
Patient-14	95.5˚F	96˚F	92%	89%	94	86	24.6˚C	22.7˚C
Patient-15	99.1˚F	98.4˚F	93%	95%	81	80	22.9˚C	23.1˚C
Patient-16	97˚F	98.3˚F	90%	91%	95	90	21.6˚C	22.5˚C
Patient-17	95˚F	95˚F	96%	96%	89	85	21.2˚C	21.5˚C
Patient-18	98˚F	97˚F	95%	95%	85	81	21.6˚C	20.4˚C
Patient-19	98˚F	98˚F	92%	91%	78	75	23.6˚C	24.3˚C
Patient-20	97˚F	96.9˚F	90%	93%	85	82	24.1˚C	23.2˚C

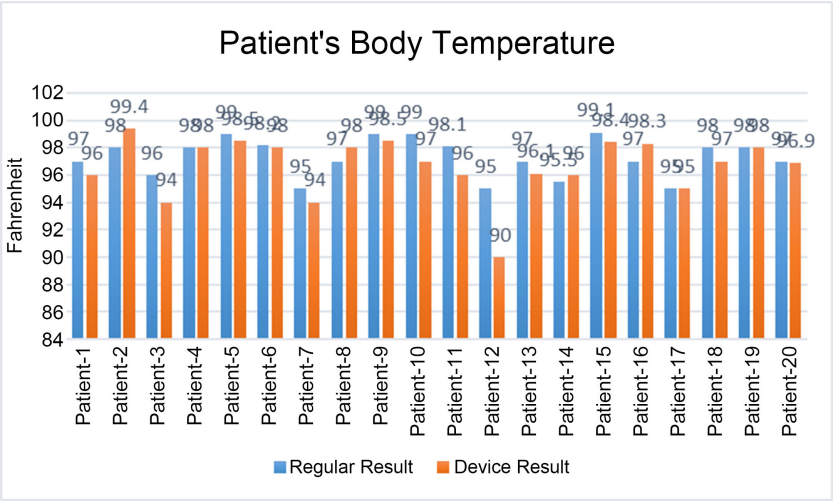

Figure 17. Temperature measurement of patients.

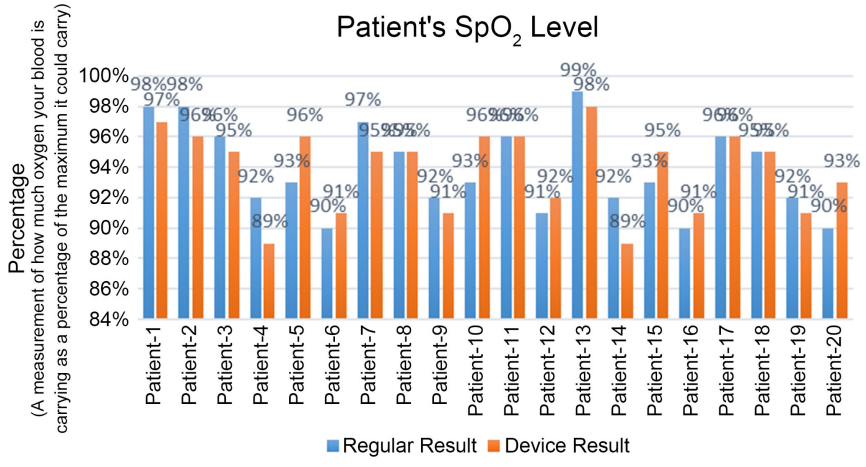

Figure 18. SpO_2 level measurement of patients.

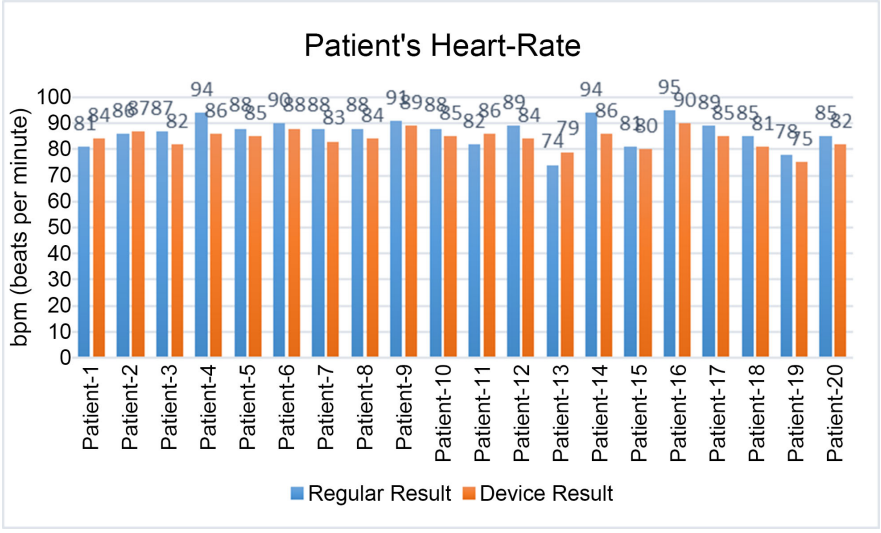

Figure 19. Heart rate measurement of patients.

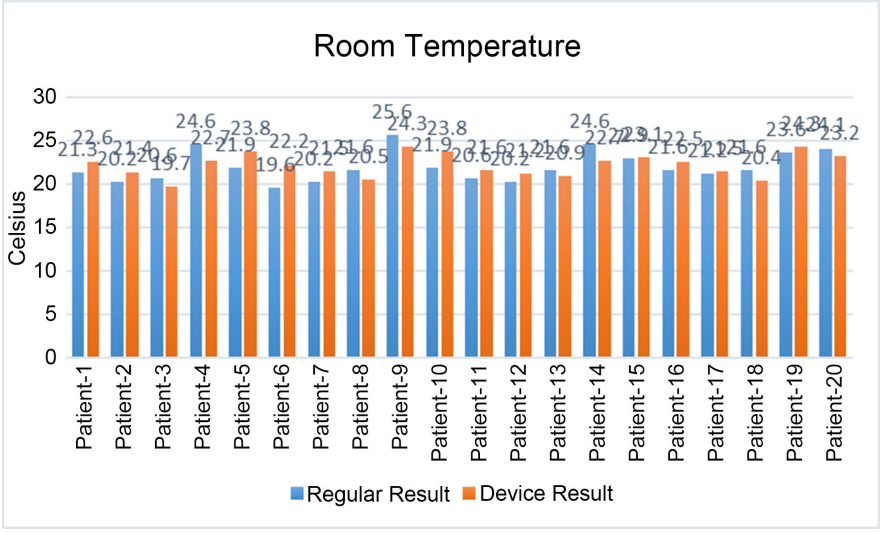

Figure 20. Temperature measurement of patient's room.

6. Conclusion

In summary, the Internet of Things (IoT) is transforming nursing care by providing numerous innovative solutions that are constantly evolving. As medical research progresses, IoT devices are becoming increasingly essential. Healthcare professionals are leveraging IoT technology to monitor and diagnose various health issues, measure multiple health parameters, and provide diagnostic facilities in remote locations. Regardless of a patient's location, IoT devices enable them to receive services from anywhere, which has shifted the healthcare industry from being hospital-centric to patient-centric. Nurses and doctors may need to be trained on how to use the proposed system, and some healthcare providers may be resistant to adopting new technologies, which could limit its effectiveness. The proposed system offers various applications and benefits, including enhanced patient care and flexibility for doctors and nurses, ultimately saving time. However, designing, manufacturing, and using IoT-based nurse activity monitoring and control systems also pose challenges and issues that require attention. In future work, the proposed system can include storage for patient medical records and the ability to monitor patients through video cameras, GPS location tracking, and flow sensors for accurate infusion tracking. This comprehensive approach to patient monitoring aims to improve healthcare management and enhance patient outcomes.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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