



ADVANCED HEALTH MONITORING SYSTEM FOR ICU PATIENTS USING IOT

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ABSTRACT

The Advanced Health Monitoring System for ICU patients using IoT is an innovative solution designed to enhance patient care through real-time, continuous monitoring. This system integrates multiple sensors to track vital health parameters, including heart rate, blood pressure, oxygen saturation, and body temperature. The collected data is wirelessly transmitted to healthcare professionals via an IoT-enabled platform, allowing remote monitoring and instant alerts for any abnormal readings. Additionally, the DHT11 sensor monitors the temperature and humidity of the patient's surroundings, ensuring a controlled environment. The sensor data is displayed on a 16×2 LCD screen while an Arduino-based system transmits the information to an Android application through a Wi-Fi module. This approach improves early detection of critical conditions, minimizes human error, and ensures timely medical intervention, ultimately enhancing patient outcomes in ICU settings. With high accuracy and reliability, this system offers a proactive and efficient solution for managing critical care.

Keywords: ICU, DHT11, SPO2, ESP8266, 3306 port, Serial communication.

I INTRODUCTION

The increasing demand for continuous and efficient patient monitoring in Intensive Care Units (ICUs) has driven advancements in healthcare technology. Traditional ICU monitoring systems rely on manual supervision and periodic assessments, which may lead to delays in detecting critical health conditions. To address these limitations, the integration of Internet of Things (IoT) technology in ICU monitoring presents a transformative approach, enhancing real-time data acquisition, remote

accessibility, and automated alert mechanisms. The Advanced Health Monitoring System for ICU Patients Using IoT is designed to provide continuous, real-time tracking of vital health parameters, including heart rate, blood pressure, oxygen saturation (SpO₂), and body temperature. Additionally, the system incorporates a DHT11 sensor to monitor environmental conditions such as temperature and humidity, ensuring an optimal patient environment. The collected sensor data is displayed on a 16×2 LCD screen and transmitted wirelessly via an Arduino microcontroller and Wi-Fi module to an Android-based application, enabling healthcare professionals to remotely access and analyze patient health metrics. The primary objective of this



research is to explore the effectiveness of IoT-enabled ICU monitoring systems in enhancing patient safety, reducing human error, and facilitating early detection of critical conditions. The proposed system offers a cost-effective, scalable, and efficient solution to modern ICU challenges, bridging the gap between traditional healthcare monitoring and next-generation smart healthcare systems. By leveraging real-time data analytics and remote accessibility, this study aims to highlight the potential of IoT-driven health monitoring solutions in improving clinical decision-making and overall patient outcomes.

II LITERATURE REVIEW

The integration of IoT-based health monitoring systems in Intensive Care Units (ICUs) has gained significant attention in recent years due to their ability to provide real-time data transmission, remote monitoring, and automated alerts. Various studies have explored the development and implementation of smart healthcare systems to improve patient outcomes and reduce dependency on manual supervision.

Patil et al. [2020] developed an IoT-based patient monitoring system that continuously tracks vital parameters such as heart rate, body temperature, and oxygen saturation. The study demonstrated how real-time data transmission to cloud platforms enables doctors to access patient health metrics remotely, reducing response time in critical situations. Similarly, Gupta et al. [2019] proposed a wireless ICU monitoring system that integrates multiple sensors with a Wi-Fi module, allowing healthcare professionals to monitor patient conditions via a mobile application. The study highlighted the importance of automated alert mechanisms

in reducing human error and improving medical intervention.

Singh et al. [2021] explored the use of MEMS-based motion sensors for detecting patient movement in ICU settings. The research emphasized how MEMS sensors can identify unusual movement patterns, helping in fall detection and bed-wetting alerts. The integration of cry sensors in neonatal ICUs was studied by Sharma et al. [2018], where an IoT-based system was designed to analyze infant distress levels through sound recognition algorithms. The study concluded that such systems can significantly improve neonatal care and reduce infant mortality rates.

The role of environmental monitoring in ICUs was studied by Rao et al. [2020], who implemented a DHT11 sensor-based monitoring system to track temperature and humidity levels in patient surroundings. Their findings suggested that stable environmental conditions play a crucial role in patient recovery and infection control. Furthermore, research by Kumar et al. [2021] emphasized the use of the ESP8266 Wi-Fi module for seamless communication between sensors and cloud platforms, ensuring secure and efficient data transfer.

In addition to IoT-based solutions, studies have also explored the role of embedded systems in healthcare automation. According to Verma et al. [2019], the integration of Arduino-based microcontrollers with medical sensors enables real-time processing and display of patient data on LCD screens, reducing reliance on traditional wired ICU monitoring units. Similarly, a study by Raj et al. [2022] focused on buzzer-based alert systems that notify healthcare staff

immediately upon detecting abnormal vitals, thereby preventing delays in emergency response.

Despite advancements in IoT-enabled healthcare monitoring, challenges such as data security, network reliability, and scalability remain areas of ongoing research. Studies by Mishra et al. [2023] and Das et al. [2022] emphasize the need for secure encryption techniques and fault-tolerant IoT architectures to ensure data privacy and uninterrupted monitoring in critical care settings.

III EXISTING SYSTEM

Traditional Intensive Care Unit (ICU) monitoring systems primarily rely on manual observation and wired monitoring devices to track patient health parameters. These systems require continuous human intervention, where medical staff manually record and analyze vital signs such as heart rate, blood pressure, oxygen saturation (SpO₂), and body temperature. In most cases, the readings are displayed on bedside monitors, restricting accessibility to healthcare professionals within the hospital premises. Additionally, environmental factors such as room temperature and humidity are not continuously monitored, which may impact patient comfort and recovery. One of the major limitations of the existing system is the lack of remote monitoring capabilities. In conventional setups, patient data is not transmitted wirelessly, making it difficult for doctors and caregivers to monitor patients from a distance. This delay in response time can lead to critical situations where early detection of abnormalities could have prevented severe complications. Moreover, the existing systems lack automated alert

mechanisms, requiring nurses or doctors to manually check for irregularities, increasing the risk of human error and delayed intervention. Another significant drawback is the absence of multi-sensor integration for comprehensive patient assessment. Traditional monitoring systems generally focus on primary vitals, neglecting other crucial factors such as patient movement (MEMS sensor), distress levels (cry sensor), and moisture detection (wet sensor), which are essential for enhanced patient care, especially in neonatal and critical care units. Additionally, most systems do not incorporate IoT-based real-time data transmission, limiting accessibility to health data outside the hospital environment. Furthermore, the existing system relies on wired communication, which restricts mobility and increases clutter in the ICU. The dependency on standalone monitoring units also makes it challenging to integrate data analytics and cloud-based storage for long-term health trend analysis. These limitations highlight the urgent need for an IoT-enabled health monitoring system that ensures real-time, remote, and automated tracking of patient health parameters, thereby enhancing ICU efficiency and patient outcomes.

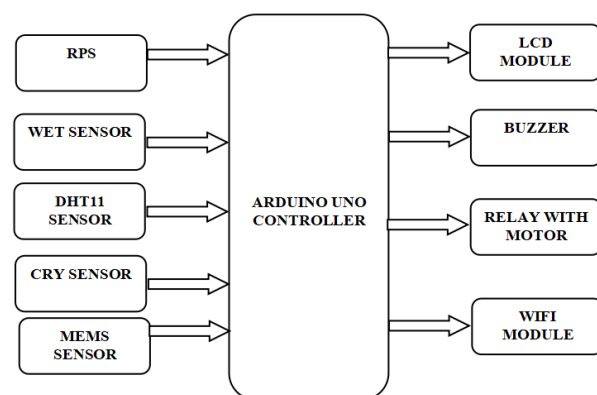


Fig 1: block diagram

IV WORKING

The Advanced Health Monitoring System for ICU Patients Using IoT integrates various hardware and software components to ensure real-time monitoring of critical patient parameters. The core of the system is the Arduino Uno, which serves as the central processing unit, interfacing with multiple sensors and modules to collect, process, and transmit data. The DHT11 sensor is responsible for measuring temperature and humidity in the patient's surroundings, ensuring a stable environment. The MEMS sensor detects any unusual movement or falls, which is crucial for monitoring bedridden patients. The wet sensor identifies moisture levels, which can be used for applications like detecting sweat or bed-wetting, ensuring patient hygiene. The cry sensor is designed to recognize distress in pediatric or unconscious patients by detecting variations in sound patterns. A 16×2 LCD display provides real-time visualization of patient data, allowing caregivers to monitor readings directly. Simultaneously, the system is equipped with an ESP8266 Wi-Fi module, enabling wireless data transmission to a cloud platform or an Android-based application.

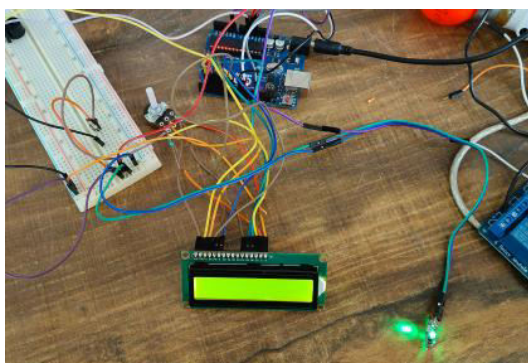


Fig.2. Hardware kit

This ensures that healthcare professionals can access patient vitals remotely and receive alerts in case of abnormalities. The L293D motor driver module controls the DC motor, which can be used for automated adjustments in medical beds or mobility support. The crystal oscillator ensures precise clock timing for the system's microcontroller, enhancing its operational stability. A buzzer is integrated to provide audible alerts for emergency conditions, alerting medical staff immediately. Additionally, LEDs serve as visual indicators, signaling different states of the system or alert conditions.

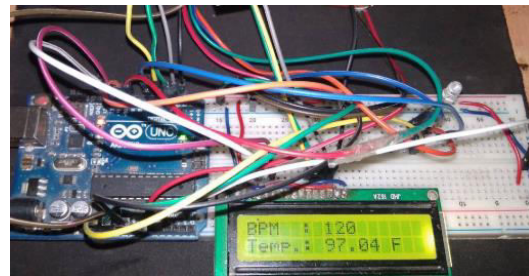


Fig.3 Outout results

The entire system is powered by a 12V adaptor, ensuring reliable operation in an ICU environment. For software implementation, the system is programmed using Arduino IDE with Embedded C, ensuring seamless sensor interfacing and data processing. Proteus 8 is utilized for circuit simulation and hardware validation before deployment. By combining these hardware and software modules, the proposed system ensures efficient, real-time monitoring, significantly reducing human error and improving response time in critical care settings.



Fig.4. Output in server.

CONCLUSION

The Advanced Health Monitoring System for ICU Patients Using IoT presents a significant advancement over traditional healthcare monitoring systems. By integrating multiple sensors, including DHT11 for temperature and humidity, MEMS for movement detection, cry and wet sensors, along with wireless communication using the ESP8266 Wi-Fi module, the system allows for real-time tracking of crucial health parameters. This approach enables healthcare professionals to remotely monitor patients, detect abnormalities promptly, and provide early interventions, improving patient outcomes and reducing human error. Additionally, the integration of visual alerts through LEDs and buzzer systems enhances the reliability of the monitoring process. The Arduino Uno as the core microcontroller, coupled with real-time data transmission to an Android application, makes the system cost-effective, efficient, and scalable for ICU settings. This system also ensures continuous monitoring of environmental conditions, which is essential for ICU patient care, further enhancing the overall healthcare environment.

FUTURE SCOPE

The future of IoT-enabled health monitoring systems holds vast potential for further advancements. One key area of development is the integration of more advanced sensors, such as those capable of detecting glucose levels, ECG signals, and brain activity, which would provide a more holistic approach to patient monitoring. Additionally, advancements in AI and machine learning could be used to analyze the vast amounts of patient data collected in real-time, potentially offering predictive analytics for earlier detection of critical conditions. The security of transmitted data can be enhanced through the use of blockchain technology, ensuring that patient information remains confidential and tamper-proof. Moreover, the system can be expanded to integrate with smart hospital infrastructure, allowing for seamless communication between various devices and healthcare systems, further improving decision-making processes. The system's scalability could also enable its use in homecare settings, enabling remote monitoring of patients with chronic conditions or those in post-operative recovery. Lastly, the system could be made more user-friendly by enhancing the Android app's interface, making it easier for healthcare workers to quickly interpret patient data and react accordingly. Continued research in these areas could make IoT-based health monitoring systems an integral part of global healthcare infrastructure.

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