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ICU PATIENT MONITORING SYSTEM USING IOT

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ABSTRACT

The journal wraps around a model that aims to assist the fact to assist doctors in tracking post-surgery patients and notifying them promptly using sensor technology. With increasing life expectancy and declining birth rates, the aging population poses socioeconomic challenges. Remote health monitoring, facilitated by non-invasive wearable sensors and modern communication technologies, offers an efficient and affordable solution for the elderly. This allows seniors to live in comfort at home, monitor vital signs, assess health conditions in real time, and provide feedback. The Internet of Things (IoT) is a promising solution for comprehensive, accessible healthcare anytime and anywhere. Establishing a comprehensive healthcare monitoring system is crucial to validate patient data and effectiveness.

Keywords: Internet Of Things, Atmega328 Micro Controller, PHMS, Sensor, Esp8260 Wifi Module, Buzzer.

I. INTRODUCTION

As global progress continues, health monitoring systems have become indispensable in various fields including hospitals, homecare, and sports. These systems are crucial for patients with chronic diseases that require consistent monitoring. Instead of manually tracking health metrics, integrated biomedical sensors like temperature and heart rate sensors offer a more comprehensive view of a patient's condition. Should there be any significant changes, immediate notifications are sent, enabling swift action to prevent future health complications. This not only benefits the patient but also aids their physician in timely decision-making. In recent times, the surge in remote technology, especially the Internet of Things (IoT), has transformed various industries, particularly automation and control. The biomedical field has embraced this trend to enhance healthcare delivery. Not only traditional hospitals but also private healthcare setups are leveraging IoT technology. A well-structured system focuses on power efficiency, cost savings, and increased effectiveness. Previously, physicians would spend considerable time on elderly patient care, from registration to monitoring. Traditional methods often required a two-day wait for test results and consultations. However, many individuals would postpone or skip these lengthy processes if they felt reasonably healthy. Modern methods, rooted in technological advancements, have streamlined these procedures, saving significant time and ensuring better patient compliance.

II. LITERATURE SURVEY

In patients affected by severe acute respiratory syndrome coronavirus – 2 (SARS-CoV-2), accurate measurement and monitoring of respiration are essential. Patients with severe chronic diseases and pneumonia require continuous respiration monitoring and oxygenation support. Existing respiratory sensing techniques necessitate direct contact with the human body and the use of expensive and heavy Holter monitors for real-time monitoring. In this study, we propose an affordable, non-invasive, and reliable paper-based wearable screen-printed sensor for human respiration monitoring as an effective alternative to existing sensing systems. The sensor was fabricated using traditional screen printing, incorporating multi-walled carbon nanotubes (MWCNTs) and polydimethylsiloxane (PDMS) composite-based interdigitated electrodes on paper substrate. The paper's hygroscopic nature during inhalation and exhalation leads to changes in dielectric constant and, consequently, the capacitance of the sensor. The composite interdigitated electrode configuration exhibited rapid response times, with a rise time of 1.178 seconds during exhalation and a fall time of 0.88 seconds during inhalation.In response to the growing number of connected medical devices, the Internet of Medical Things (IoMT) has emerged as a healthcare application of the Internet of Things (IoT), designed to collect, analyze, and

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transmit medical data. During pandemics like COVID-19, IoMT plays a crucial role in monitoring patients and detecting key symptoms remotely through various smart sensors. However, there is a need to address emotional care within IoMT, particularly for vulnerable populations like the elderly. In this context, we propose an emotion-aware healthcare monitoring system in IoMT based on brainwaves. Advances in electroencephalography (EEG) sensors in current headsets and devices make brainwave-based emotion detection feasible. IoMT devices capture a patient's brainwaves within a smart home scenario, and the system incorporates touch behavior analysis as a second layer to enhance emotion recognition. In a user study involving 60 participants, our approach proves effective in detecting emotions such as comfort and discomfort, complementing existing emotion-aware healthcare applications.

The Internet of Things (IoT) has enabled automated services for various applications, including continuous remote patient monitoring (RPM). However, the complexity of RPM architectures, large datasets, and limited device power capacity pose challenges. This paper introduces a tier-based End-to-End architecture for continuous patient monitoring, centered around a patient-centric agent (PCA). The PCA manages a blockchain component to ensure secure data storage from body area sensors while preserving privacy. This architecture includes a lightweight communication protocol to enforce data security in real-time patient monitoring, with data insertion into a personal blockchain. The blockchain is customized for RPM, with optimizations like PCA-driven Miner selection, management of multiple blockchains per patient, and block modification with prefix trees to minimize energy consumption and facilitate secure transactions. Simulation results demonstrate enhanced security and privacy in RPM with the PCA-based End-to-End architecture. For wireless patient monitoring, we propose an integration and modularization solution for a passive computational radio frequency identification (RFID) module. In this configuration, all electronic components are encapsulated within the cavity of a textile antenna, creating a compact and concealed embodiment suitable for hospital garments, especially for older patients. Modularization is achieved through a snap-on attachment method, simplifying assembly and maintenance. This approach allows customization of the sensor and textile antenna to meet specific application requirements, including performance and disposability. Experimental results show that the wireless wearable sensor can operate with an antenna broadside gain of 2.74 dBi over a wide bandwidth spanning 893-964 MHz, supporting worldwide operation in the ultrahigh-frequency (UHF) industrial, scientific, and medical (ISM) bands. The wearable sensor demonstrates excellent performance in terms of received signal strength, data read rate, and batteryless operational range within the context of a monitoring system.

III. METHODOLOGY

The methodology of accurate respiration measurement is essential for SARS-CoV-2 patients and individuals with chronic diseases. Existing methods involve direct contact and expensive Holter monitors. Our proposed methodology focuses on an affordable paper-based wearable sensor fabricated using screen printing technology. The sensor employs a hygroscopic paper substrate for humidity sensing and interdigitated electrodes to detect respiration changes through capacitance measurements. Notably, our configuration demonstrates improved response times, with 1.178 seconds during exhalation and 0.88 seconds during inhalation.

Emotion-Aware Healthcare System

The Internet of Medical Things (IoMT), a healthcare application of IoT, facilitates the collection and transmission of medical data for patient monitoring. To address the emotional care deficit in IoMT, we propose an emotion-aware healthcare system using brainwave-based emotion detection. EEG sensors capture brainwave data in a smart home environment, while touch behavior analysis enhances emotion recognition. A study involving 60 participants validates the effectiveness of this approach in detecting emotions such as comfort and discomfort, thereby complementing existing healthcare applications.

Patient-Centric Agent (PCA)-Based RPM Architecture

IoT enables remote patient monitoring (RPM) without human intervention. To overcome RPM challenges, we introduce a patient-centric agent (PCA)-based architecture. The PCA manages a secure blockchain infrastructure for data collected from body sensors. This architecture ensures privacy, secure communication, data sharing among healthcare professionals, and seamless integration with health records. Customized

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blockchain modifications are implemented to enhance security and privacy. Simulation results confirm the effectiveness and robustness of this PCA-based RPM architecture.

Integrated Solution for Wireless Patient Monitoring

It present an integrated solution for wireless patient monitoring utilizing passive computational RFID modules. The electronics are concealed within a textile antenna, designed for discreet incorporation into hospital garments, especially tailored for elderly patients. The modular design includes a user-friendly snap-on attachment method for ease of assembly and maintenance. Customizable configurations are provided to accommodate diverse application requirements. Experimental results demonstrate the strong performance of this wearable sensor across a wide frequency range, making it suitable for global operation in medical ban.

IV. MODELING AND ANALYSIS

The hardware kit utilizes a step-down transformer, converting the incoming 220v to a 12v power supply. This transformed power is then fed through a bridge rectifier, which effectively changes the 12v AC supply into a stable 12v DC supply. To mitigate any undesirable AC noise signal stemming from the original source, a capacitor is integrated into the circuit. To further manage the power distribution, two essential IC voltage regulators, namely the 7812 and 7805, come into play. They allocate the distinct 12v and 5v power outputs required by the controller and sensors. Among these sensors, the pulse sensor gauges the heart rate of the individual, while the fall detection mechanism discerns instances of a person falling on the bed. Correspondingly, the body temperature sensor is adept at detecting variations in bodily heat. These sensor readings are seamlessly transmitted via IoT technology through the Blynk application, which in turn promptly triggers alerts via a buzzer when necessary.

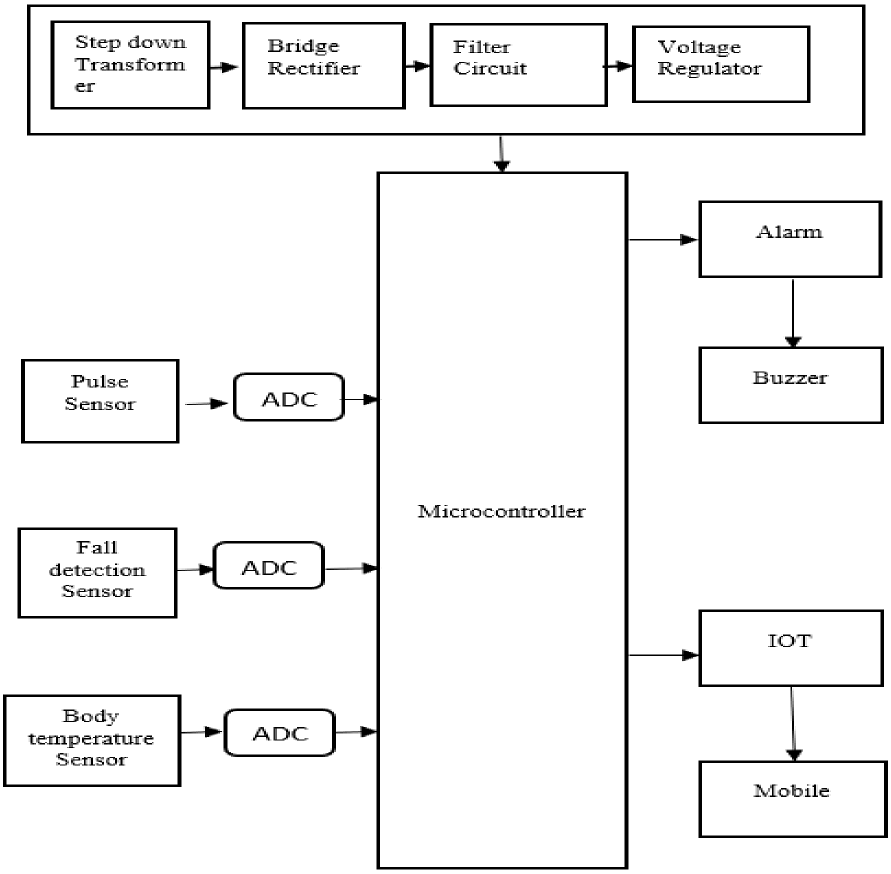

Figure 1: Block diagram

HARDWARE COMPONENTS

It has components like the Arduino Uno is a microcontroller board that supports the microcontroller via USB connection and can be powered via a power jack, ICSP header, or battery. It features 14 digital input/output pins, 6 PWM outputs, 6 analog inputs, and a 16 MHz crystal oscillator. The Uno differs from its predecessors by using the Atmega8U2 instead of the FTDI driver chip. A buzzer is a signaling device that produces a distinctive rasping noise. An innovative buzzer circuit uses a relay, a small audio transformer, and a speaker to produce sound. The heart rate sensor is designed to provide a digital output corresponding to the heartbeat when a finger is placed on it. It uses light modulation to detect the heart rate, using a high-intensity LED and an LDR. A power supply is an electrical power source that supplies energy to a load or set of loads. Linear supplies are simpler but bulkier for high current devices while switched-mode supplies are more compact, efficient, and complex but may be less efficient. Linear power supplies are used to adjust voltage from AC power sources to a lower level when generating DC power. Rectification is achieved using various methods with the bridge rectifier being prominent for generating full-wave DC output. Temperature and wetness sensors are introduced such as the LM35 temperature sensor and the WET Sensor which provide valuable data for environmental monitoring and control applications.

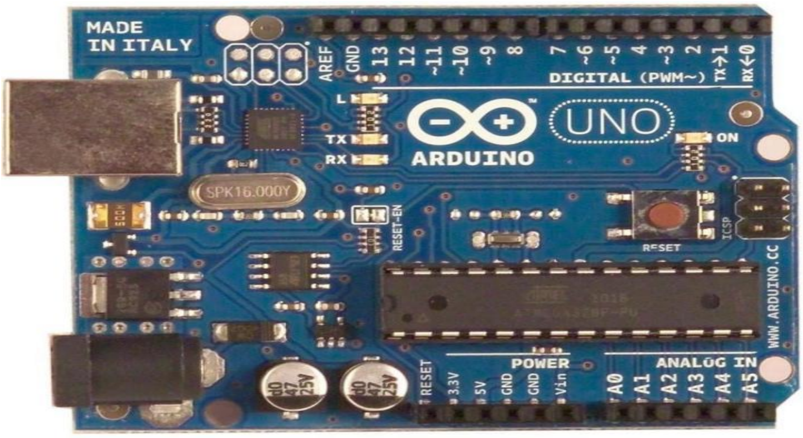

Figure 2: Arduino Uno

SOFTWARE COMPONENTS

The Arduino platform is an open-source electronics platform that includes an integrated development environment (IDE) for programming Arduino boards. The IDE simplifies the process of writing, compiling, and uploading code to Arduino boards and supports a range of Arduino boards and shields. Third-party hardware can be added by extending the hardware directory within the sketchbook directory. Blynk is a popular third-party software platform that simplifies the process of connecting hardware to the cloud, enabling the creation of IoT projects without complex coding. The provided code is written in C++ programming language for use with an ESP32 microcontroller and Blynk, an IoT platform that allows remote control of hardware through a smartphone app. IoT technology in ICU patient monitoring systems has shown great promise in enhancing patient care and medical processes by enabling real-time monitoring of vital signs, patient data, and other critical information. However, there are several areas that warrant further exploration and development in the future. First, security must be rigorously addressed to safeguard patient data and maintain compliance with privacy regulations. Second, scalability and interoperability need to be enhanced to accommodate diverse healthcare environments and devices. Thirdly, advanced analytics and predictive algorithms will be crucial to transform collected data into actionable insights. Lastly, collaboration between medical professionals, engineers, and data scientists is crucial for ongoing evolution of this technology. Addressing these challenges will further propel the advancement of IoT-enabled ICU patient monitoring systems contributing to the transformation of critical care and improving patient outcomes.

V. RESULTS AND DISCUSSION

The paper explores the development of an ICU patient monitoring system utilizing IoT technology. Its primary objective is to aid healthcare professionals in the monitoring and timely notification of post-surgery patients' conditions through sensor technology. The study delves into the integration of diverse hardware and software components, while also introducing inventive techniques for patient monitoring. This summary provides an overview of the methodology, hardware and software components, and engages in a discussion of the findings and their implications. The paper aptly underscores the significance of IoT within the realm of healthcare,

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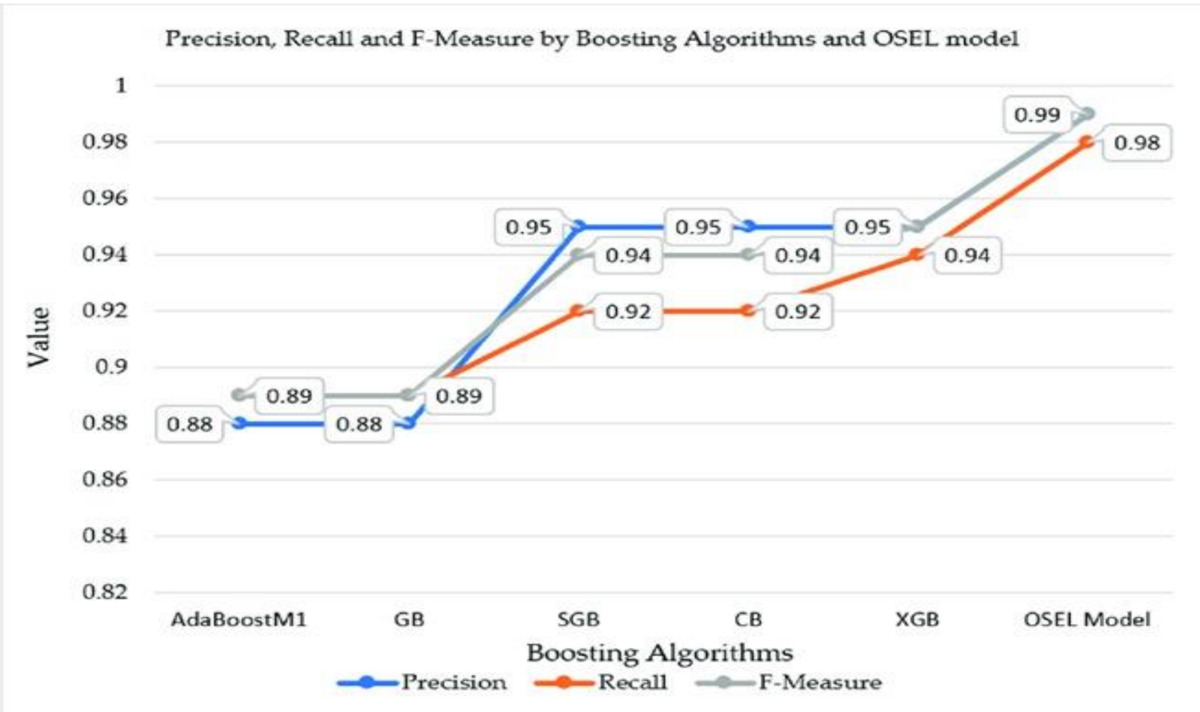
particularly in the context of remote patient monitoring. IoT technology enables real-time data collection and analysis, which is of paramount importance for post-surgery patient care and the early detection of health-related issues.

An innovative aspect of the paper is the utilization of a paper-based wearable sensor for measuring respiration. This approach stands out due to its cost-effectiveness and the rapid response times it achieves, which are crucial for effective monitoring of patients' breathing patterns.

The research involved a multi-layered approach to sensing and emotion recognition. First, paper was utilized as the sensing material for humidity in the sensor due to its hygroscopic properties. The fluctuations in humidity during inhalation and exhalation caused variations in the paper's dielectric constant, resulting in changes in sensor capacitance. To enhance sensor performance, a composite interdigitated electrode configuration was employed, which yielded impressive response times. Specifically, during exhalation, a rise time of 1.178 seconds was observed, while during inhalation, a fall time of 0.88 seconds was recorded.

Beyond humidity sensing, the system incorporated touch behavior analysis as a secondary layer to augment brainwave-based emotion recognition. In a user study involving 60 participants, the system's capabilities in detecting emotions such as comfort and discomfort were evaluated. The results demonstrated the practicality and effectiveness of this combined approach, suggesting its potential to complement existing emotion-aware healthcare applications and mechanism



VI. CONCLUSION

The IoT patient monitoring system has proven to be a valuable tool in healthcare in total . With the increasing demand for remote health monitoring, it is essential to establish a comprehensive healthcare monitoring system that validates patient data and effectiveness. The proposed methodology of accurate respiration measurement using paper-based wearable sensors offers an affordable solution for patients with chronic diseases. Additionally, the emotion-aware healthcare system, patient-centric agent (PCA)-based RPM architecture, and integrated solution for wireless patient monitoring are innovative solutions that enhance healthcare delivery. The hardware components used in this system include Arduino Uno, buzzer, heart rate sensor, power supply, temperature and wetness sensors. The software components include the Arduino platform and Blynk IoT platform. While IoT technology has shown great promise in enhancing patient care and medical processes by enabling real-time monitoring of vital signs, there are still challenges that need to be addressed. Security must be rigorously addressed to safeguard patient data and maintain compliance with privacy regulations. Scalability and interoperability need to be enhanced to accommodate diverse healthcare environments and devices. Advanced analytics and predictive algorithms will be crucial to transform collected data into actionable insights. Collaboration between medical professionals, engineers, and data scientists is crucial for ongoing evolution of this technology. Addressing these challenges will further propel the advancement of IoT-enabled ICU patient monitoring systems contributing to the transformation of critical care and improving patient outcomes.

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