2024 3rd IEEE International Conference on Artificial Intelligence for Internet of Things (AIIoT 2024)

IOT BASED ICU PATIENT MONITORING SMART SYSTEM

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2024 3rd International Conference on Artificial Intelligence For Internet of Things (AIIoT) | 979-8-3503-7212-0/24/$31.00 ©2024 IEEE | DOI: 10.1109/AIIoT58432.2024.10574787

Abstract:

This extend presents an IoT-based ICU understanding checking framework that utilizes temperature, ECG, and respiratory sensors interfaces with an ESP8266 microcontroller for real-time information collection. The obtained information is transmitted to the AWS Cloud through MQTT, where it experiences preparing and dispersion to DynamoDB for capacity, SNS for communication, and parallel investigation by machine learning calculations. The nonappearance of Lambda capacities streamlines the information stream, with DynamoDB and SNS contributing synergistically. A web application frontend coordinating the bits of knowledge from DynamoDB and ML, giving healthcare experts with a natural interface for observing. At the same time, SNS acts as a basic communication sensor, dispatching cautions to healthcare suppliers and end-users. This extends grandstands an unpredictably planned framework balanced to revolutionize ICU understanding care, emphasizing incite location, personalized treatment methodologies, and improved healthcare results.

Keywords—*AWS, AWS Iot core, Dynamo DB, MQTT, Simple notification service (SNS), Application programming interface (API), Machine learning.*

INTRODUCTION:

The Internet of Things (IoT) has become a force for change in the quickly changing healthcare industry, providing creative ways to improve patient care. The Intensive Care Unit (ICU) is one specifically important setting where it is crucial to continuously monitor patients' vital signs. With their ability to seamlessly connect several medical devices, collect real-time data, and give healthcare professionals accurate and timely information, IoT-based ICU patient monitoring smart systems represent a paradigm shift in healthcare delivery. Through early detection of possible problems and timely action, this integrated ecosystem guarantees patients receive comprehensive and ongoing monitoring.[1]

Specialized sensors are integrated into an IoT-based ICU health monitoring smart system, which is essential for gathering and transmitting vital physiological data.[2]

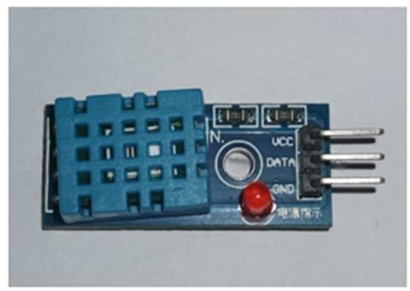

Fig. 1. Humidity and Temperature Sensor

The Fig.1 shows the sensors for humidity and temperature which are used to keep an eye on the patient's surroundings and make sure that the environment is favourable for healing. These sensors help healthcare providers maintain the ideal atmosphere for patients' well-being by giving them real-time feedback on the temperature and humidity levels. [3]

Fig. 2. Respiratory Sensor

The Fig.2 shows the sensor for Respiratory rate measurement and by recording the patient's breathing patterns, respiratory sensors add to the full surveillance by facilitating the early detection of abnormalities or respiratory distress.

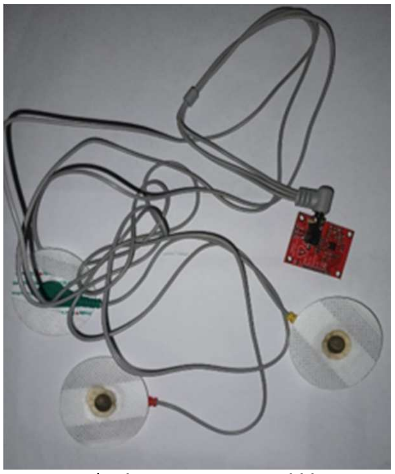

Fig. 3. ECG Sensor AD232

The Fig. 3 shows ECG sensors which record the electrical activity of the heart simultaneously, offering vital information about cardiac health and facilitating the early detection of any anomalies. Together, these sensors function as a synergy within the IoT framework, facilitating not just continuous data collecting but also a patient-centered approach that gives healthcare providers the knowledge they need to intervene promptly and customize treatment plans. [4][5][6]

Applications for patient monitoring systems in healthcare are numerous and include remote monitoring, wellness tracking, and critical care settings. These devices are essential for the continuous monitoring of vital signs in intensive care units (ICUs), which guarantees the early identification of any deviations from standard parameters. By offering real-time data to detect issues and facilitate a seamless recovery, patient monitoring aids in postoperative care. Healthcare providers can monitor patients' health remotely with IoT-powered remote patient monitoring [7][8], which minimizes the need for frequent hospital visits and is particularly useful for managing chronic diseases like diabetes and cardiovascular disorders. These devices are also essential for monitoring expectant mothers and their developing fetuses, monitoring older people better at assisted living centers or at home, and advancing sports medicine by monitoring the physiological parameters of athletes as they train. Furthermore, patient monitoring systems support pharmaceutical research, sleep monitoring, and even wearable health and wellbeing tracking. This wide range of uses demonstrates the adaptability and significance of patient monitoring systems in improving healthcare in numerous fields. [9][10]

METHODOLOGY:

A network of sensors, including temperature, humidity, respiration, and ECG sensors, diligently gathers real-time patient data in our carefully designed ICU patient monitoring setup. An AWS Cloud MQTT broker acts as the key hub for data exchange, receiving this abundance of data with ease [11][12]. The data is subsequently processed. Patient data is managed and stored by DynamoDB, a NoSQL database, and SNS (Simple Notification Service) makes sure that users and healthcare practitioners are informed on time by providing pertinent alerts. In order to improve the system's capacity to identify patterns or abnormalities, machine learning algorithms are also applied to the data analysis process [13]. The results of the machine learning and DynamoDB operations are then sent to a web application frontend, giving medical practitioners an extensive interface for observation and analysis [12][14]. In addition, SNS provides vital notifications and messages, acting as a vital sensor for user communication. This well-organized data flow from sensors to cloud services and back to user interfaces demonstrates the effectiveness and system integration capabilities in improving clinical decision-making and patient care.

LITERATURE REVIEW:

IoT-based ICU patient monitoring systems are gaining attention in the literature for their critical role in improving healthcare through real-time data collection, analysis, and smooth communication. Several studies highlight how crucial it is to integrate several sensors—like temperature, humidity, respiration, and ECG sensors—for thorough patient monitoring. Because of its scalability and dependability, the use of AWS Cloud services—such as MQTT for data transfer and Lambda for effective data processing—has grown in popularity. DynamoDB is a well-known NoSQL database that excels in efficiently managing massive amounts of patient data. Additionally, the system's analytical capabilities are improved using machine learning algorithms, making it possible to identify health irregularities early on. SNS becomes an essential part of real-time communication, alerting end users and healthcare practitioners alike. The research continuously emphasizes how these systems can enhance remote patient management, postoperative monitoring, and critical care. Furthermore, the smooth integration of frontends for online applications guarantees interfaces that are easy to use for medical professionals. Overall, there is growing agreement in the research regarding the effectiveness of IoT-based ICU patient monitoring systems in transforming the way healthcare is delivered by giving timely and accurate information to improve patient care and decision-making.

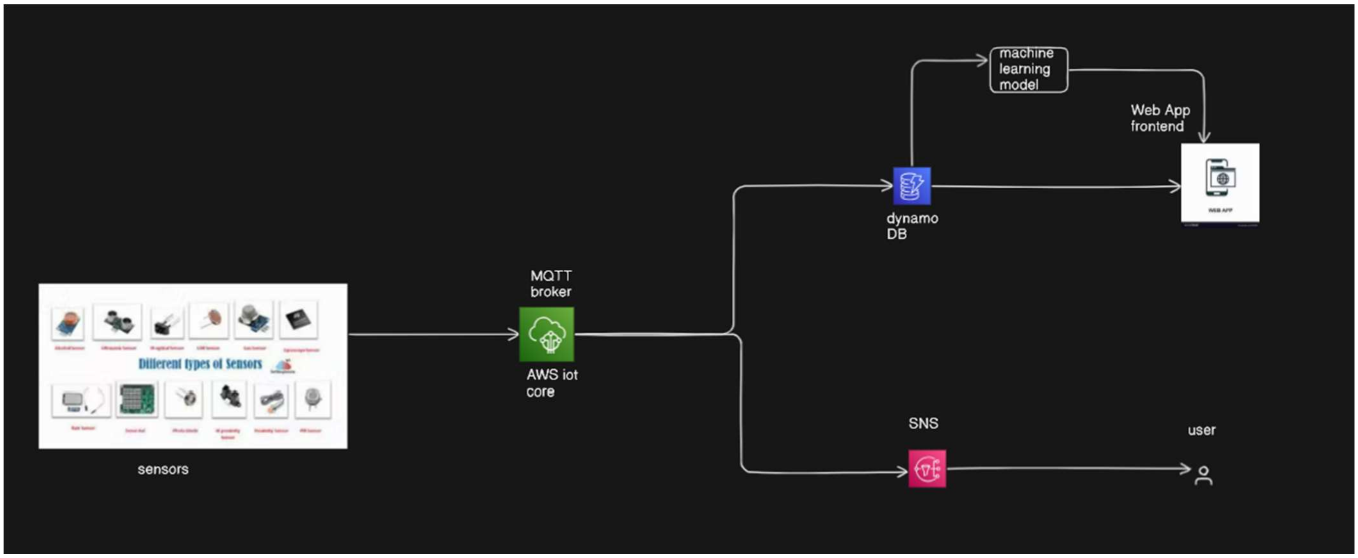

Fig. 4. Architecture of Health Monitoring System integrated with AWS

DESIGN OF PATIENT HEALTH MONITORING SYSTEM:

The IoT-based ICU patient health monitoring system's initial hardware configuration starts with specialized sensors connected to an ESP8266 microcontroller for temperature, humidity, respiration, and ECG monitoring. The ESP8266 serves as a central hub for data collecting and transmission and was selected because to its affordability and Wi-Fi capabilities. The ESP8266 communicates with the sensors through particular pins, collecting patient vital sign data in real time. [15][16]

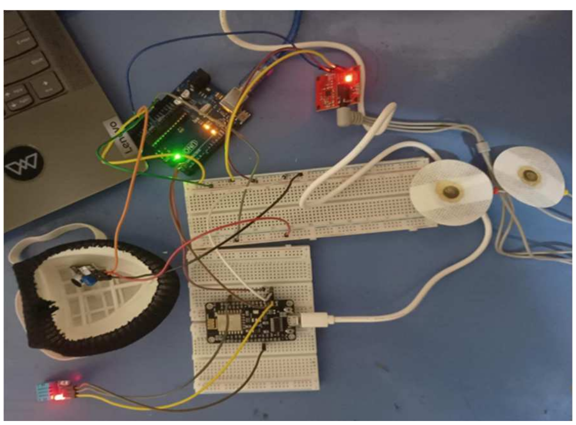

Fig. 5. Integrated PMS Hardware

In tending to the basic of having because it were one analog pin of the ESP8266 microcontroller though joining two analog sensors, a down to soil course of action was executed by leveraging the capabilities of the Arduino UNO. With its five available analog pins, the Arduino UNO gives the elemental additional capacity for sensor integration as shown in Fig. 5. To energize communication between the Arduino UNO and the ESP8266, a transmitter-receiver setup was built up. The transmission pin of the Arduino UNO is interconnected with the receiver pin of the ESP8266, and correspondingly, the transmission pin of the ESP8266 is related to the receiver pin of the Arduino UNO. This bidirectional interface engages steady data exchange between the two microcontrollers. To ensure synchronization, both the ESP8266 and Arduino UNO were planned to operate at a unfaltering baud rate of 115200. This collaborative course of activity in a perfect world addresses the analog adhere obstacle on the ESP8266, empowering the synchronous securing of data from two analog sensors through the Arduino UNO center individual. [16][17]

The ESP8266 is modified to handle and bundle the sensor information, building up a secure Wi-Fi association to the AWS Cloud MQTT broker. Utilizing the MQTT convention, the ESP8266 distributes the accumulated information as MQTT messages, which are at that point transmitted to the MQTT broker within the AWS Cloud as shown in Fig. 4. This broker acts as a centralized communication point, effectively dealing with the approaching information streams.

Understanding information is put away and kept up for investigation and recovery in Amazon DynamoDB, a NoSQL database, through one information pipeline. In parallel, a diverse zone employments machine learning (ML) calculation to analyze information and discover designs, anomalies, and patterns within the quiet information. The internet application frontend gets both the ML experiences and the information put away in DynamoDB, giving restorative professionals an broad interface for in-depth investigate and real-time observing.

At the same time, AWS Basic Notice Benefit (SNS) capacities as an fundamental communication sensor. SNS makes beyond any doubt that messages and notices are conveyed on time to conclusion clients and healthcare professionals. SNS acts as a notice framework for restorative work force, advising them of vital events or changes in persistent parameters. SNS serves as a coordinate line of communication for conclusion clients to get customized cautions and overhauls, moving forward their understanding of their possess wellbeing state. To sum up, the ESP8266 hardware connections together with the ensuing cloud-based data flow result in an intricate and well-thought-out IoT-based ICU patient monitoring system. This architecture makes sure that sensitive patient data is securely and seamlessly transferred from the physical sensors to the cloud, enabling effective data processing, storage, analysis, and communication for better patient outcomes.

RESULTS

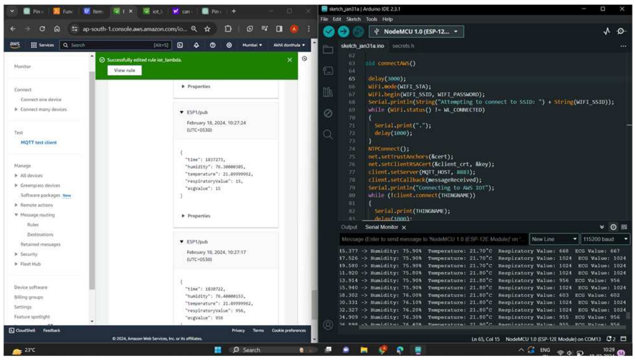

Fig. 6. Sensory Data Transmission and AWS IOT Core

The Fig. 6 shows the successful operation shown in the Arduino IDE and Serial Monitor validates the efficiency of the Arduino-connected circuit. The dependability of the ICU patient monitoring system is ensured by real-time updates on the Serial Monitor, which verify the stable AWS connection status and continuous receiving and transfer of sensor data to the MQTT broker. [12][18]

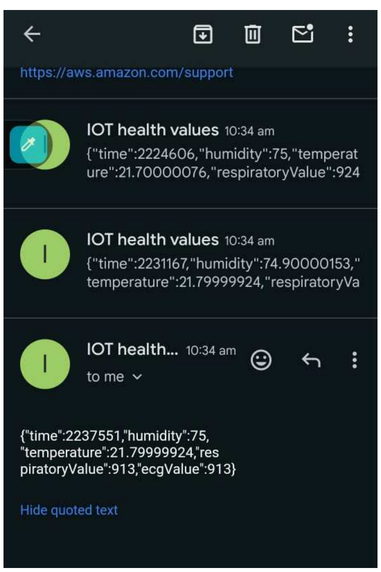

Fig. 7. Health Alert: AWS IoT Core and SNS Integrated Patient Notification System.

Through AWS rules, AWS IoT Core and Simple Notification Service (SNS) work together to create a quick and automatic communication channel. Important health updates are delivered promptly and directly to patients via SNS, thanks to the smooth transmission of patient data from AWS to their email as shown in Fig. 7. This simplified integration improves the effectiveness of communication and helps create a healthcare system that is responsive. [2]

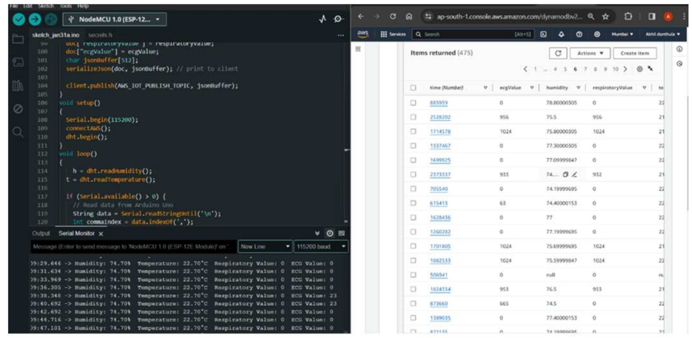

Fig. 8. Data sent to AWS dynamo DB

In the above Fig. 8, DynamoDB stores the broker-sourced data effectively and provides a variety of uses for it. From historical trend analysis and predictive modelling to individualized patient profiles, this recorded data is an invaluable resource for a wide range of applications. Healthcare workers may obtain meaningful insights thanks to DynamoDB's scalability and accessibility, which supports well-informed decision-making and raises the overall efficacy of the ICU patient monitoring system. [14][19]

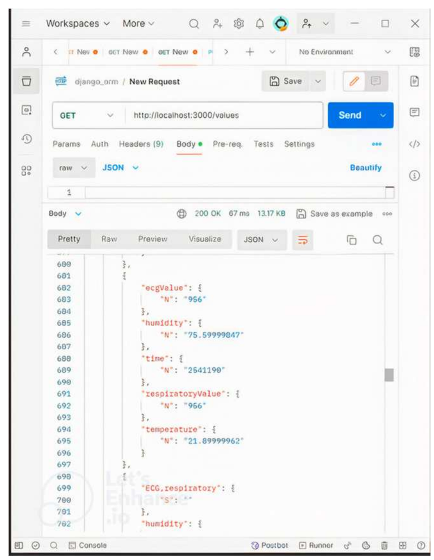

Fig. 9. API Integration with Dynamo DB

Using the AWS SDK and IAM user for secure and authenticated access, we have created a versatile API that is seamlessly linked with AWS to guarantee real-time accessibility to patient data as shown in Fig. 9. Physicians in particular are empowered by this API to obtain patient data as needed IAM user authentication assures data security, and the interface with AWS provides a stable and scalable infrastructure. The doctor's access to vital patient data is improved by this simplified approach, meeting the changing demands of healthcare decision-making.

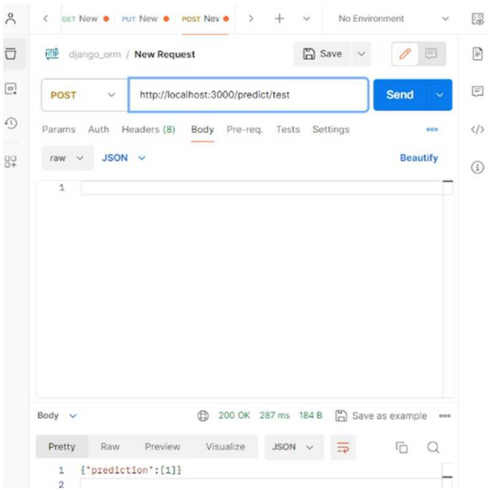

Fig. 10. Machine Learning Model Prediction

Our patient-centrically planned API consequently bolsters quiet information into a machine learning show to empower expectations approximately when a visit to the specialist is prescribed. The reason of this customized methodology is to provide patients proactive information approximately their wellbeing status. The API employments machine learning as in Fig.10 to produce personalized proposals based on the information that has been considered. This makes a difference individuals make choices approximately whether to look for therapeutic guide and gives them valuable data. [19]

The incorporation of machine learning models is a critical component in improving the precision and efficiency of diagnosis and treatment choices in the setting of an Internet of Things-based smart health patient monitoring device. ML algorithms are able to detect minute patterns and correlations that can be missed by human analysis by continuously evaluating sensor data and patient health measurements that are saved in the AWS cloud. These models have the capacity to identify deviations from typical health indicators and offer pre-emptive alerts regarding possible health hazards or the commencement of particular ailments. Furthermore, through feedback loops, machine learning algorithms can adjust and enhance over time, honing their predictions and suggestions considering fresh information and results.

This project distinguishes itself from existing efforts in the field of IoT-based smart health monitoring by integrating machine learning models, which makes it unique. A layer of intelligence and predictive power is added by ML, which raises the system's effectiveness in proactive healthcare management, while many programs of a similar nature only concentrate on data collecting and basic analytics. This study pushes the envelope in terms of what is feasible for remote patient monitoring and healthcare decision-making by utilizing machine learning (ML) to analyze sensor data and provide predictions.

CONCLUSION

In conclusion, the IoT-based ICU quiet observing framework displayed in this venture speaks to a comprehensive and imaginative approach to healthcare innovation. By coordination temperature, ECG, and respiratory sensors with an ESP8266 microcontroller and leveraging AWS Cloud administrations, counting MQTT, DynamoDB, SNS, and machine learning, the framework encourages real-time, persistent observing of basic understanding parameters. The equipment associations, from sensor information securing to cloud-based preparing and communication, lay the establishment for a strong and interconnected arrangement. This engineering not as it were guaranteeing the secure and effective transmission of persistent information but moreover empowers healthcare experts to get to opportune data for educated decision-making. The integration of web application frontends and SNS advance improves the system's client interface and communication capabilities. By and large, this extend underscores the potential of IoT in changing ICU persistent care, advertising a adaptable and versatile arrangement that prioritizes early location, personalized treatment, and moved forward healthcare results. The effective execution of this checking framework marks a noteworthy walk towards the realization of progressed, technology-driven healthcare arrangements.

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