Human Centric Cloud Based Portable ICU for Advance Assistance System

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***Abstract*— The Human-Centric Cloud-Based Portable ICU system represents a transformative approach to emergency medical care by seamlessly integrating real-time ambulance assistance with hospital infrastructure through advanced IoT technologies. This innovative system enhances patient outcomes by optimizing the coordination between emergency medical services and healthcare facilities. Portable medical devices equipped with IoT sensors measure key health parameters, such as body temperature, heart rate, pulse rate, and SpO2 levels, allowing first responders to quickly assess a patient's condition. These devices facilitate the creation of a unique patient ID, consolidating all pertinent medical information and ensuring efficient data handling from the initial ambulance encounter.**

All collected data is securely transmitted via robust communication protocols like MQTT and cellular networks to a centralized cloud database. This cloud-based hub serves as an information exchange point between ambulances and hospitals. Upon receiving data, hospitals are immediately notified of the incoming patient's condition, enabling them to assess their capacity to provide appropriate care based on available beds, doctors, and specialized medical infrastructure. Real-time analytics and dashboards provide actionable insights, allowing hospitals to rapidly communicate their readiness and availability back to the ambulance crew, directing the patient to the most suitable facility without delay.

I. INTRODUCTION

Timely medical intervention is essential during emergencies, as even brief delays can significantly reduce survival rates. For example, each minute without defibrillation during a cardiac arrest diminishes the chances of survival by 7-10%. To address these critical needs, human-centric cloud-based portable ICU systems are emerging as game-changers in emergency care. These advanced systems integrate seamlessly with hospital infrastructure, allowing for real-time monitoring and data exchange. By providing continuous updates on vital signs and patient status, these portable ICUs ensure that hospitals are well-prepared for the patient's arrival, thus minimizing the time lost in transitioning from the ambulance to the hospital.

The implementation of cloud-based portable ICU systems enhances overall coordination and reduces delays in emergency response. These systems leverage IoT technologies to deliver accurate and timely information, optimizing patient care during transport. By synchronizing data across different healthcare touchpoints, the system supports immediate medical responses and enables a more effective, informed treatment approach. This advancement not only improves patient outcomes by addressing critical conditions more swiftly but also fosters a more connected and responsive healthcare environment.

II. LITERATURE SURVEY

[1] Poncette et al. (2022) explore the role of a human-centered design (HCD) approach in developing remote patient-monitoring systems for intensive care units (ICUs). The study highlights the necessity of continuous monitoring, technological advancements, and usability in healthcare technologies. A major barrier identified is the lack of clinician adoption due to poor usability, which can lead to medical errors. By applying HCD methods, the authors demonstrate significant improvements in the usability, efficiency, and effectiveness of these systems. They argue that HCD enhances end-user satisfaction and overall system safety, emphasizing the need for early user involvement in product design. Further research is required to explore strategies for integrating HCD methods early in the development process to foster better usability and clinical outcomes in digital health technologies.

[2] Goyal, Kaushik, and Khan (2021) propose an IoT-based cloud network for smart healthcare, employing a Particle Swarm Optimization (PSO) algorithm for better data fusion in diagnosing neurological conditions like epilepsy. The study addresses the growing demand for healthcare services due to aging populations and chronic diseases. By optimizing EEG data processing using PSO, the system enhances diagnostic accuracy and efficiency compared to traditional Artificial Neural Network (ANN) models. The authors demonstrate improvements in computational speed and sensitivity for neurological diagnoses. Future research is suggested to focus on developing energy-efficient IoT-based cloud networks for real-time patient monitoring, balancing trade-offs between energy consumption, service quality, and efficiency.

[3] Shah, Bhat, and Khan (2021) examine the integration of Cloud and IoT in healthcare to address challenges posed by an aging population and increasing chronic diseases. The fusion of these technologies enables efficient, real-time patient monitoring while reducing hospitalization costs. The Cloud-IoT model facilitates data management and seamless interaction between healthcare devices, significantly improving patient care. However, the authors stress the importance of overcoming security vulnerabilities and ensuring patient data privacy.

[4] Miao, Ding, & Wu (2022) Miaoinvestigate IoT-based systems for real-time, privacy-preserving disease diagnosis, focusing on ECG signal monitoring. The study emphasizes the importance of IoT technologies in improving emergency healthcare response times and the quality of patient care, particularly for high-risk patients. However, the authors underline the critical need for robust data security and privacy measures to foster trust and ensure compliance with ethical standards. The research suggests that while IoT offers significant benefits for emergency medical care, real-world validation and continuous advancements in cybersecurity are essential. Future work should focus on addressing cultural and geographical challenges and refining privacy protection protocols to ensure widespread adoption.

III. PROPOSED METHODOLOGY

We are trying to be connected multiple entities through standard software API and centralized cloud server integrations. Along with data standardization we are trying to build human centric emergency support providing portable ICU and ambulance system to drive emergency patient at right hospitals having all the necessary resources to treat the patient on time. By the way of implementing the sharable and distributed application programming interfaces this multiple entity integration is possible as presented in the figure. more resembles any normal cloud application, but we can see here that we are trying to be integrating multiple hospital software to each other to create communication and data exchange channel for patient history treatment and the medical practices exactly the bank having inter communication gateway to perform ATM transaction form any bank ATM payment transaction. See the complexity is exactly the way what these banking servers have these days.

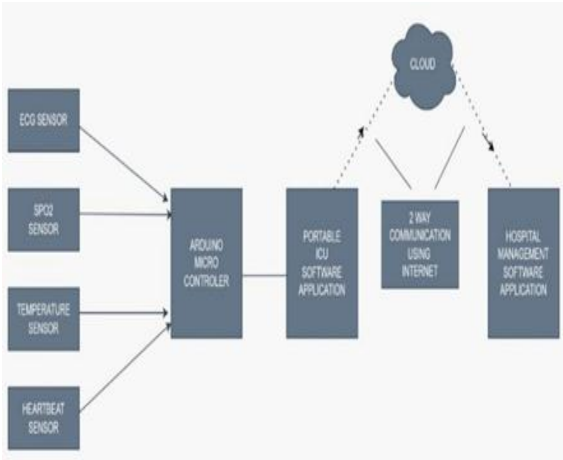

Fig.1 Block Diagram

Following are primary sensory component are used in system.

MAX30100: The MAX30100 is an integrated pulse oximeter and heart rate sensor designed for wearable and medical applications. It combines two essential components: a red and infrared LED for blood oxygen saturation (SpO_2) measurement and a photodetector to sense reflected light from tissues. By analyzing the variations in light absorption, it accurately detects heart rate and oxygen levels in the bloodstream. The sensor operates on low power, making it suitable for battery-operated devices. It features built-in ambient light rejection and a low-noise signal processing unit for precise readings.

AD8232 ECG Sensor: The AD8232 is a compact, low-power ECG (Electrocardiogram) sensor designed for heart signal monitoring. It functions as an analog front-end (AFE) by amplifying and filtering weak bioelectrical signals from the heart, ensuring clean and noise-free output. The module includes a built-in operational amplifier and signal conditioning circuits that remove unwanted interference, such as motion artifacts and baseline drift. With its low power consumption and small size, the AD8232 is ideal for wearable health monitors, remote patient tracking, and fitness applications.

DS18B20 Temperature Sensor: The DS18B20 is a digital temperature sensor known for its high accuracy and ease of integration. It operates on a one-wire communication protocol, allowing multiple sensors to be connected using a single data line. The sensor provides temperature readings in the range of -55°C to +125°C with an accuracy of ±0.5°C in most of its operational range.

Arduino Microcontroller: This device acts as the central processing unit, collecting data from all the sensors. It processes the sensor inputs and sends the data to the next stage.

Portable ICU Software Application: This application runs on a connected device and interfaces with the Arduino microcontroller to gather real-time patient data. It likely displays and manages the data collected from the sensors.

Cloud Integration: The system connects to the cloud via the internet, allowing data from the portable ICU application to be uploaded for remote monitoring.

Hospital Management Software Application: The cloud communicates with this application, enabling healthcare professionals to monitor the patient's data from any location. This two-way communication system ensures that patient data is continuously updated and accessible in real-time.

IV. RESULT AND DISCUSSION

The proposed research model is depicted in figure 2, which makes the wire-connected sensor modules and portable size quite evident. The control unit, sensor unit, display unit, and USB wired connection unit are all part of the central processing unit [10]. The proposed system operates in four primary modes: A) temperature capture B) oxygen and heartbeat capture C) electrocardiogram reading. The user can quickly transition between any selected mode and work in it at will. There is no set order in which the modes operate; any mode can be entered and exited at any moment. The selected mode's sensor input reading, and the current operating mode are displayed on an LCD display.

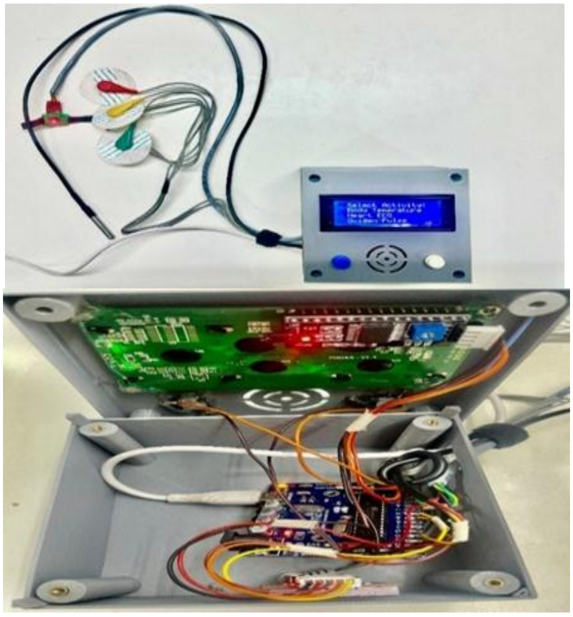

Fig 2: Portable hardware model

the system only to make the decision about the selection of final hospital to reach out. System let the ambulance attendant to take the final call as we cannot ignore the fact that local ambulance attendant sometime has precise information about the route to select and the current traffic situation in the city. After looking at the hospital response and the feasibility ambulance attendant select the feasible hospital to reach out for the final treatment to the patient. Upon selection of the finalized hospital system will start the navigation application to show best possible and fastest route to the hospital. This could be any third-party mapping application where proposed system will input the source and the destination of the route. This approach can be further enhanced to integrate the real-time traffic information as input to the system and make the discussion based on the reachability as primary condition after hospital distance for making decision in real-time. This is important as even after availability of resources if patient can't reach the location won't solve the problem and it won't help the patient by any ways.

V. FUTURE SCOPE

Looking ahead, the integration of AI and machine learning into the Human-Centric Cloud-Based Portable ICU system could further enhance its capabilities. AI-driven predictive analytics could enable the system to anticipate medical complications and recommend proactive interventions during patient transport. Additionally, personalized care could be optimized by analyzing historical health data and real-time vitals, allowing for tailored treatment plans even before the patient arrives at the hospital. Future developments could also explore expanding the system's reach to remote and underserved areas, where timely medical care is often unavailable. Collaboration among healthcare providers, technology developers, and regulatory bodies will be crucial in refining and scaling this system, ensuring it becomes a cornerstone of modern emergency healthcare worldwide.

VI. CONCLUSION

The Human-Centric Cloud-Based Portable ICU system is poised to transform emergency healthcare systems continue to evolve, the integration of advanced technologies like AI holds the potential to further refine this system, offering predictive analytics and personalized treatment options. This project not only addresses current challenges in emergency response but also paves the way for future innovations that could reshape how critical care is administered globally. The Human-Centric Cloud-Based Portable ICU system represents a significant advancement in emergency healthcare by leveraging IoT, cloud computing, and real-time analytics. Through continued research and innovation, this system could become a cornerstone of modern emergency medical services

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