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IOT Based Health Monitoring System (Wired)

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***Abstract*—The IoT-based health monitoring system described in this work is intended to provide continuous, real-time patient monitoring with improved data security, scalability, and dependability. IoT technologies have demonstrated tremendous promise in tackling the difficulties of remote health monitoring, particularly for vulnerable populations, in the face of rising healthcare needs. This system is perfect for medical settings where interference is an issue since it uses a wired network and a master-slave design to enable secure and reliable data transmission over long distances. Important parts that regulate the gathering, processing, and communication of sensor data include the Raspberry Pi Pico as the central processing unit and ATmega8 microcontrollers acting as master and slave controllers. Data integrity is ensured via the RS485 standard, which makes long-distance data transfer easier while reducing signal deterioration. This system effectively tracked patient body temperature in both hardware and simulation setups, proving its scalability and resilience for bigger healthcare settings. Future developments will improve patient data accessibility for families and healthcare professionals by including more sensors, AI-based health analytics, and a secure mobile app. This study intends to influence future advancements in safe, scalable healthcare IoT solutions while confirming the viability and impact of IoT technology in changing patient monitoring.**

Keyword: IoT-based health monitoring, Real-time patient monitoring, RS485 data transmission, Scalable healthcare solutions.

1.INTRODUCTION

In recent years, the rapid advancement in technology has transformed various sectors, one of them is IoT. IoT means the inter-connection of smart devices and sensors which enables real-time data exchange and communication. In the field of healthcare, IoT has contributed significantly in continuous health monitoring of patient based on the real time data.

With increase in population and virus like covid, the health monitoring of a patient physically not possible at every time. Thus, there remotely health monitoring is necessary in such conditions. Hence the growth of IoT based health monitoring system has grown significantly through the past years. If we are talking about the remotely health monitoring system then it should be reliable for patient and patient's family. Thus, the accuracy of health monitoring system should be highest, which do not put the life of patient in danger.

Recent research shows the benefits of IoT technologies in enhancing patient health monitoring systems. Shiva Rama Krishnan et al. (2020) shows the critical role of IoT in addressing urgent health monitoring needs of patients, particularly of the elder persons. Their system consists of temperature and heartbeat sensors connected to an Arduino Uno microcontroller to transmit critical health data to caretaker, which aim to reduce the risk of sudden medical emergencies.

Jayakumar et al. (2020) recommend a multidisciplinary approach in the design of this systems. Their IoT system integrates various sensors such as ECG and heart rate monitors, allowing for continuous tracking of this important parameters. They used a cloud-based platform which enables surveyor to see the real time data and past data from anywhere through cloud services.

On this foundations, Pawan Singh (2020) discusses the challenges come under this IoT based health monitoring,

particularly in terms of data management and communication efficacy. Solving these challenges is crucial for the successful integration and reliability of IoT technologies into healthcare systems. For improved patient outcomes, Valsalan et al. (2020), further showed the importance of continuous monitoring, especially in the context of global health crises.

Additionally, the monitoring system developed by Tamilselvi et al. (2020) demonstrate the versatility of IoT applications, especially for patients with coma. He used a range of sensors to track critical health parameters such as heart rate, body temperature, and oxygen saturation, which helps care taker for efficient health monitoring in worst condition.

This paper shows the design, implementation and structure of proposed IoT-based patient health monitoring systems developed by us. After researching recent advancements in sensor technologies, data communication, and cloud computing, this paper highlights the capabilities of proposed system in enhancing patient care with secured data transfer, long distance communication, real time health monitoring and scalability of system. Additionally, it addresses the challenges associated with IoT deployment in healthcare, including data privacy and user acceptance.

2.PROPOSED SYSTEM

The proposed IOT based health monitoring system shown in figure (1). is designed for continuously health monitoring, emergency alerts, scalability and secured data transmission over channel. The proposed system also felicitates the facilities of mobile app, through which the patient's family member and doctors can continuously monitor the health condition of patient from anywhere. The mobile app provides both present and past data of patient health parameter. The proposed IoT-based patient health monitoring system prioritizes data security through a wired data transmission, in place of technologies like Wi-Fi and Bluetooth that are susceptible to interception and interference. The proposed system uses a secure architecture where sensors (heart rate, temperature, and SpO_2) transmit data through shielded physical cables to a main unit. This proposed wired system not only ensures security by requiring physical access for any potential breach but also provides stable, reliable connections in medical environments where signal interference and mismatch could be problematic for proper monitoring. The proposed system uses a master- slave architecture for scalability of the system, allowing efficient monitoring across a large number of patient nodes. The system uses a main central processing unit which serves as the main hub. This unit is responsible for handling cloud communication, app integration, displaying information on different monitors, and managing interactions with other processing units known as master controllers. The main CPU ensure that all data collected from patient is stored on cloud and showing on different display. The master controller is connected to slave controller via I2C bus protocol which enable one master to communicate with 127 different slave controllers which expands the system very much. The slave controller is connected to different sensors through different communication protocol shown in figure (2), which collect the data like body temperature, heart rate, SPO2 level etc from patients and send to slaves' controller. The slave controller send data to master controller through I2C protocol and the data from the master controllers is then forwarded to the main CPU using UART protocol through RS485 Modbus protocol for long-distance communication. RS485 is used for reliable and secure data transfer across large distances, such as between different hospital wards or departments. Here the use of RS485/Modbus minimizes signal degradation and ensures accurate data transmission over long distances, maintaining data integrity and security.

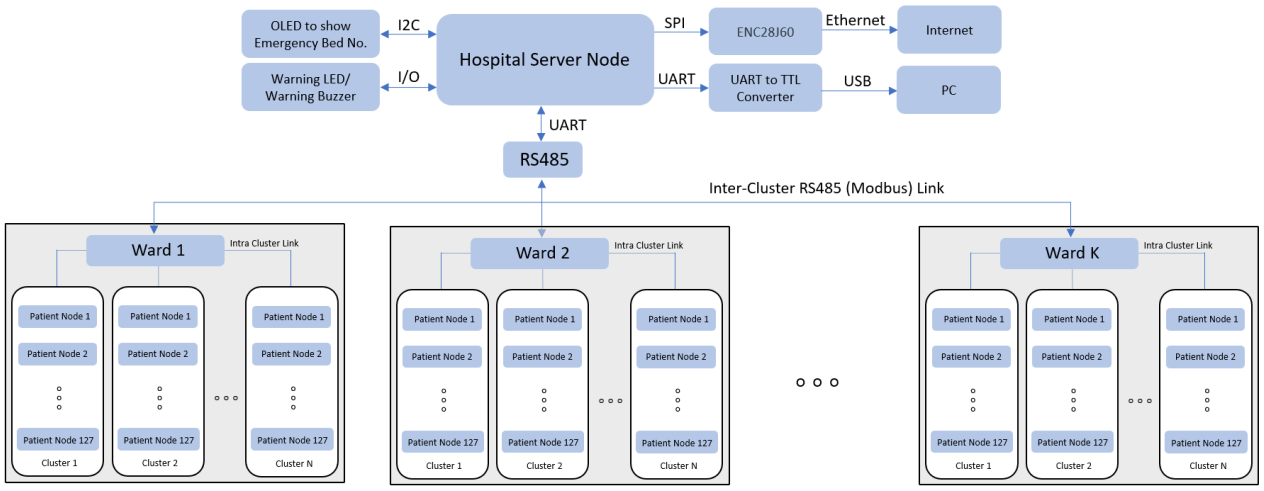

Figure (1). Architecture of Proposed IOT Based Health Monitoring System

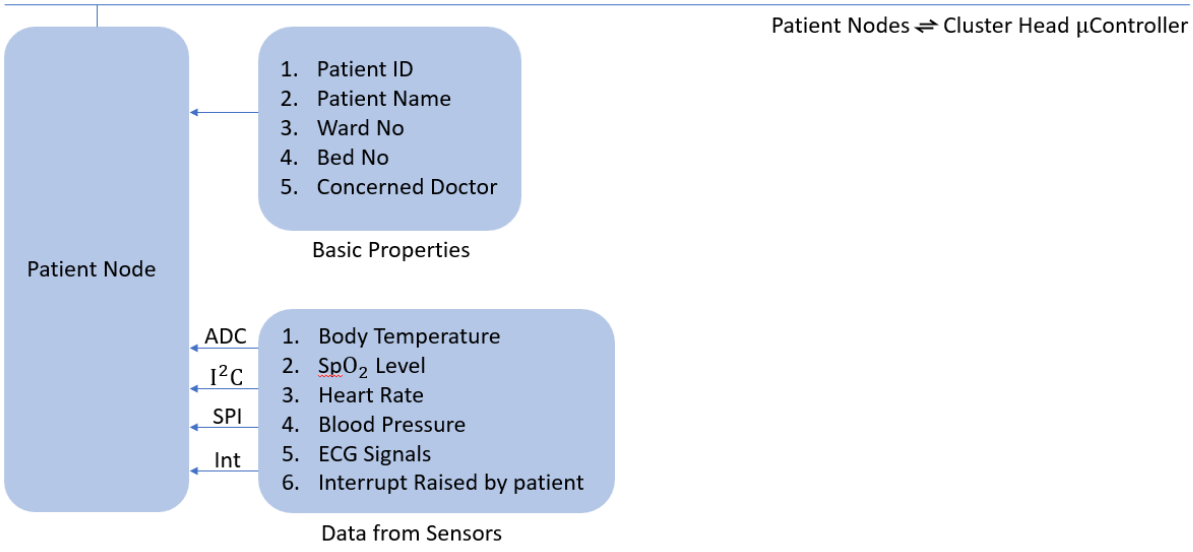

Figure (2). Patient node interfacing different sensors

3.COMPONENTS

The proposed system uses component which is best in terms of application, reliability, costing and accuracy.

Raspberry Pi Pico (Main CPU): The Raspberry Pi Pico shown in figure (3) serves as the main central processing unit, managing data collection, processing, and communication with cloud services and mobile applications. The Raspberry Pi Pico is a low-cost microcontroller board based on the RP2040 chip. It features a dual-core ARM Cortex-M0+ processor, 264KB of SRAM, and 2MB of flash memory. It supports various communication protocols like UART, SPI, and I2C, making it ideal for handling system management, sensor interfacing, and cloud communication in the IoT-based monitoring system.

Figure (3). Raspberry Pi Pico

ATmega8 Microcontroller (Master and Slave Controllers): The system employs ATmega8 microcontrollers shown in figure (4) in both master and slave configurations. The ATmega8 is an 8-bit microcontroller based on the AVR architecture, with 8KB flash memory, 1KB SRAM, and 512 bytes of EEPROM. It operates at a clock speed of 16 MHz and supports communication protocols like UART, I2C, and SPI. It is used in both master and slave configurations to manage data collection and relay sensor information in the system.

Figure (4).

Atmega8 Microcontroller

RS485 Module: The RS485 module shown in figure (5) facilitates long-distance communication between the main CPU and master controllers The RS485 module is a differential communication standard designed for long-distance data transmission. It supports half-duplex communication and is capable of transmitting data up to 4,000 feet (1,200 meters) at speeds up to 10 Mbps. Its robust signal integrity and resistance to electrical noise make it suitable for industrial and healthcare IoT systems. Its connection is shown in figure (6)

Figure (5).

RS485 Module

Figure (6). MAX485 bus connection

LM35 Temperature Sensor: The LM35 is an analog temperature sensor connected to the slave ATmega8 controllers to measure patients' body temperature. The LM35 is a precision analog temperature sensor with a linear output. It has a temperature range of -55°C to +150°C with an accuracy of

±0.5°C. The sensor provides a 10mV output per degree Celsius, making it ideal for body temperature monitoring applications due to its simplicity and reliability.

Figure (7). LM35 Temperature sensor

4.RESULTS

The IoT-based health monitoring system for patients was effectively tested, simulated, and implemented on hardware to observe its capabilities in real-time monitoring and displaying health data. In both the simulation and hardware configurations, we used two pair of master and slave connection, a master unit was connected to a slave node and linked to a central Raspberry Pi Pico unit. Simulation that shown in figure (8) was conducted using Proteus software, where the communication between the Raspberry Pi Pico and the ATmega8 microcontrollers was evaluated. Both master units gathered temperature readings from their respective slave nodes, which were equipped with an LM35 temperature sensor, and transmitted this data to the main processing unit. The Raspberry Pi Pico processed the information and presented it on an OLED display, showing the body temperature of two patients in real-time. The hardware setup functioned similarly, with the LM35 sensor accurately recording the body temperature of each individual, and the readings being correctly displayed on the OLED screen. The communication between the Raspberry Pi Pico and the master-slave nodes proved to be dependable, ensuring the accurate collection, transmission, and display of data. The outcomes from both the simulation and hardware trials verified the system's durability, expandability, and capacity for real-time data monitoring.

5. CONCLUSION

In this document, we present an IoT-based health monitoring system that incorporates various components, protocols, technologies, and methods to ensure reliable, accurate, and secure transmission of a patient's data for real-time health tracking. The system utilizes a Raspberry Pi Pico as its main processing unit, enabling connections with cloud services, app integration, and multiple display options. Employing a master-slave architecture and the I2C protocol enhances the system's scalability, making it applicable in diverse healthcare environments such as hospitals and remote clinics. RS485 facilitates long-distance data transmission while maintaining signal strength and mitigating interference. The LM35 sensor is utilized to accurately measure the patient's body temperature for the controllers. An Atmega8 serves as both the master and slave controller, contributing to the system's efficiency. By implementing robust communication protocols, the system guarantees secure and interference-free data transfer, which is crucial for ongoing health monitoring. Despite the prevalence of wireless technologies, this system remains a dependable wired setup that leverages various wired communication protocols. The findings from the proposed system affirm the design and execution of the IoT-based patient health monitoring system, demonstrating its viability for real-world applications in healthcare settings.

6.FUTURE

The proposed IoT-based health monitoring system effectively monitored a patient's temperature, with both the simulation and hardware setup functioning properly. In the future, we plan to incorporate additional sensors, such as those for heart rate, SPO2, and blood sugar levels. An emergency button will be included in the system to address urgent issues raised by patients. We aim to develop a mobile application utilizing AI technology, which will enable detailed analysis of a patient's health based on current and historical monitored data. We will enhance the app's security by implementing advanced security protocols and methods for data transmission. Additionally, the mobile app will feature leading doctors from around the world, fostering a community where top physicians can provide treatment suggestions for patients' better health.

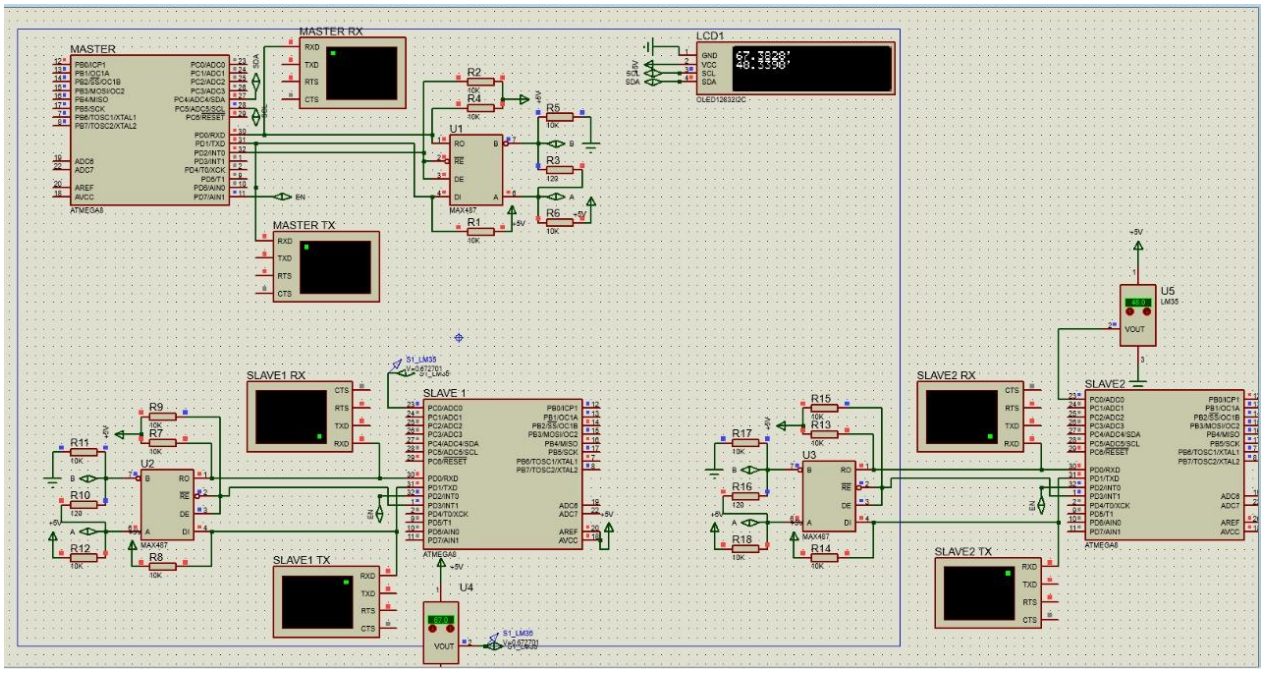

Figure (8).
Proteus simulation results of proposed IOT based health monitoring system

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