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Smart IV Bag and Health Monitoring System for Hospitals and Remote Places Using IOT

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Abstract: The health monitoring system utilizing an ESP32 controller and Arduino Nano presents an innovative approach to enhance patient care through continuous real-time monitoring of vital health parameters. This system integrates various sensors, including ECG, DHT11, HX711, and an R305 fingerprint sensor, to collect comprehensive physiological data and ensure secure access.

The ESP32 microcontroller processes this data, providing immediate local alerts via a buzzer and LED indicators, while the Arduino Nano manages the GSM module to send remote notifications to healthcare professionals. Furthermore, the system employs IoT capabilities to transmit data to cloud platforms, facilitating remote monitoring and analysis. By automating the monitoring process, this project reduces the workload on healthcare staff and ensures timely medical interventions, thereby improving patient outcomes. The system's ability to provide real-time data visualization, secure access control, and remote monitoring aligns with the growing need for connected and intelligent healthcare solutions.

This comprehensive health monitoring system not only enhances patient safety and care efficiency but also supports the advancement of modern healthcare infrastructures through robust data management and communication technologies.

INTRODUCTION

The increasing complexity of healthcare environments necessitates the development of advanced monitoring systems capable of providing continuous, real-time data on patients' health parameters.

Traditional methods of patient monitoring often involve manual checks and intermittent assessments, which can lead to delays in detecting critical changes in a patient's condition. To address these challenges, this project leverages the Internet of Things (IoT) technology to create a comprehensive health monitoring system using an ESP32 controller and Arduino Nano.

The core objective of this project is to enhance patient care by integrating a range of sensors and communication modules into a unified system that monitors vital signs and environmental conditions. The ESP32 microcontroller, known for its powerful processing capabilities and built-in Wi-Fi and Bluetooth connectivity, serves as the central hub of this system. It interfaces with various sensors such as an ECG sensor for heart activity, a DHT11 sensor for temperature and humidity, and an HX711 load cell for weight measurement. Additionally, an R305 fingerprint sensor ensures that access to the system is secure and restricted to authorized personnel only.

The Arduino Nano complements the ESP32 by handling specific tasks, such as managing the GSM module for sending alerts and the LCD display for real-time data visualization. This dual-controller setup allows for efficient data processing and seamless communication between components.

The health monitoring system continuously collects data from the sensors, which is then processed by the ESP32 to detect any abnormalities. In the event of a critical condition, the system triggers local alerts via a buzzer and LED indicators to immediately notify nearby healthcare staff. Simultaneously, the GSM module sends SMS notifications or phone calls to designated healthcare professionals, ensuring prompt intervention even if they are not on-site. The IoT capabilities of the ESP32 enable

the transmission of data to cloud platforms, allowing for remote monitoring and historical data analysis.

This project aims to reduce the workload on healthcare professionals by automating the monitoring process, ensuring that patients receive timely and accurate medical attention. By integrating advanced sensor technology, real-time data processing, secure communication methods, and remote monitoring capabilities, the system provides a robust and efficient solution for modern healthcare needs. The health monitoring system not only enhances patient safety and care efficiency but also supports the trend towards more connected and intelligent healthcare infrastructures, ultimately contributing to better patient management and outcomes.

LITERATURE SURVEY

1) Low-Cost Digitization of Infusion Pump:
- Components: Arduino Uno, IR sensor, ESP8266, keypad, and LCD.
- Monitors saline level, drop rate, and solution content in an IV bag.
- Requires a dedicated server for implementation.

2) IoT-Based IV Pole Monitoring System:
- Monitors IV bag levels and alerts when empty.
- Continuously monitors patient's heart rate, SPO2 readings, and temperature.
- Uses sensors to measure physical parameters and a cam module to monitor the patient's live condition.
- Does not monitor drip rate and sets critical values for all sensors.

3) Intravenous Drip Monitoring System for Smart Hospital Using IoT:
- Components: IV fluid level sensor, body temperature sensor, and Bluetooth module.
- Transmits data to nurses for monitoring.
- Lacks a keypad for setting different critical levels for different patients.

4) Intelligent Medical Monitoring System Based on Sensors and Wireless Sensor Network:
- Focuses on healthcare for elderly people using Wireless Sensor Networks (WSN) technologies.
- Collects physical parameters using sensors and wearable computing devices.
- Transmits data to a central receiver via WSN.
- Aims to improve healthcare for the elderly and adapt to future changes in healthcare.

5) New Algorithm of Liquid Level of In Bottle Based on Image Processing
- The intelligent infusion system relies on a method or quickly and accurately determining the liquid level in infusion bottles.
- Our proposed algorithm uses image processing techniques like detecting edges, binarizing, filtering, image projection, and motion detection to achieve automatic liquid level detection.
- This algorithm is notable for its resilience to noise, speed, and simplicity.
- Experimental results confirm its effectiveness and viability.

WORKING

A) Description:

The health monitoring system described in this project is designed to provide continuous, real-time monitoring of vital health parameters using IoT technology. The system integrates multiple sensors to collect comprehensive physiological data, which is then processed and analyzed to ensure timely medical intervention. The core components of the system include an ESP32 controller, an Arduino Nano, various sensors, and communication modules. The ESP32 serves as the primary controller, handling data collection, processing, and local alerts, while the Arduino Nano manages the GSM module and LCD display for remote alerts and data visualization

B) Methodology :

1) System Initialization**:**
- The power supply is activated, providing the necessary voltage and current to all components.
- The ESP32 and Arduino Nano initialize, establishing communication with connected sensors and modules**.**

2) Data Collection:
- Sensors:
- ECG Sensor: Captures electrocardiogram (ECG) signals to monitor heart activity.
- DHT11 Sensor: Measures ambient temperature and humidity, providing environmental data.
- HX711 Load Cell: Measures weight of iv bag, applicable for monitoring IV fluid levels
- R305 Fingerprint Sensor: accessing previous information of user if he visited to hospital by verifying the identity of users

3) Data Processing
- The ESP32 collects analog signals from the sensors and converts them into digital data.
- The collected data is analyzed in real-time to detect any abnormalities or critical conditions. For example, irregular heart activity detected by the

ECG sensor or abnormal temperature readings from the DHT11 sensor.

4) IV bag Monitoring :
Load cell is used to measure the weight of bottle if weight fallows bellow the threshold value then an alert message will be send on nurses mobile phone and buzzer will ring

5) Real-Time Monitoring:
- LCD Display: Managed by the Arduino Nano, the LCD displays real-time data on patient vitals, such as heart rate, temperature, and weight. This provides a user-friendly interface for healthcare professionals to monitor patient status at a glance.

6) Alert Mechanism:
- Detection of Abnormalities: The ESP32 continuously compares the collected data against predefined thresholds.
- When an abnormal condition is detected, the ESP32 triggers alerts.
- Buzzer and LED: The buzzer sounds an audible alarm to alert nearby healthcare staff.
- The LED flashes to provide a visual indication of an alert, ensuring immediate attention.

7) Remote Alerts:
- The GSM module sends alerts to healthcare professionals via SMS or phone calls.
- The IoT module uploads data to the cloud, enabling remote monitoring and historical data analysis.

C) Block Diagram:

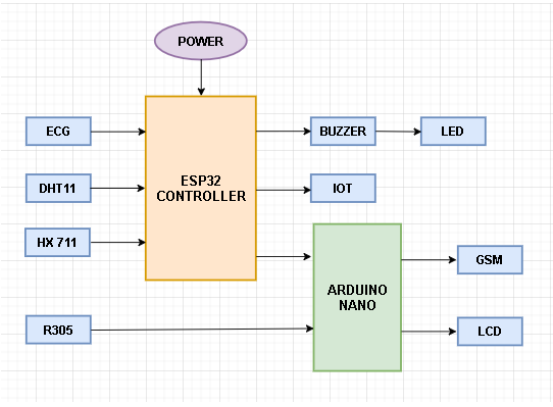

Fig 1: Block Diagram

Hardware Description:

- Power Supply - Power Source: This component supplies the necessary voltage and current to all connected components in the system. It ensures stable and reliable operation of the sensors, controllers, and peripheral devices
- ESP32 Controller - A powerful microcontroller with integrated Wi-Fi and Bluetooth capabilities. It serves as the primary processing unit, handling data from various sensors and managing communication with peripheral devices.

- **Sensors and Modules Connected to ESP32**
- ECG Sensor:
  - Function: Monitors heart activity by measuring the electrical signals produced by the heart.
  - Connection: Sends analog signals to the ESP32 for processing and analysis.
- DHT11 Sensor:
  - Function: Measures temperature and humidity.
  - Connection: Communicates with the ESP32 using a single-wire digital signal.
- HX711 Load Cell Amplifier:
  - Function: Amplifies signals from a load cell (weight sensor) to measure weight of the IV bag.
  - Connection: Sends data to the ESP32 through digital signals.
- R305 Fingerprint Sensor:
  - Function: Captures and processes fingerprint data for biometric authentication.
  - Connection: Interfaces with the Arduino Nano, which then communicates with the ESP32.

- **Peripheral Devices Connected to ESP32**
- Buzzer:
  - Function: Provides audio alerts or notifications.
  - Connection: Controlled by the ESP32 via a digital output pin.

D) FLOWCHART

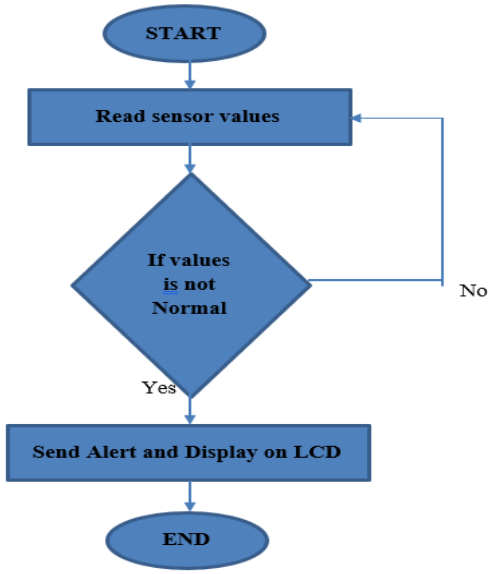

Fig 2: Flowchart

RESULTS

The entire kit functions properly based on the program in the ESP32 & Arduino NANO. Initially, the sensors were able to read the variations in weight of the saline bottle. The complete kit comprises of various sensors, Arduino, LDC display, GSM module, and a load cell. A smart phone is also used via Wi-Fi through ESP32 module to monitor all the values in a screen which can be recorded for further usages.

The readings of the various sensors were made visible in an LCD display with proper time interval for visualization. These parameters are tracked, and the data is stored in the IoT cloud platform Thingspeak. In Thingspeak, the data is shown graphically which is helpful for future reference.

The System also displays the message on LCD.

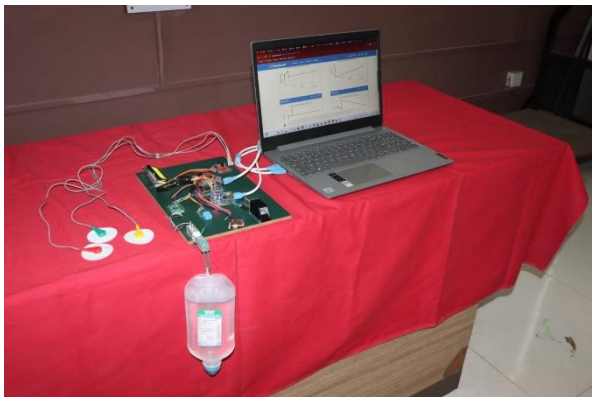

Fig 3: System Design

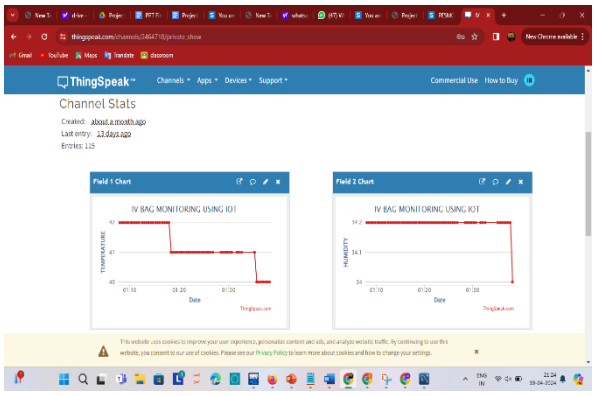

Fig 4: Result for temperature & humidity

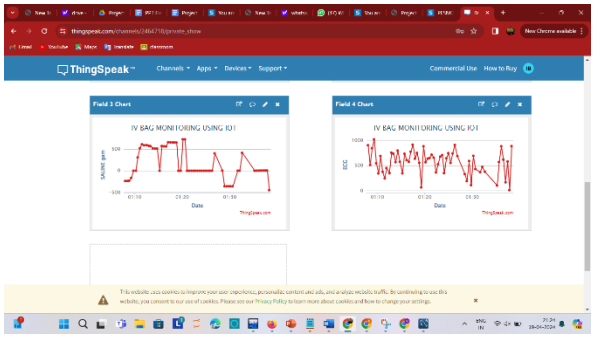

Fig 5: Result for Saline level & ECG

CONCLUSION

The hardware configuration described integrates an ESP32 controller and an Arduino Nano to create a comprehensive and versatile monitoring system. By leveraging the capabilities of the ESP32, such as Wi-Fi and Bluetooth connectivity, and the efficient processing power of the Arduino Nano, this setup is designed to handle various sensors and peripheral devices effectively.

The system includes critical sensors like the ECG for heart activity monitoring, the DHT11 for temperature and humidity measurements, and the HX711 for weight sensing. The integration of the R305 fingerprint sensor provides biometric authentication, adding a layer of security to the system. The use of peripheral devices like the buzzer and LED ensures immediate alerts and notifications, while the GSM module and IoT capabilities facilitate remote communication and monitoring.

This configuration ensures a robust, scalable, and secure system capable of real-time data acquisition, processing, and communication. It is well-suited for applications in health monitoring, environmental sensing, and biometric security. The successful implementation of such a system highlights the effective use of microcontroller technologies in building advanced, multi-functional monitoring solutions.

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