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Wireless Nursing Home Management: A Real- Time Iot-Based Healthcare Solution

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Abstract- ***This paper describes the creation of a Wireless Nursing Home Management System aimed at enhancing real-time patient surveillance and administrative activities. The system employs two Arduino Uno transmitter nodes positioned near patients to assess vital signs including pulse rate, oxygen saturation, body temperature, and ECG signals using MAX30102, DS18B20, and AD8232 sensors. The readings are shown on small OLED displays and transmitted wirelessly through nRF24L01 modules to a central Arduino receiver linked to a PC. A Python application handles this data, saves it in a MongoDB database, and displays it via a dynamic web interface featuring interactive graphs and real-time notifications. Alongside patient monitoring, the system features administrative components for handling patient records, inventory management, and staff payroll. This cohesive and adaptable solution seeks to enhance healthcare services and operational effectiveness in nursing facilities by utilizing IoT and automation.***

Keywords – Wireless healthcare monitoring, Arduino Uno, Max30102m real-time patient data, IoT-based nursing system, ECG tracking.

I. INTRODUCTION

In the modern world, caring for senior citizens in nursing facilities necessitates prompt action and effective administration. Many nursing homes still handle daily duties and patient health checks manually, which can lead to delays and raise the possibility of overlooking critical health conditions.

This project presents a Wireless Nursing Home Management System that helps manage nursing home records and provides real-time patient monitoring using technology. Arduino Uno boards with health sensors such as the AD8232 for ECG, the DS18B20 for temperature, and the MAX30102 for pulse and oxygen are used to construct the system. These sensors are positioned close to every patient in order to gather vital health information.

Using nRF24L01 modules, the data is wirelessly transmitted to a central system and displayed on tiny OLED screens. The data is received by a Python-based computer program, which then stores it in a MongoDB database and displays it on a web dashboard. This enables the personnel to view health data in real time and receive notifications in the event that any readings are odd.

The system includes tools for managing staff compensation, medical supply management, and patient information in addition to health monitoring. As a result, the system is helpful for enhancing patient care and streamlining nursing home operations.

II. LITERATURE REVIEW

The progress of IoT (Internet of Things) and embedded systems has led to considerable enhancements in healthcare, particularly in systems

for monitoring patients. In recent years, scientists have concentrated on creating systems capable of constantly tracking patients' vital signs and offering prompt notifications to caregivers, decreasing the likelihood of treatment delays.

Tripathi et al. (2023) created a system that employed simple sensors and Wi-Fi to track body temperature and heart rate, notifying caregivers when irregular values were observed. Likewise, Ahmed et al. (2023) improved this method by incorporating AI to assess health data and forecast possible risks, enhancing the system's intelligence and reaction speed.

Patel et al. (2022) developed a cloud-enabled patient monitoring system that enabled remote access to health data. This allowed doctors and family members to remain informed about a patient's condition from any location, while also providing alerts during emergencies.

Zhang et al. (2023) examined the application of various wireless technologies for the transmission of health data. Their results indicated that RF modules such as nRF24L01 are affordable and dependable for short-range communication, rendering them perfect for healthcare settings.

Although these studies primarily concentrated on patient monitoring, our suggested system integrates health tracking with nursing home management.
Along with tracking vital signs such as pulse, oxygen levels, temperature, and ECG, it also oversees patient records, inventory, and payroll—providing a comprehensive and functional solution for nursing homes.

III. PROPOSED SYSTEM

The proposed Wireless Nursing Home Management System combines hardware and software elements to track patient vitals in real time and manage administrative duties in a nursing home setting. The architecture of the system is layered and includes sensor nodes, a communication layer, and a backend management system.

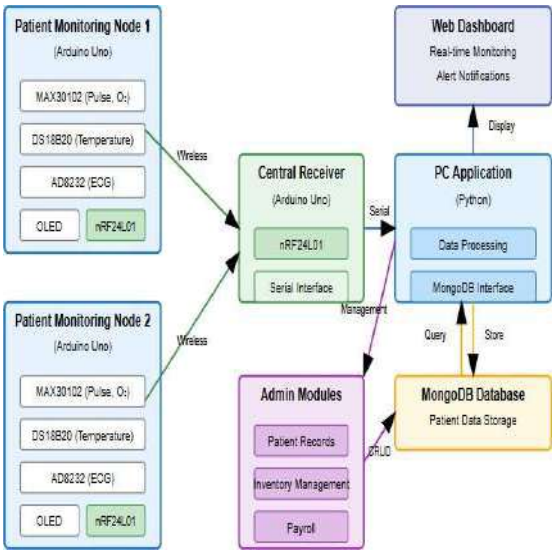
3.1 System Design

The system is organized into three primary layers:

1. **Sensor Layer:** Every patient node features an Arduino Uno linked to three biomedical sensors: MAX30102 for measuring pulse rate and oxygen saturation, DS18B20 for tracking temperature, and AD8232 for ECG signal collection. The gathered information is shown on a 0.96" OLED screen for immediate local viewing.
2. **Communication Layer:** The sensor information is sent wirelessly via the nRF24L01+PA+LNA RF module. Every transmitter node transmits its information to a central Arduino Uno receiver linked to a PC. The modules interact through the SPI protocol, guaranteeing reliable and energy-efficient data transfer.
3. **Backend System:** The main Arduino receiver sends the information to a Python-driven backend application on a computer through serial communication. This backend system handles:

- Obtaining and interpreting real-time information
- Saving the information in a MongoDB database
- Displaying the vital signs on a web dashboard
- Notifying when any parameter surpasses established limits.
- Overseeing patient records, inventory, and employee payroll via specialized administration modules.

3.2 Block Diagram



3.3 Communication of Data

1. Data transfer in the system adheres to this procedure:
2. Every Arduino Uno at the patient node gathers sensor information.
3. Information is sent through the nRF24L01 module to the main receiver.
4. The Arduino receiver transmits this data to the PC via serial communication.
5. The Python application obtains and handles the data, transforming it into an organized format.
6. Sensor data is saved in MongoDB and simultaneously shown on a real-time dashboard.
7. When critical thresholds are exceeded, the system alerts caregivers.

3.4 Backend System

The backend is created with Python and incorporates these essential features:

1. Data Reception: Acquires serial information from the Arduino receiver.
2. Data Storage: Saves vital sign information in MongoDB along with timestamps.
3. Alert System: Informs caregivers of irregular values through the dashboard.
4. Web Dashboard: Created with Flask and Chart.js or Plotly, the dashboard showcases vital signs through graphs and gauges.
5. Admin Panel: Components for handling patient information, medical stock, and staff payroll are included to facilitate comprehensive nursing home functions.

3.5 Web Dashboard.

The web dashboard serves as a key element of the Administration System, located on a PC linked to the Arduino Uno receiver. This PC obtains essential signals sent wirelessly from the patient nodes through the nRF24L01 module. The dashboard is created with Python and consists of three primary modules: Patient Information, Stock, and Payroll.

3.5.1 Patient Information Section:

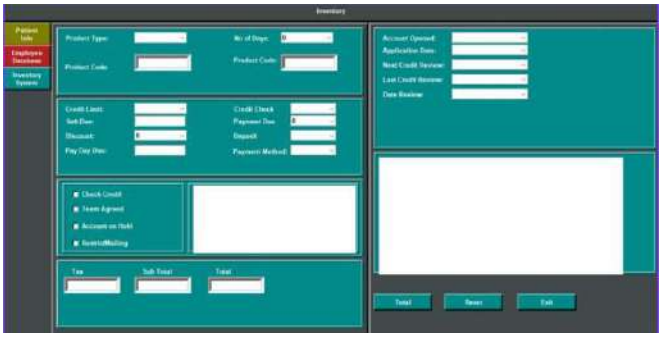
This module enables users to input and oversee comprehensive patient details, such as name, age, address, Aadhar number, health status, admission date, and costs. It visually represents essential signs like pulse rate, oxygen level, and temperature in real time. Should any parameter surpass safe thresholds, the system activates an audio alert, prompting immediate attention from the personnel.

3.5.2 Payroll Section:

This module manages employee records and payroll processing. It keeps employee personal information, monitors attendance, computes wages, tax withholdings, retirement fund, and produces monthly payroll reports.

3.5.3 Inventory Section:

The inventory segment keeps track of vital medical supplies such as medications, injections, ampoules, and various other consumables. It also oversees supplier details, buying history, and inventory levels to facilitate seamless daily operations.



IV. ELEMENTS AND DETAILS

This segment details the hardware elements utilized in the Wireless Nursing Home Management System, accompanied by concise explanations of their roles.

4.1 Arduino Uno (Microcontroller)

The Arduino Uno acts as the main microcontroller for both transmitter and receiver units. It gathers data from sensors, processes it, and either shows it on the OLED or sends it through the RF module. The receiver Arduino transmits the information to a PC through serial communication.

Technical Details:

- ATmega328P controller
- 14 digital input/output pins, 6 analog inputs
- Operating voltage: 5 volts
- Clock frequency: 16 MHz

4.2 MAX30102 (Sensor for Pulse and Oxygen)

The MAX30102 is a consolidated sensor module designed for measuring heart rate and oxygen saturation (SpO2). It employs photoplethysmography (PPG) and is perfect for real-time health observation.

Technical Details:

- Monitors SpO2 levels and pulse rate
- I2C data transfer
- Combined red and infrared LEDs
- Minimal energy usage

4.3 DS18B20 (Waterproof Temperature Probe)

The DS18B20 measures body temperature. Its water-resistant design ensures safety and dependability for health applications that involve close contact.

Technical Details:

- Temperature span: –55°C to +125°C
- Precision: ±0.5°C
- 1-Wire data exchange
- Sealed and waterproof stainless-steel enclosure

4.4 AD8232 (Electrocardiogram Sensor Module)

The AD8232 is utilized for acquiring ECG signals. It senses the heart's electrical activity and transmits an analog signal to the microcontroller.

Technical Details:

- Functions on 3.3V or 5V
- Single-lead ECG identification
- Analog output signal
- Minimal noise, high accuracy

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4.5-inch OLED Screen (0.96")

This display module presents real-time readings of patient vital signs such as pulse rate, temperature, and SpO2 at each patient location.

Technical Details:

- Dimension: 0.96 inch
- Resolution: 128 by 64 pixels
- Interfacing: I2C
- Minimal power consumption

4.6 nRF24L01+PA+LNA (Wireless Transceiver Module)

This RF module facilitates wireless communication between the patient nodes and the main receiver.

Technical Details:

- Frequency: ISM band at 2.4GHz
- Communication distance: up to 100 meters (with PA+LNA)
- SPI protocol
- Low-power, high-speed transmission

4.7 PC (Python Backend + MongoDB)

The computer operates the backend application that is based on Python. It collects data through a serial port, saves it in MongoDB, and offers a web interface for oversight and management.

Technical Details:

- Operating System: Windows
- Python utilizing the Flask framework
- MongoDB as a solution for data storage
- Web interface utilizing HTML, CSS, JavaScript, and Chart.js.

V. IMPLEMENTATION

The Wireless Nursing Home Management System was executed in several phases—starting with the integration of sensors at the hardware level, then wireless data transfer, backend application creation, and the launch of the web dashboard. The implementation was created to guarantee dependability, simplicity in maintenance, and real-time functionality.

5.1 Hardware Setup

Every patient monitoring node is constructed with an Arduino Uno microcontroller. The subsequent components are attached to it:

- MAX30102 sensor for measuring heart rate and blood oxygen level (SpO2)
- DS18B20 waterproof thermometer for body temperature
- AD8232 ECG sensor for recording heart activity
- 0.96" OLED Screen to show vitals locally in real time
- nRF24L01+PA+LNA module for wireless data communication

Two identical patient nodes were generated and positioned close to two distinct beds. A third Arduino Uno acts as the receiver node, fitted with an nRF24L01 module to receive data and send it to a connected PC through serial communication.

5.2 Programming

The code for both the transmitter and receiver nodes was developed and uploaded through the Arduino IDE. The libraries listed below were utilized:

- MAX30105.h, HeartRate.h for pulse and blood oxygen saturation
- OneWire.h, DallasTemperature.h for reading temperatures
- Adafruit_SSD1306.h for the OLED screen
- RF24.h, nRF24L01.h for wireless transmission

Every Arduino continuously reads sensor data, processes the information, shows it on the OLED, and sends it to the receiver via RF communication.

5.3 Wireless Transmission

The nRF24L01+PA+LNA RF modules manage wireless transmission through configuration using the SPI protocol. These modules facilitate stable, energy-efficient, and short-range communication between the central receiver and the transmitter nodes. The system was effectively tested indoors within a range of 50 to 70 meters.

5.4 Backend Integration

The receiver Arduino is linked to a computer that operates a Python application created with:

- pyserial for communication via serial port
- pymongo for connecting to MongoDB

Data that is received is decoded and saved in a MongoDB database, with timestamps assigned to each entry.

5.5 Web Dashboard

The web dashboard is developed with Flask and presented using standard HTML/CSS, plus Chart.js and Bootstrap for live visualization. The control panel features: Real-time presentation of vital signs (Pulse, SpO2, Temperature, ECG).

Entry to three modules:

Patient Information: Contains admission information, personal data, real-time graphs.

Inventory: Monitors the stock of medications and medical materials.

Payroll: Handles employee documentation and compensation details.

The dashboard operates locally on the host computer and can be accessed through any web browser.

VI. Result

The Wireless Nursing Home Management System underwent testing in simulated nursing home environments and provided precise, real-time tracking of vital signs such as pulse rate, oxygen saturation, temperature, and ECG signals. Sensor data was shown locally on OLED displays and sent wirelessly to the central receiver, maintaining a reliable communication range of up to 70 meters. The information was effectively acquired by the Python application, stored in MongoDB, and displayed on a web dashboard with little latency. The system produced instant visual and audio signals upon detecting unusual values, guaranteeing a prompt reaction. Furthermore, the administrative modules for patient information, inventory, and payroll operated effectively, allowing for smooth management of records and resources. The system was demonstrated to be stable, scalable, and efficient for real-time health tracking and nursing home management.

VII. CONCLUSION

The Wireless Nursing Home Management System effectively combines real-time patient observation with key administrative tasks, providing a comprehensive and economical solution for contemporary elder care. The integration of Arduino Uno boards with biomedical sensors facilitated precise measurement of essential parameters like heart rate, oxygen saturation, temperature, and ECG, while the nRF24L01 modules provided reliable wireless communication. The backend of the system, built with Python, along with its web dashboard, offered a dependable foundation for data storage, visualization, and alert creation. Moreover, the unification of patient records, inventory monitoring, and payroll administration into one system improves operational efficiency. The project shows that affordable components and open-source tools can be used to create a scalable and effective healthcare monitoring system ideal for nursing homes and comparable care settings.

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