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Original Article

IoT Based ICU Patient Monitoring and Secured Systems

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Abstract: *This project proposes an IoT-based patient monitoring system designed to monitor key health parameters and ensure timely intervention in case of emergencies. The system integrates various sensors including gas sensor, temperature sensor, heartbeat sensor, accelerometer, and load cell, along with GSM communication capabilities for real-time data transmission to healthcare providers or caregivers.*

The gas sensor is employed to detect the presence of any harmful gases in the patient's environment, ensuring a safe and healthy atmosphere. The temperature sensor continuously monitors the patient's body temperature, providing vital information for early detection of fever or hypothermia. The heartbeat sensor tracks the patient's heart rate, detecting any abnormalities or irregularities in cardiac activity. The accelerometer measures the patient's movement and posture, facilitating activity tracking and fall detection. Additionally, the load cell is utilized to monitor the patient's weight, offering insights into their overall health status and potential fluid retention.

The NodeMCU, a low-cost open-source IoT platform based on the ESP8266 Wi-Fi module, serves as the central node for data acquisition and communication. It collects data from all the sensors and utilizes GSM technology to transmit this data to a designated server or mobile device in real-time. The GSM module ensures seamless communication even in remote areas where Wi-Fi connectivity may be limited.

Keywords: *IoT, ICU Patient Monitor, Secured System.*

I. INTRODUCTION

Every day we depend on instant notification in almost all aspects of our lives. Our cell phones deliver an alert when we get a message or when we have a meeting scheduled. The refrigerator in our kitchen beeps when we leave it open too long. Our cars even send a notification when we are low on windshield wiper fluid. Now you can be notified when a patient's oxygen tank is getting low.

Medical facilities continue to put procedures and technology products in place to help improve management and monitor patient's safety. But, the current way to determine when the contents of an oxygen cylinder are low is to check the pressure gauge manually. Constantly monitoring a patient's oxygen cylinder is a time-consuming task that adds considerable labor costs and takes time away from other medical tasks that can impact patient care.

Research has shown that an overwhelming 84 percent of reported oxygen-related incidents have been due to empty oxygen cylinders and have resulted in negative patient outcomes. Adverse respiratory incidents such as those caused by empty oxygen cylinders are largely preventable and extremely costly. Inefficient oxygen management is not only costly to a patient's health; it is also expensive for medical facilities and their insurance carriers. It takes only minutes before a patient's life is at risk due to lack of proper oxygen levels.

Federal law requires medical facilities such as nursing homes, laboratories and hospitals to undergo an annual survey and certification process which covers many different aspects of patient health and safety. During the inspection process, if a patient is reported to have low or empty oxygen, there are several F-tags that could apply and result in costly fines.

Millions of people in the United States require supplemental oxygen, and the number continues to grow every year. The number of seniors is expected to double over the next 30 years with the 76 million baby boomers currently in the country. The Centers for Disease Control and Prevention (CDC) states that Americans with chronic health conditions such respiratory diseases, heart disease and diabetes account for 86 percent of healthcare spending. The CDC also states that chronic diseases are responsible for seven out of 10 deaths each year.

II. SYSTEM IMPLEMENTATION

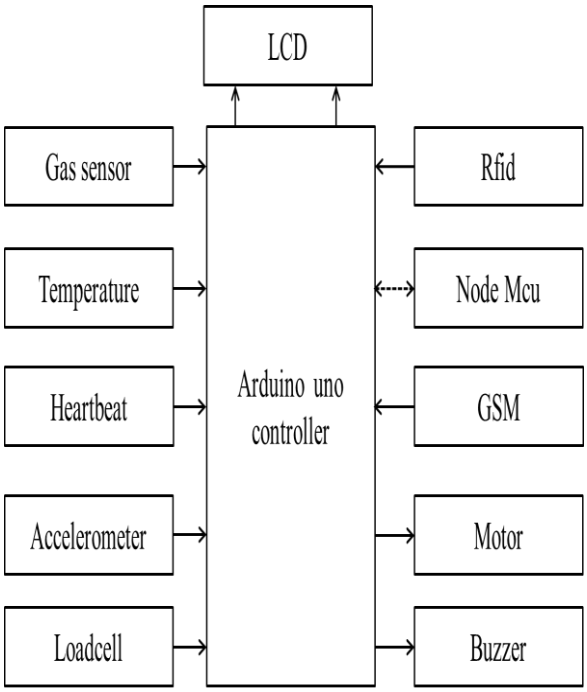
A. Existing System

In existing systems used GSM protocol that can be hacked easily by any professional hacker. So, it becomes very easy for enemies to take out the information. Bluetooth devices and RF modules have been used to transmit the data wirelessly. But these devices and modules have certain limitations and drawbacks. They are not cost efficient, not energy efficient as they consume more power to operate, and have very short transmission and reception range.

PROPOSED SYSTEM

The proposed system offers several benefits, including continuous monitoring of multiple health parameters, early detection of health issues, and timely intervention in emergencies. By providing healthcare providers and caregivers with real-time access to patient data, it enhances the quality of care and enables personalized interventions based on individual health needs. Furthermore, the system promotes patient independence and improves overall healthcare outcomes by facilitating remote monitoring and management of chronic conditions.

BLOCK DIAGRAM



BLOCK DIAGRAM DESCRIPTION

Arduino Board: Acts as the main control unit for data processing and decision-making.

Gas Sensor: Detects the presence of harmful gases such as carbon monoxide, methane, etc., ensuring safety in the environment.

Temperature Sensor: Measures ambient temperature, providing crucial data for environmental monitoring and control.

GSM Module: Enables SMS notifications to be sent to designated contacts in case of abnormal environmental conditions or emergencies.

WiFi Module: Facilitates internet connectivity for remote monitoring and control of the system through a web interface or mobile application.

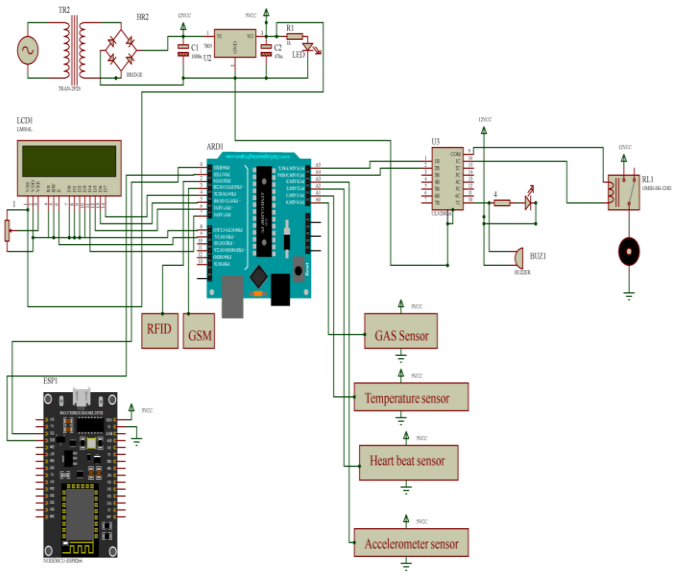
RFID Reader: Provides access control functionality, allowing authorized personnel to interact with the system securely.

Buzzer: Emits audible alerts in response to predefined triggers, such as detecting high levels of gas or abnormal temperatures.

LCD Display: Provides real-time visualization of sensor data and system status, ensuring easy monitoring for users.

Motor: Can be used for controlling ventilation systems or other mechanisms based on environmental parameters detected by sensors.

CIRCUIT DIAGRAM



CIRCUIT DIAGRAM DESCRIPTION

Acts as the central processing unit, controlling and coordinating all other components.Detects the presence of

gases such as carbon monoxide, methane, etc. It can be used for safety applications like detecting gas leaks.Measures ambient temperature. Useful for monitoring environmental conditions or as part of a thermostat system.Allows the Arduino to communicate via GSM network. Can be used for sending SMS notifications, remote control, or data logging.Enables the Arduino to connect to Wi-Fi networks. Useful for IoT applications, remote monitoring, or accessing web services.Reads RFID tags. Can be used for access control, inventory tracking, or identification purposes.Produces audible alerts or alarms. Used for signaling events such as gas detection, temperature thresholds, or RFID tag detection.Provides visual feedback. Can show sensor readings, system status, or user prompts.Can be a DC motor or a stepper motor. Controlled by the Arduino, it can be used for various tasks like opening doors, moving objects, or controlling mechanical systems.

3. HARDWARE DETAILS

RFID

Radio-frequency identification (**RFID**) is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information. Some tags are powered by electromagnetic induction from magnetic fields produced near the reader. Some types collect energy from the interrogating radio waves and act as a passive transponder. Other types have a local power source such as a battery and may operate at hundreds of meters from the reader. Unlike a barcode, the tag does not necessarily need to be within line of sight of the reader and may be embedded in the tracked object. RFID is one method for Automatic Identification and Data Capture (AIDC).

RFID tags are used in many industries, for example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line; RFID-tagged pharmaceuticals can be tracked through warehouses; andimplanting RFID microchips in livestock and pets allows positive identification of animals.

Temperature Sensor - DS18B20

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18B20 can derive power directly from the data line (“parasite power”), eliminating the need for an external power supply. Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

HEART BEAT SENSOR

A person’s heartbeat is the sound of the valves in his/her’s heart contracting or expanding as they force blood

from one region to another. The number of times the heart beats per minute (BPM), is the heart beat rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse.

LOAD CELL

A **load cell** is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. The various types of load cells include hydraulic load cells, pneumatic load cells and strain gauge load cells.

Strain gauge load cell

Double bending beam load cell element

S-type load cell

Compression load cell

LCD DISPLAY

Liquid Crystal Displays (LCDs) have materials, which combine the properties of both liquid and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. One each polarizer are pasted outside the two glass panels. This polarizer would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarizer and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction.

Arduino:

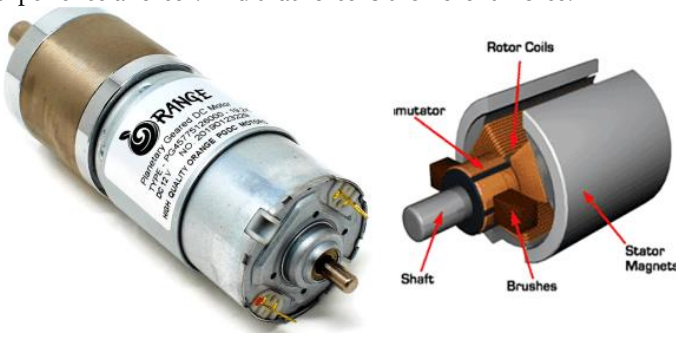
Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control objects in the physical world.

The project is based on microcontroller board designs, manufactured by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on the Processing project, which includes support for theC and C++ programming languages.

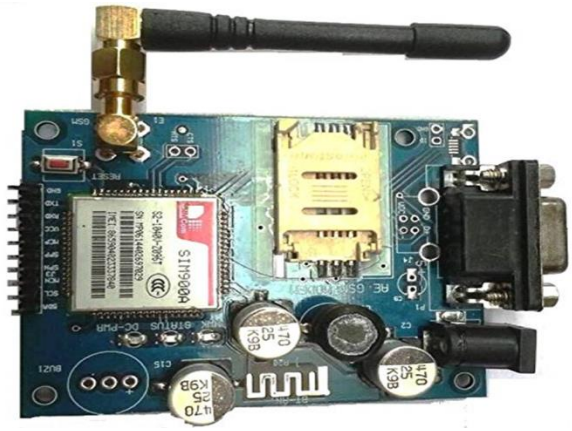
ARDUINO UNO BOARD

DC Motor

The **DC motor** is the motor which converts the direct current into the mechanical work. It works on the principle of Lorentz Law, which states that "the current carrying conductor placed in a magnetic and electric field experience a force". And that force is the Lorentz force.



GSM MODEM



A **GSM modem** is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone.

When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities.

4. CONCLUSION

In conclusion, the IoT-based patient monitoring system presented in this project harnesses the power of IoT technology to revolutionize healthcare delivery, offering a cost-effective and scalable solution for remote patient monitoring. With its integration of multiple sensors and GSM communication capabilities, the system has the potential to transform healthcare practices, ensuring timely intervention and improving patient outcomes.

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