Smart Bed For Patient Healht Monitoring System

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Abstract- *The smart bed for patient health monitoring system is primarily used by hospitalized patients as well as patients receiving home care for health monitoring. The electronic device bed accommodates those who are injured or incapacitated. The bed is affordable and highly functional, with sensors integrated into both hospital beds and home care beds. A cloud web service is employed for monitoring, sending, and receiving messages from the smart bed. Additionally, a mobile application is utilized to adjust the movement of the head and leg parts of the smart bed, aiding in the notification of caregivers regarding injured patients. Temperature, humidity, and the current level of saline in the saline bottle are automatically monitored. Furthermore, a sensor is used to detect changes in a patient's position, thereby alerting caregivers.*

Keywords- smart bed, sensors, cloud web service, mobile application, sensor.

I. INTRODUCTION

Contemporary technical and medical breakthroughs have ushered in a plethora of modern or contemporary scientific equipment that are equipped with highly advanced embedded manipulation capabilities and interaction. Scientific fields have been primarily affected by this upsurge since the very last decade of the 20th century, assuming new paperwork and capacities. Incorporating solutions for patient care, support, and monitoring, smart medical beds are built using a thorough, multidisciplinary design approach. Smart beds have the entirely unique potential to allow for extra work for carers and more responsive surroundings for patients when smoothly integrated into the healthcare system.

Due to the economic crisis, everyone is currently occupied with their normal jobs, making taking care of people a difficult responsibility for those who are employed. Elderly persons commonly fall out of bed, which can result in catastrophic injuries such muscle tears, fractures, and other serious problems. It can take some time for a carer to reach the wounded person in time. Elderly people require ongoing personal care and medical attention, so it is necessary to suggest technology to deal with these problems and make Elderly people feel comfortable using it. Systems that are easy to use take care of and inform the appropriate person about the health issues and need for support.

II. SCOPE OF THE PROJECT

IoT projects for smart beds can have a wide range of objectives, but the following are some of the more important ones:

Use sensors to keep an eye on the bed's many aspects, including body temperature, saline monitoring, and position of patient on bed. If any irregularities are found, send warnings or notifications to users and to medical professionals.

III. METHODOLOGY

The smart bed for patient health monitoring system operates in two modes: bed mode and sensor mode. In bed mode, an Arduino app is utilized to control the movement of the head and leg parts of the bed through Bluetooth. This mode eliminates the need for dependence on another person and grants patients the freedom to operate the bed movements effortlessly. By using motor drivers controlled through the app, patients can adjust the bed's position with ease.

In sensor mode, various sensors are employed to collect the current status of the patient on the bed. If there is any potential threat to the patient's health, caretakers are notified through a buzzer alert. The status of both modes is simultaneously updated on an authorized cloud service web server, enabling caretakers to promptly act in the event of a potential health risk to the patient.

Figure 1: Flowchart of Temperature and Humidity of Surrounding

Figure 1 depicts the outcome of the temperature sensed by the sensor. If the surrounding temperature is less than 31°C, the heater will be turned on. If the detected temperature lies in the range of 31°C to 37°C, no action is needed as the temperature is in the optimal condition. However, if the temperature of the patient's surroundings exceeds 38°C, then the fan will be turned on.

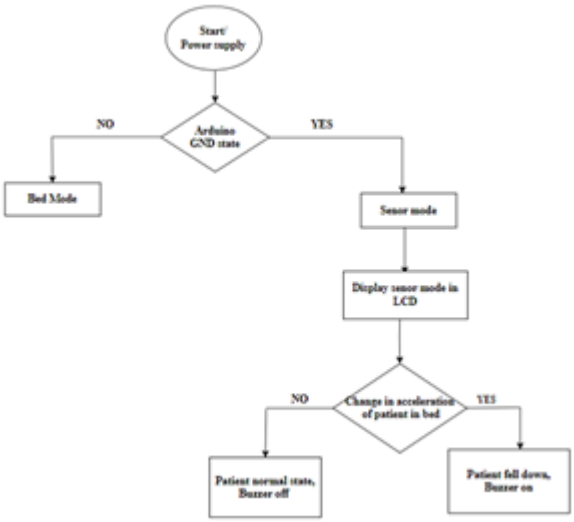

Figure 2: Flowchart depicting Patient's Condition on Bed

Figure 2 illustrates the current state of a patient on the bed. If any change in acceleration is detected by the sensor attached to the bed, the buzzer will turn on to alert the caretakers that the patient is at risk of falling from the bed.

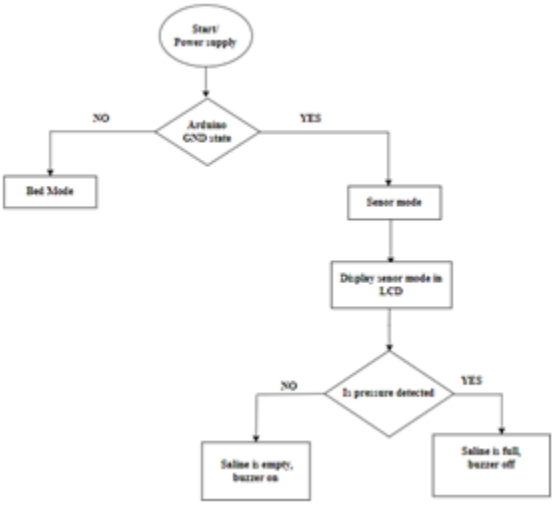

Figure 3: Flowchart of Saline level inside the bottle

Figure 3 illustrates whether the saline level in the bottle is empty or full. If the bottle becomes empty, there will be no more moisture and pressure detected by the sensors. As a result, the buzzer will turn on to alert the caretakers, prompting them to refill the bottle with saline or remove connection from the hand to prevent the backflow of blood into the bottle.

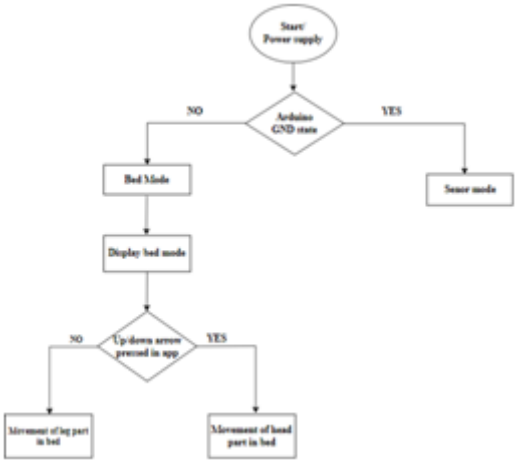

Figure 4: Bed mode functionalities

Figure 4 represents the system operating in bed mode, where the head and leg sections of the bed can be controlled using an app. The patient or caretakers can easily operate the app to adjust the bed's position according to their requirements.

IV. IMPLEMENTATION

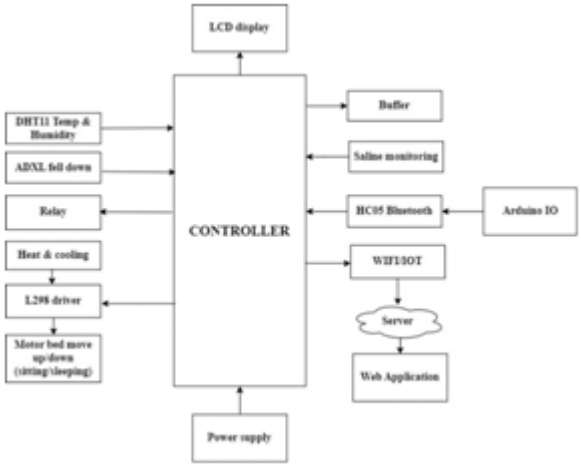

Figure 5: System Architecture

In the above Figure 5, an adapter is used to provide a power supply of 12 volts to the system from AC voltage of 230 volts. If the pin connected is in the GND state, then the system operates in sensor mode. There are four sensors used in the system: a moisture sensor, a DHT11 Temperature and Humidity monitoring sensor, pressure sensor and an ADXL sensor. All sensors operate on 5 volts, and the voltage regulation is controlled by a relay circuit incorporated in the system which takes 12 volts as an input voltage and outputs the voltage based on the component in use. A Wi-Fi card is used to establish a connection between the system and the web application of the Adafruit Cloud service.

If the detected temperature of the surrounding environment is above 38°C, then the fan is turned on to cool down the bed. If the detected temperature is in the range of 31°C to 37°C, there is no need to alter the state of the bed. However, if the sensed temperature is below 31°C, then the heater is turned on. The current temperature and humidity level of the environment are displayed on the LCD. The fan and heaters take 12 volts to turn on. The ADXL Fall down sensor calculates the change in acceleration of the patient's body movement. If it detects any change in acceleration, it will notify caretakers by turning on the buzzer, and all incidents will be constantly updated to the web application and locally on the LCD display. Saline monitoring is achieved through the moisture sensor along with a pressure sensor. Whenever the required level of fluid or saline is present inside the container, a constant connection is established, completing the circuit, and the presence of pressure is detected by the pressure sensor. However, when zero pressure is detected, it signifies that the fluid in the container is empty. At this point, the buzzer is turned on to send an alert to caretakers and to avoid backflow of blood into the container. The output of the moisture sensor will be displayed on the LCD and updated on the web application.

When the pin is connected to 3.3 volts state, the system will operate in bed mode. The L298 Driver is utilized to control the movements of motors in clockwise or counterclockwise directions through any Bluetooth- controlled app. Both motors and the L298 Driver attached to the head and leg parts of the bed use 12 volts to control the direction of movement. To use the app, a Bluetooth connection must be established, and an app must be installed to enable the interface for operations. The installed app can be used by both the patient and the doctor. LCD display's entire activities locally and simultaneously in adafruit IDE web application status of head and leg parts of bed are updated.

V. COMPONENTS USED IN THE SYSTEM

A. Hardware Components:

1. DHT11 Temperature and Humidity Sensor
2. ADXL Sensor
3. Relay
4. L298 Motor Driver
5. Electric Motor
6. Buzzer
7. Moisture Sensor
8. HC05 Bluetooth
9. Wi-Fi Card
10. Arduino Controller
11. LCD Display

B. Software Components:

1. Adafruit Web Application:

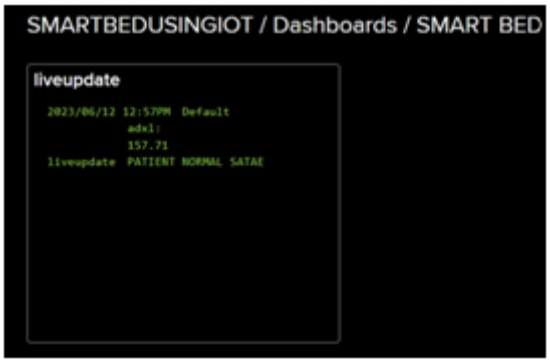

Figure 6: Adafruit Web Application's Live Update

The Adafruit web application is a cloud service used in the system to provide real-time updates on the status of patients and movements of beds through a dashboard. To access the dashboard, users must provide a username and

password as authentication credentials. The Adafruit IDE continuously updates all the outputs, allowing caretakers to stay informed about the patient's current status. The web application serves as a centralized platform where caretakers can monitor important information about patients, such as vital signs, bed position, and other relevant data. Through the dashboard, caretakers can view and track these parameters in real time, providing them with valuable insights into the patient's well-being. By utilizing the cloud service, data from various sensors and devices connected to the patient's bed can be seamlessly transmitted and processed. This ensures that the information displayed on the dashboard is always up- to-date and accurate. Caretakers can rely on this information to make informed decisions regarding the patient's care and respond promptly to any changes or emergencies that may arise.

The authentication factor, which requires a username and password, adds an additional layer of security to the system. This helps ensure that only authorized personnel can access the sensitive patient data displayed on the dashboard, maintaining patient privacy and confidentiality.

2. Arduino Bluetooth App:

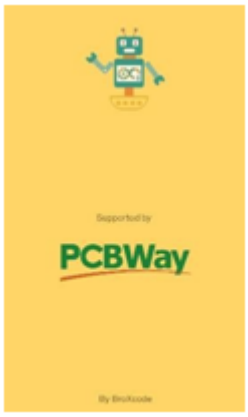

Figure 7: Arduino Bluetooth App

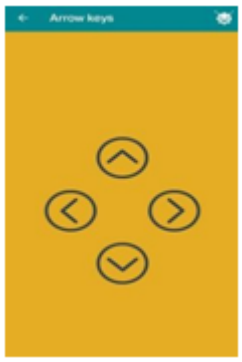

Figure 8: Arrows Used to Control Bed Movements of Arduino Bluetooth App

Popular open-source platform for electronics development and prototyping is Arduino. You may enhance the functionality of Arduino creations by enabling wireless connection with other devices, such as smartphones, tablets, or laptops, via Bluetooth connectivity. One must need a Bluetooth module or an Arduino board with built-in Bluetooth functionality to use Bluetooth functionality with Arduino. For both the Android and iOS operating systems, there are Arduino Bluetooth applications. By using the keyword "Arduino Bluetooth" or other similar search terms, you can find these apps on the relevant app stores. While some apps are compatible with several microcontroller systems, some are made particularly for the Arduino platform.

VI. RESULT

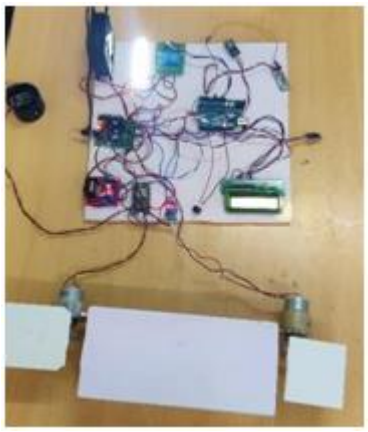

Figure 9: Smart Bed For Patient Health Monitoring System

Figure 10: Smart Bed System LCD Display

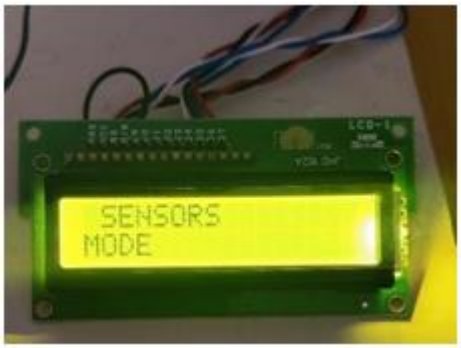

Figure 11: System Working in Sensor Mode, Displayed on LCD

Figure 12: Readings of Surrounding Temperature and Humidity levels

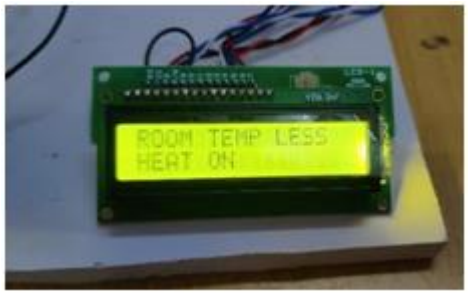

Figure 13: Room Temperature is Less, Turning on Heater

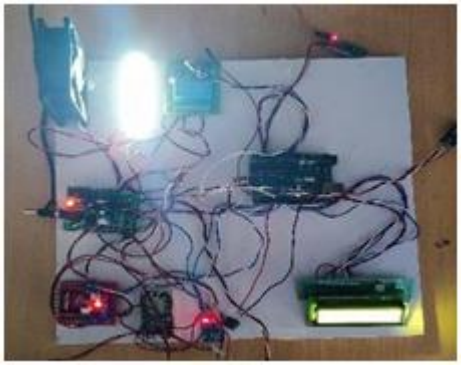

Figure 14: Heat Source is Turned On

Figure 12, Figure 13, Figure 14 illustrates the scenario of Heat or Light turn on as a result of less surrounding temperature.

Figure 15: Readings of Surrounding Temperature and Humidity levels

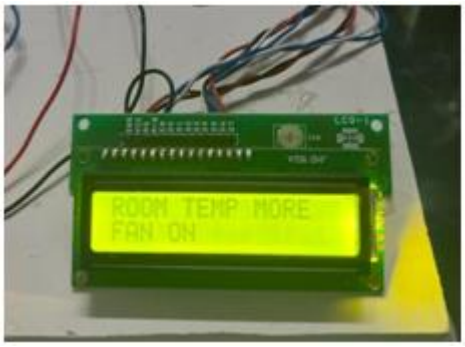

Figure 16: Room Temperature is More, Turning on Fan

Figure 17: Fan turned on

Figure 15, Figure 16, Figure 17– depicts the scenario of fan turn upon more surrounding temperature sensed by the sensor.

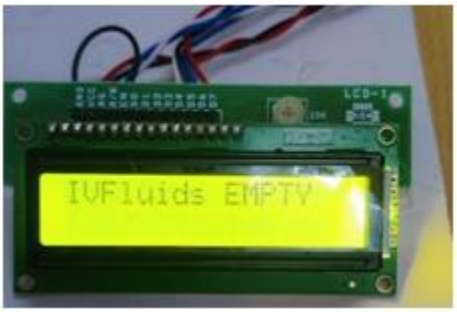

Figure 18: Saline or IV Fluids is Empty

Figure 18 shows that saline level in the bottle is empty on LCD display.

Figure 19: Patient Falling Down Alert Message

Figure 19 alerts the caretakers to look into patient's position on bed by displaying the above figure's message on LCD.

Figure 20: System Working in Bed Mode, Displayed on LCD

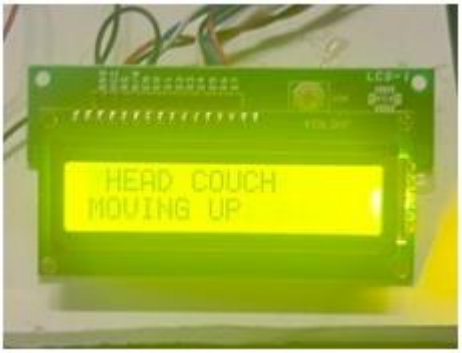

Figure 21: Head Part of Bed is Adjusted

Figure 22: Leg Part of Bed is Adjusted

Figure 21 and Figure 22 depicts the adjustments of bed parts exercised by the user of Arduino controlling Bluetooth app.

Figure 23: Live Updates of Both Modes on Adafruit IDE Web Application

VII. CONCLUSION

Electronic smart bed described in the abstract offers a cost-effective and highly usable solution for individuals who are injured or disabled. Developed innovative bed incorporates advanced features that enhance patient care and safety. One of the key features of the smart bed is its ability to send timely notifications to caregivers through a mobile application and a buzzer. This ensures that the care taker is immediately alerted in case of any injuries or emergencies, allowing for quick intervention and support. The smart bed also includes functionalities such as voice-controlled bed position movement, which enables patients to adjust the bed's position with ease and convenience. This feature promotes comfort and independence for individuals with limited mobility. Moreover, the bed is equipped with sensors that monitor temperature, humidity, and body temperature. This provides valuable data for healthcare professionals to assess the patient's well-being and make informed decisions regarding their care. Additionally, the smart bed incorporates a fall detection feature that identifies potential falls and promptly alerts the appropriate authorities. This feature significantly reduces the risk of accidents and ensures that patients receive timely assistance when needed. The bed's voice command capabilities enable patients to control various functions, further enhancing their autonomy and convenience. Furthermore, the inclusion of a saline monitoring system allows healthcare providers to closely monitor the level of saline in the bottle, ensuring that patients receive the necessary fluids without interruption. In summary, the proposed project offers a low-cost, electronic automation bed that addresses the specific needs of patients requiring care and support. By integrating advanced features such as notifications, voice control, sensor monitoring, and fall detection, this smart bed enhances patient safety, comfort, and overall well-being.

VIII. FUTURE SCOPE

The future scope of smart bed for patient health monitoring system is vast and holds great potential for further advancements and innovations. Some potential areas of development and future enhancements for smart bed for patient health monitoring system include:

1. Future Smart Beds could include more sophisticated sensors and algorithms to collect and thoroughly analyze sleep data. To have a better understanding of sleep patterns and quality, this could involve taking physiological measurements of brainwave activity, eye movement, and other factors.
2. Artificial intelligence (AI) algorithms incorporated into smart beds can help them over time learn and adjust to different sleep preferences and habits. Additionally, AI can offer more precise sleep analysis and tailored suggestions for raising sleep quality.
3. To prevent bed sores and enhance patient comfort, future enhancements can include implementing side movement capabilities in the smart bed.
4. Another potential future enhancement is the implementation of ECG monitoring in the smart bed. By incorporating ECG sensors into the bed's design, it can monitor the patient's heart activity, detect abnormalities, and transmit the data to medical staff for analysis and timely intervention.

IX. ACKNOWLEDGMENT

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