Development of Health Monitoring System with Automated Bed Control using Hand Gesture & Voice Recognition

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Development Of Health Monitoring System With Automated Bed Control Using Hand Gesture & Voice Recognition

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Abstract : The project focuses on the development of a gesture-controlled and voice-controlled bed system for improved patient care and comfort. The system integrates various sensors such as temperature, humidity, air quality, heart rate, SpO2, and blood pressure, allowing for continuous monitoring of vital signs. The bed movements are controlled through hand gestures and voice commands, providing patients with greater independence and convenience. Additionally, the system alerts healthcare professionals via Telegram in case of abnormal temperature, poor air quality, low heart rate, or high blood pressure. The data collected from the sensors is also transmitted to ThingSpeak for further analysis and tracking. The project aims to enhance the healthcare experience for patients and support caregivers in delivering personalized care.

Keywords- Gesture controlled, voice controlled, patient care, continuous monitoring, healthcare technology

I. INTRODUCTION

The project revolves around addressing the challenges faced by individuals with disabilities, the elderly, and patients requiring continuous care. In contemporary society, the availability of full-time caregivers is limited, and there is a growing need for innovative solutions that can enhance the quality of life for these individuals. To meet this need, we have developed a groundbreaking gesture-controlled and voice-controlled bed system.

The primary objective of our project is to provide a more independent and comfortable experience for users through the integration of hand gesture and voice recognition technology in controlling the bed's position. By eliminating the need for constant assistance, individuals can have greater control over their bed movements, allowing them to find their desired position and achieve optimal comfort. This technology empowers users to adjust the bed's position effortlessly by simply using hand gestures or issuing voice commands, enabling them to customize their comfort levels according to their preferences and physical needs.

In addition to the innovative control mechanisms, the bed system incorporates various sensors to continuously monitor the user's health parameters. These sensors include heartbeat sensors, temperature sensors, SpO2 and blood pressure monitors, humidity sensors, and air quality sensors. The real-time data collected by these sensors is processed and analyzed to provide insights into the user's health status. By continuously monitoring vital signs and environmental conditions, the bed system ensures proactive care and facilitates early intervention in case of any health-related concerns. The smart bed system is designed with safety features to enhance user well-being. It includes an emergency button that users can easily access to request immediate assistance. The system also employs an alarm mechanism that triggers if any vital health parameter exceeds predefined thresholds, alerting both the user and the healthcare staff. These safety features provide peace of mind to users and their caregivers, knowing that help can be summoned promptly in case of any emergency.

In summary, our project focuses on improving the quality of life for individuals with disabilities, the elderly, and those in need of continuous care. The integration of gesture and voice control, along with comprehensive health monitoring and safety features, sets our bed system apart, offering enhanced independence, comfort, and peace of mind for users and their caregivers. Through our innovative solution, we aim to transform the way care is provided, enabling individuals to have greater autonomy and a more fulfilling life experience.

II. Related Work

In the field of alerting systems for bedridden patients and gesture-controlled bed movements, several related works have been conducted, aiming to enhance the caregiving experience and improve patient outcomes.One study by E Spandana, M Rajasekar, and N Sandhya (2021) focuses on an alerting system based on hand gesture recognition. The system utilizes a camera module to capture hand images, and through background subtraction, image recognition, and speech conversion, it notifies healthcare providers when patients require assistance. This real-time approach enhances operational efficiency, responsiveness, and patient satisfaction.Another study by Ignacio Ghersi, Mario Mariño, and Mónica Teresita Miralles (2018) explores the concept of smart medical beds in patient-care environments. They discuss the functional, aesthetic, and interactive features of these beds and assess the global market and related standards. The study also addresses emerging challenges and opportunities for adding monitoring and assistive implementations to medical devices.Ms. T. Umarani, Ms. I. Preethy, Ms. N.M. Thennarasi, and Ms. J.E. Jeyanthi (2019) propose a gesture-controlled bed movement system using webcams and simple hardware components. Their real-time system allows for changing the bed's position through hand gestures, facilitating human-computer interaction.In a study by Ms. Kalpana Lamb and Prof. Mrs. Swati Madhe (2016), an automatic bed position control system based on hand gesture recognition is presented. The system uses the background subtraction algorithm and Symlet wavelet transform for accurate hand gesture recognition. The detected gestures are processed by a micro-controller, which controls the DC motor to change the bed's position accordingly.These related works have contributed to the advancement of alerting systems and gesture-controlled bed movements, addressing various aspects such as hand gesture recognition, real-time processing, and accurate positioning. However, the proposed project aims to overcome certain limitations by incorporating additional features and algorithms, thereby enhancing the functionality and monitoring capabilities of the smart bed system.

III. Proposed System

A. BLOCK DIAGRAM OF PROPOSED SYSTEM

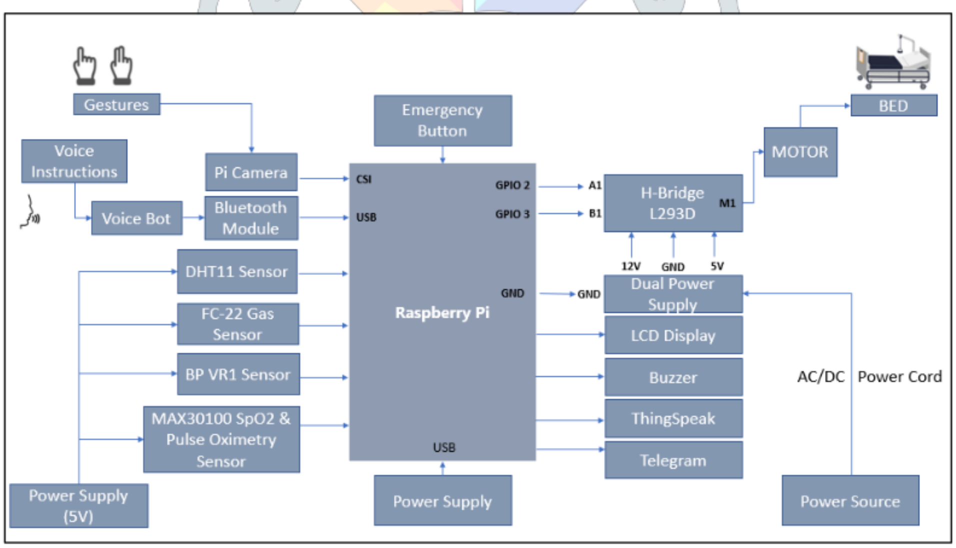


Fig. 1: Block-diagram of the proposed methodology

The proposed project incorporates multiple blocks to enable its functionality, as depicted in Figure 1. The first block is the Gesture Recognition Block, which employs advanced gesture recognition technology to interpret hand gestures made by the user. This block utilizes sensors and sophisticated algorithms to accurately detect and interpret the gestures, allowing for intuitive control of the bed's movements. By simply performing specific hand gestures, users can initiate actions such as adjusting the bed's position or activating predefined functions.The Voice Recognition Block is another essential component of the system. It employs powerful speech recognition algorithms and audio processing techniques to recognize and understand voice commands given by the user. This block enables hands-free control of the bed, providing convenience and ease of use.The DC Motor Control Block plays a vital role in translating the user's commands into physical movements of the bed. It consists of a DC motor and a dedicated motor driver that receives signals from the Gesture Recognition or Voice Recognition Block and precisely controls the motor's speed and direction. This allows for smooth and accurate adjustments of the bed's position based on the user's inputs.The Sensor Network Block integrates various sensors, including heartbeat sensors, temperature sensors, SPo2 and blood pressure monitors, humidity sensors, and air quality sensors. These sensors continuously monitor the patient's vital signs and the surrounding environmental conditions. The collected data provides valuable insights into the patient's well-being and helps ensure a safe and comfortable environment.The Raspberry Board Block serves as the central processing unit of the system. It receives and processes the analog signals from the sensors, performing signal conditioning, data conversion, and analysis. This block enables real-time monitoring and analysis of the patient's health parameters, facilitating timely interventions if necessary.Overall, the proposed system utilizes a combination of gesture recognition, voice recognition, motor control, and sensor integration to provide intuitive and responsive control of the bed while ensuring continuous monitoring of vital parameters and environmental conditions.

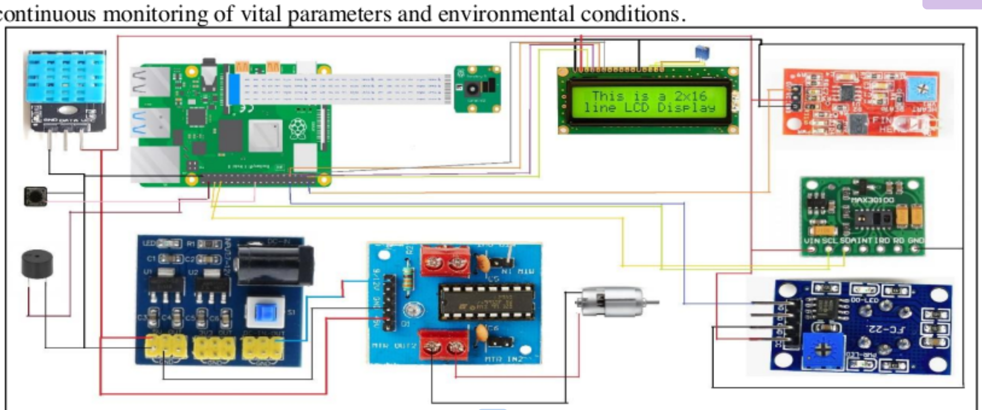


Fig. 2 : Circuit diagram of the proposed system

Figure 2 represents the circuit diagram of the proposed system, showcasing the interconnections and components involved in the project. It provides a visual representation of the electrical connections and the arrangement of various elements. The diagram includes the Raspberry Pi board, sensors such as temperature, humidity, and gas sensors, the motor driver, power supply, and other essential components. Each component's placement and connectivity are illustrated, helping to understand the overall circuitry of the system. The circuit diagram serves as a guide for assembling and wiring the components correctly, ensuring proper functionality and coordination among different elements of the project.

B. HARDWARE COMPONENTS

1. **Raspberry Pi 3 B:** The Raspberry Pi serves as the main controller unit of the system, responsible for processing data, controlling the bed movements, and integrating various components.
2. **Bluetooth BC417 Module:** This module enables wireless communication between the Raspberry Pi and external devices, facilitating the integration of voice recognition and gesture control capabilities.
3. **H-Bridge L293D Motor Driver**: The motor driver is used to control the DC motor responsible for adjusting the bed's position. It provides the necessary power and direction control for smooth bed movement.
4. **Raspberry Pi Camera 5MP:** The camera module is utilized for capturing images or video for monitoring purposes, such as detecting hand gestures or recording the environment.
5. **USB UART Serial Converter port:** This component enables serial communication between the Raspberry Pi and other devices, facilitating data transfer and control.
6. **Dual power supply**: It is used to provide power to the H-Bridge motor driver in addition to powering the DC motor. The 5V power supply handles the control signals and logic components, while the 12V power supply drives the motor through the H-Bridge. This setup ensures efficient and reliable operation of the motor and allows for precise control of bed movements in the gesture-controlled system.
7. **DC Motor:** A DC motor is utilized to control the movement of the bed in the project.
8. **DHT11 Sensor:** The DHT11 sensor is used in the project to measure temperature and humidity levels in the environment where the patient is lying on the bed. It provides real-time data on these parameters, allowing healthcare professionals to monitor the comfort and well-being of the patient. The sensor's compact size, low power consumption, and reliable performance make it suitable for integration into the bed system for accurate environmental monitoring.

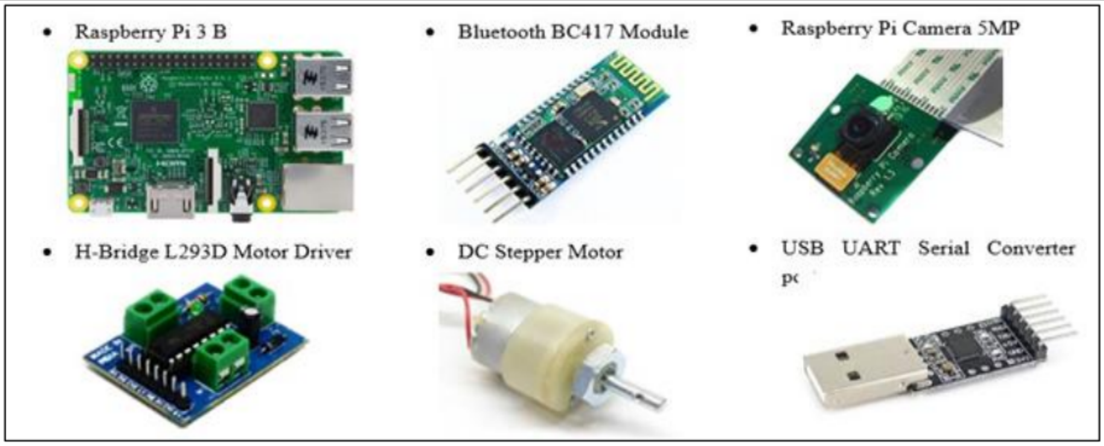


Fig.3 Hardware Components

9. **FC-22 Gas Sensor:** The FC-22 gas sensor is utilized in the project to monitor air quality and detect harmful gases in the vicinity of the patient. It provides reliable measurements of various gases, allowing for early detection of potential health hazards. By integrating the FC-22 sensor into the bed system, healthcare professionals can ensure a safe and healthy environment for the patient, while enabling timely interventions in case of any gas-related risks or issues.
10. **BP VR1 Sensor:** The BP level sensor is utilized in the project to measure and monitor the blood pressure of the patient. It provides valuable information on the patient's blood pressure levels, enabling healthcare professionals to assess cardiovascular health and detect any abnormalities or fluctuations. By incorporating the BP level sensor into the bed system, continuous monitoring of blood pressure is achieved, allowing for timely intervention and management of hypertension or other blood pressure-related conditions. This helps in providing personalized care and ensuring the well-being of the patient.
11. **LCD:** The LCD 16*2 display is utilized in the project to provide a user-friendly interface for displaying the values of various sensors used in the system. It allows for clear and concise visualization of important information such as heart rate, blood pressure, temperature, humidity, and air quality readings. The LCD display enhances the usability of the system, enabling healthcare professionals and caregivers to easily monitor and interpret the sensor data, promoting effective decision-making and ensuring optimal patient care.

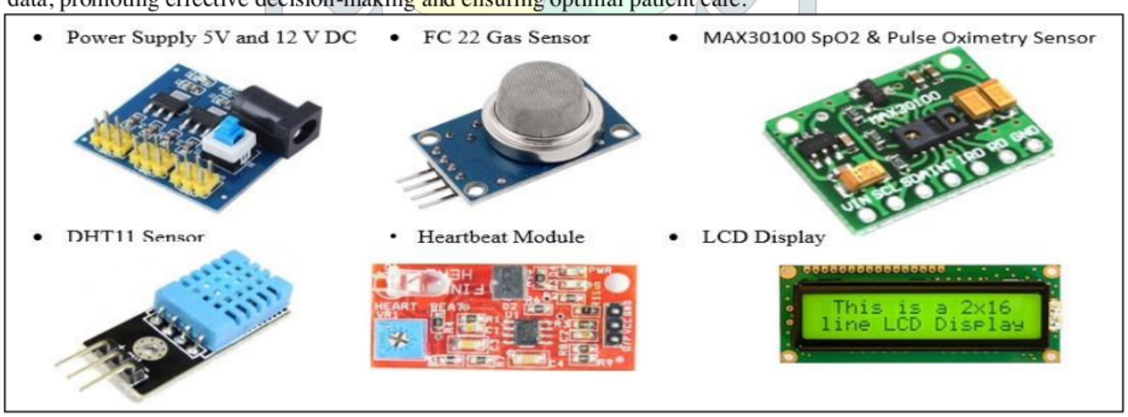


Fig. 4 Sensors used in proposed system

12. **MAX30100 SpO2 & Pulse Oximetry Sensor:** The MAX30100 sensor is employed in the project to measure and monitor various vital parameters such as heart rate, blood oxygen saturation (SpO2), and pulse oximetry. It utilizes advanced optical sensing technology to accurately capture and analyze the patient's physiological data. By integrating the MAX30100 sensor into the bed system, continuous and non-invasive monitoring of vital signs is achieved, enabling healthcare professionals to assess the patient's overall health status and detect any abnormalities. This information facilitates timely interventions and personalized care, improving patient outcomes and ensuring their well-being.

All these sensors like heart rate sensor, SpO2 and BP sensor, temperature sensor, humidity sensor, and air quality sensor are used to collect real-time data on the patient's vital signs and environmental conditions. These sensors provide essential inputs for continuous monitoring and analysis.

C. SOFTWARE USED

The software tools used in the project work include **Raspberry Pi OS (Raspbian)**, **Python 3**, **TensorFlow, Mediapipe, Numpy,** and **ThingSpeak**.

1. **Raspberry Pi OS** is the operating system used on the Raspberry Pi board, providing a platform for running the project software.
2. **Python 3** is the programming language used to develop the code for the gesture-controlled bed system and integrate various functionalities.
3. **TensorFlow** is a machine learning framework used for developing and training the hand gesture recognition model. It enables the system to accurately interpret and recognize different hand gestures for controlling the bed movements.
4. **Mediapipe** is a library that provides ready-to-use solutions for tasks such as hand tracking, pose estimation, and facial recognition. It is used to track and analyze hand movements in real-time.
5. **Numpy** is a numerical computing library in Python, used for efficient data handling and manipulation in the project. It helps in processing and analyzing the sensor data obtained from various sensors integrated into the bed system.
6. **ThingSpeak** is an IoT platform used for collecting and visualizing the sensor data. It enables remote monitoring of the patient's vital parameters and provides insights into their health condition.

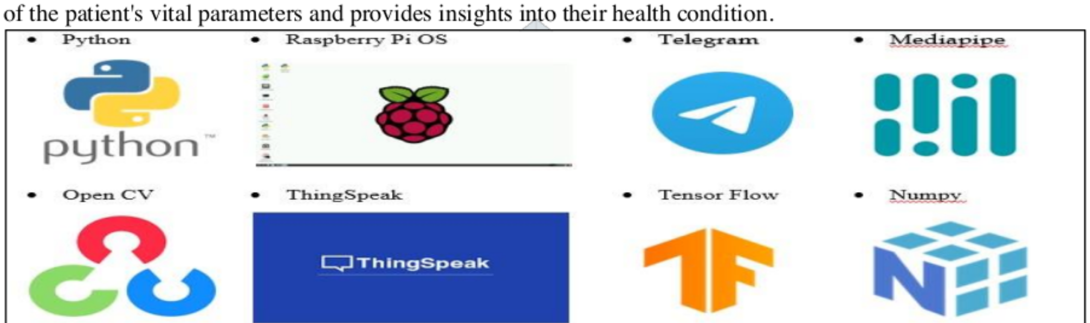


Fig. 5 Software used

These software tools in Figure 5 were utilized to develop an integrated system that combines gesture recognition, sensor data processing, and IoT capabilities, enabling precise control and monitoring of the bed movements and patient's health parameters.

D. FLOWCHART

1. Flow Diagram of Hand Gesture controlled bed:

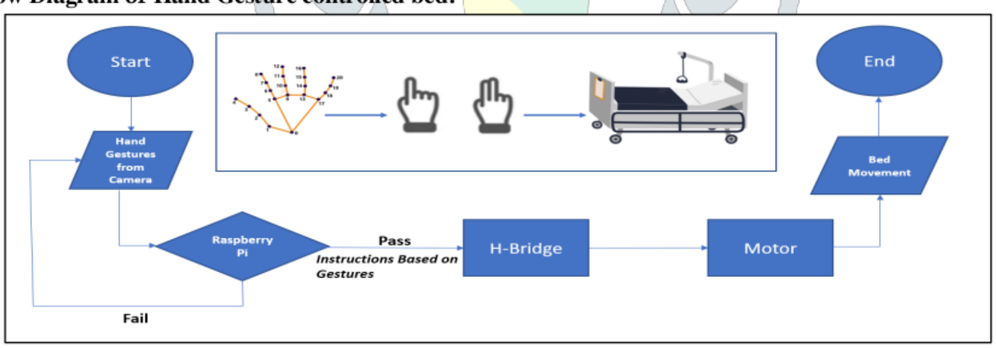


Fig. 6: Flow diagram of the proposed methodology for Hand Gesture

The plans and techniques used in the design and development of the Hand gesture recognition in Figure 6 is for change the position of automatic adjustable beds in hospitals are described in this section. In order to perform hand gesture recognition to control bed position, many tools, libraries and languages are used like Open-Source Computer Vision Library. Open CV established in Python Language. Python 3.7.4 version is an open-source environment for compile the source code. It has many inbuilt functions for recognizing hand gesture. The main component used here is the Raspberry Pi. It is used to get the information from the Patient, based on the command it can take the necessary action and then change the bed movement.

2. Flow Diagram of Voice Controlled bed:

The flowchart in Figure 7 for voice recognition illustrates the steps involved in the process of interpreting and executing voice commands. Firstly, the system starts by listening for audio input through a microphone. The audio signal is then preprocessed, including noise reduction and signal conditioning, to enhance the quality. Next, the

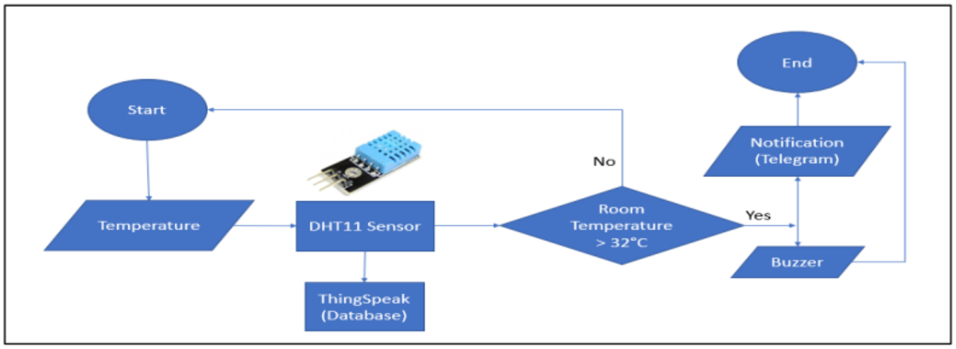


Fig. 7 Flow diagram of voice recognition model

preprocessed audio is analyzed using voice recognition algorithms, which convert the speech into text. The system then matches the recognized text with predefined commands or patterns stored in its database. If a match is found, the corresponding action associated with the command is executed. Finally, the system provides feedback or output based on the executed action, such as displaying information or performing a specific task. The flowchart guides the implementation of voice recognition, ensuring a systematic approach to capture, process, and interpret voice commands accurately for controlling the bed's movements.

3. Flow Diagram of Temperature Sensor:

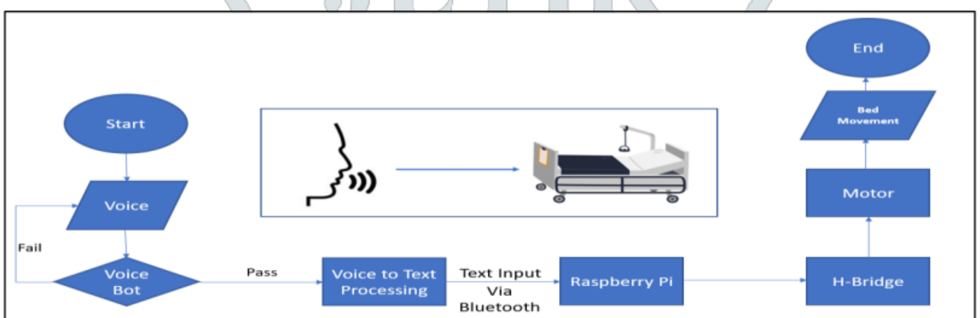


Fig. 8 Flow diagram of temperature sensor model

The flow diagram in Figure 8 for the temperature sensor in begins with the start of the temperature monitoring process. The temperature value is then read from the sensor, followed by a check to determine if it exceeds 32 degrees Celsius. If the temperature surpasses this threshold, a notification is sent on Telegram to alert the user. Concurrently, the temperature data is continuously transmitted to ThingSpeak, providing ongoing monitoring and data storage. The process repeats at regular intervals to ensure real-time tracking of temperature changes. Overall, this flow diagram showcases the systematic sequence of actions involved in monitoring the temperature, detecting threshold breaches, and facilitating timely notifications and data collection for further analysis.

4. Flow Diagram of FC-22 Gas Sensor:

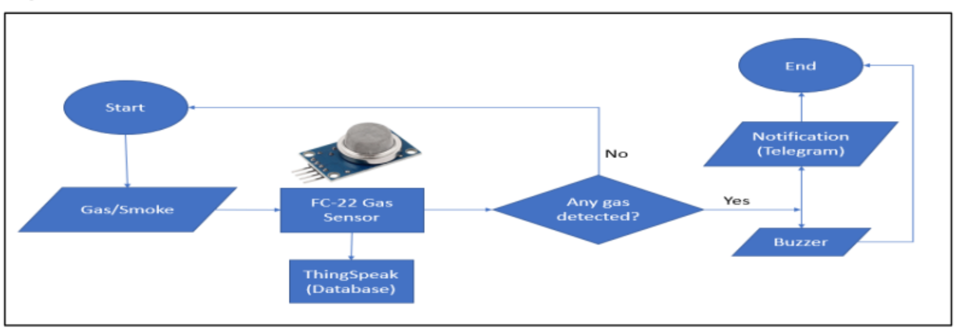


Fig. 9 Flow diagram of gas sensor model

The flow diagram for the gas sensor in Figure 9 starts with the initiation of the gas quality monitoring process. The gas sensor measures the air quality and checks for the presence of harmful gases. If the air quality is determined to be poor or if harmful gases are detected, a notification is sent on Telegram to alert the user. Simultaneously, the gas sensor continuously sends data to ThingSpeak, enabling continuous monitoring and data logging. The process repeats at regular intervals to ensure real-time tracking of air quality changes and prompt notifications in case of any concerns. This flow diagram illustrates the step-by-step process of monitoring gas levels, detecting abnormalities, and providing timely notifications and data collection for further analysis.

5. Flow Diagram of Max30102 SpO2 Sensor:

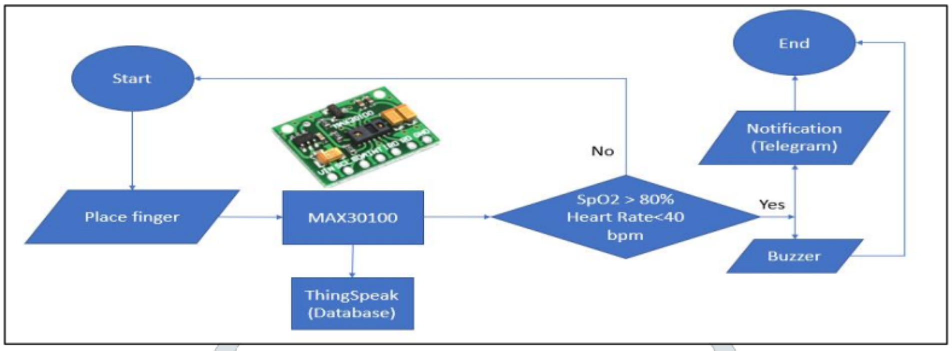


Fig. 8 Flow diagram of max30100 sensor model

The flow diagram in Figure 8 is for the MAX30100 SpO2 and Pulse Oximetry sensor starts with the initialization of the sensor for SpO2 and pulse rate measurement. The sensor continuously reads the SpO2 and pulse rate values from the user's finger. If the SpO2 level drops below 80% or if the blood pressure exceeds 170mmHg, a notification is sent on Telegram to alert the user about the abnormal readings. Additionally, the MAX30100 sensor sends continuous data to ThingSpeak for real-time monitoring and analysis. This allows for ongoing tracking of SpO2 levels and pulse rates, enabling early detection of any potential health issues. The flow diagram demonstrates the sequential steps involved in measuring SpO2 and pulse rate, detecting abnormal readings, notifying the user, and capturing data for further analysis and evaluation.

6. Flow Diagram of Heart Rate Sensor:

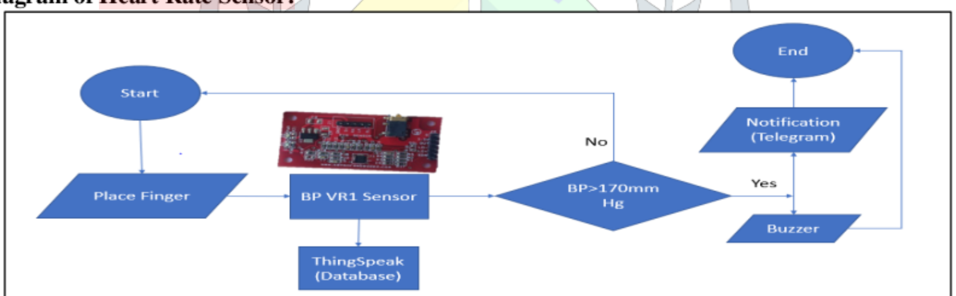


Fig. 9 Flow diagram of heart rate sensor model

The flow diagram in Figure 9 is for the heart rate sensor begins with the initiation of the heart rate monitoring process. The sensor measures the heart rate and continuously monitors it. If the heart rate drops below 40 beats per minute, a notification is sent on Telegram to notify the user about the low heart rate. Additionally, the heart rate sensor sends continuous data to ThingSpeak for real-time tracking and analysis. This allows for the ongoing monitoring of heart rate trends and the detection of any abnormalities. The flow diagram represents the sequential steps involved in monitoring the heart rate, detecting low heart rates, and providing notifications, as well as capturing and logging data for further evaluation and assessment.

IV. EXPERIMENTAL RESULTS

Fig. 10 Voice command is given to system and bed movement is shown

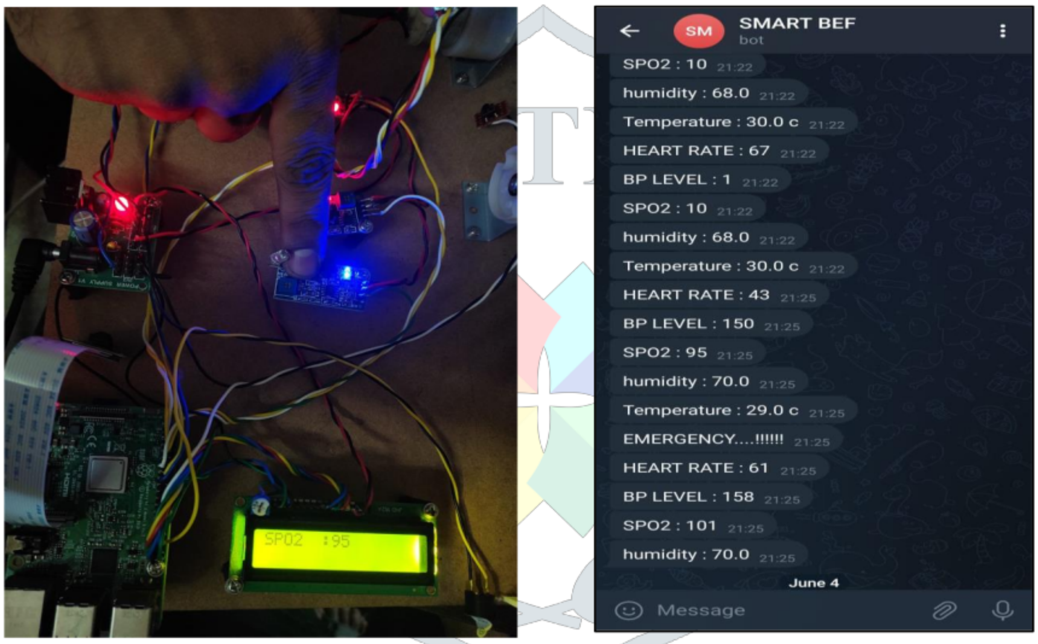


Fig. 11 Sensors is activated my placing finger on heart rate sensor & all parameters is shown on lcd and on telegram

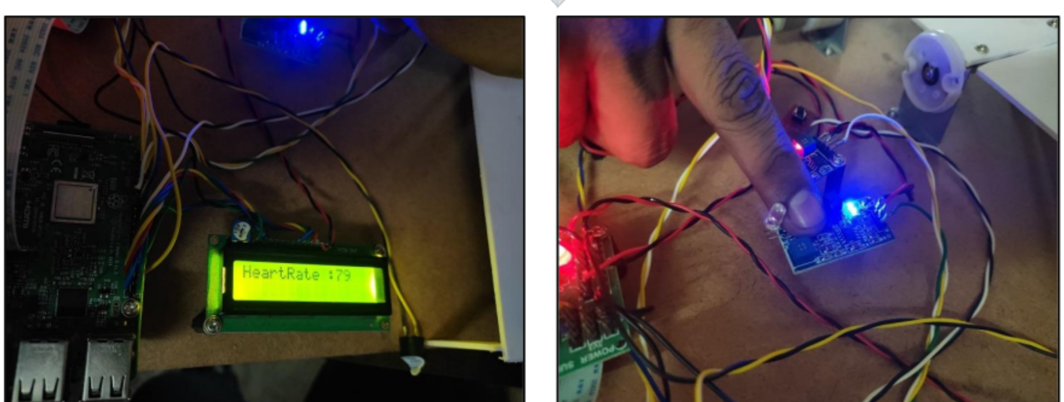


Fig. 12 placing finger on heart rate sensor & is shown on lcd

Fig. 13 Hand Gestures

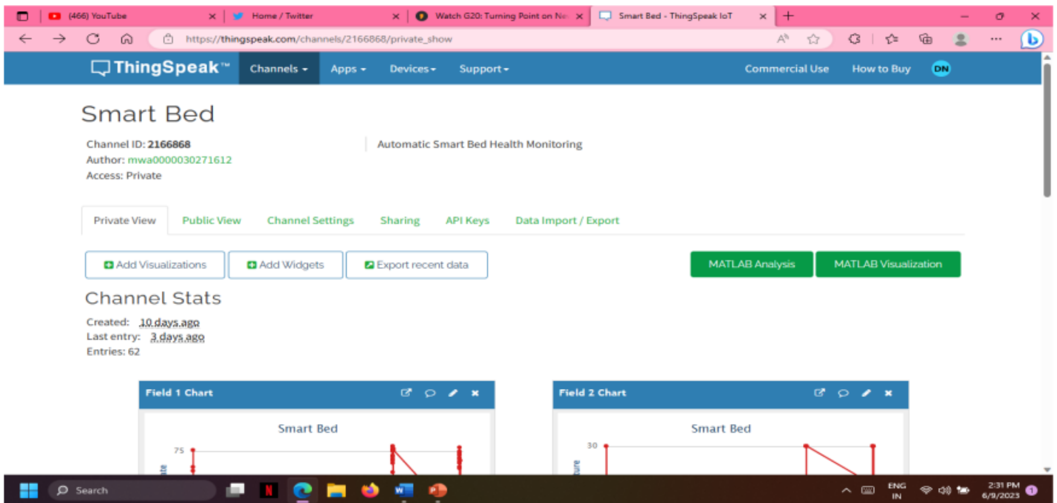
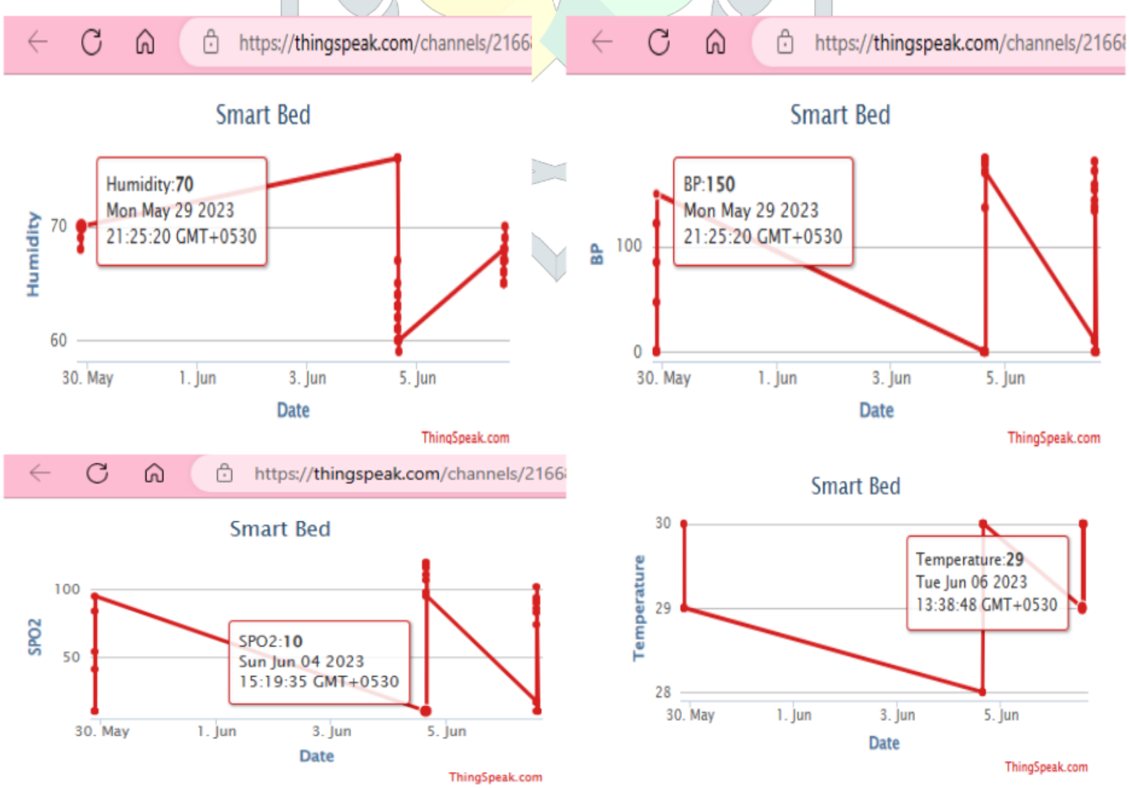


Fig 14 ThingSpeak SS



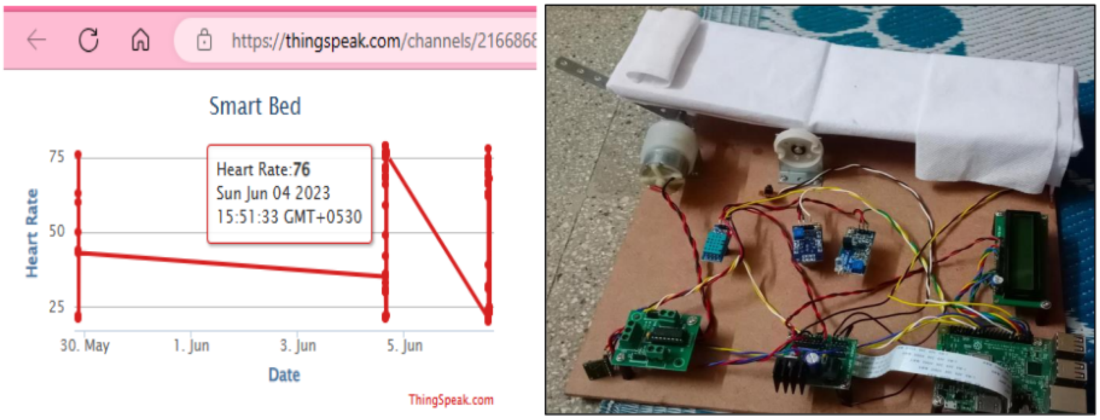


Fig. 15 Thingspeak graph snapshot & Hardware Prototype of proposed system

Fig. 16 Heart Rate sensor & Bed Movement using Hand Gestures for up and down movement

V. Conclusion & Future Work

A. Conclusion

In conclusion, the proposed project aims to develop a bed control system that enables gesture recognition and voice recognition for enhanced user convenience and patient care. The integration of various blocks, including gesture recognition, voice recognition, DC motor control, sensor network, and Raspberry board, allows for intuitive and efficient control of the bed's movements. Additionally, the continuous monitoring of vital parameters and environmental conditions adds an extra layer of safety and care for the patients. The system provides a user-friendly interface for controlling the bed through hand gestures and voice commands, reducing the need for physical buttons or manual adjustments. The implementation of advanced algorithms and the utilization of sensors ensure accurate and reliable performance. The project contributes to the field of healthcare technology by providing an innovative solution for bed control and patient monitoring. Future work can focus on expanding the capabilities of the system, integrating additional sensors and functionalities, and conducting extensive testing and validation to ensure its effectiveness and usability in real-world healthcare settings. Overall, the project holds great potential to enhance patient comfort, caregiver efficiency, and the overall quality of care in medical facilities.

B. Future Work

In terms of future work, there are several areas that can be explored to further enhance the proposed bed control system. Firstly, integrating machine learning algorithms can improve the accuracy and robustness of gesture recognition and voice recognition. This would enable the system to adapt to individual users' gestures and speech patterns, improving overall user experience. Secondly, expanding the sensor network to include additional health monitoring sensors, such as ECG and respiration rate sensors, can provide a more comprehensive view of the patient's health status. Thirdly, incorporating wireless communication capabilities, such as Bluetooth or Wi-Fi, can enable seamless connectivity with other devices or healthcare systems for data sharing and remote monitoring.

Lastly, conducting user studies and gathering feedback from healthcare professionals and patients would help to refine the system's design and usability, ensuring it meets the specific needs of different healthcare environments. By addressing these areas, the future work can further optimize the functionality, performance, and usability of the bed control system, ultimately enhancing the overall patient care experience.

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