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HUMANOID ROBOT FOR MEDICAL CARE AND ASSISTANCE

Dr. Anand M[1], Chethan M[2], Jyothsna Antony[3], Salai Tavadepan M[4], Prakash Mallik[5]

Associate Professor, Electronics and Communication Department, East West Institute of Technology, Bangalore, India[1]

Student, Electronics and Communication Department, East West Institute of Technology, Bangalore, India[2-5]

Abstract: The project aims to develop a multifunctional humanoid robot for healthcare system that performs basic medical tasks and supports hospital workflows. Equipped with sensors to monitor patient vitals (heart rate, temperature, ECG), detect obstacle to navigate safely, the robot integrates an Arduino Mega and Raspberry Pi 3B+ for communication. It can deliver food and medicine, assist with surgical instruments, and interact with staff through a microphone, Bluetooth speaker, and OLED display, enhancing operational efficiency and patient care.

Keywords: Humanoid Robot, Healthcare, Sensors, Arduino Mega, Raspberry Pi 3B+, Deliver, Interact, Surgical instruments.

I. INTRODUCTION

In recent years, the healthcare industry has embraced technological advancements to improve patient care, optimize workflows, and enhance overall operational efficiency. Among these advancements, robotics has emerged as a promising solution, enabling healthcare facilities to address increasing demands and manage a wide range of tasks, from patient monitoring to logistical support.

The humanoid robot in this project is developed with a primary goal: to support healthcare staff by performing basic yet essential tasks, such as monitoring patient conditions [1], assisting in the delivery of food and medicine, and replacing nurse during surgical procedures. By integrating this humanoid robot into the healthcare workflow, hospitals can benefit from a system that performs repetitive and time-consuming tasks accurately, ultimately leading to improved patient outcomes and a more streamlined process.

II. METHODS AND MATERIALS

The methodology for developing this humanoid robot integrates Arduino Mega and Raspberry Pi 3B+ for dual control and communication. The Arduino processes real-time sensor data from heart rate, temperature, ECG, PIR, and ultrasonic sensors, enabling patient monitoring and safe navigation.

The Raspberry Pi coordinates data transfer and high-level tasks, like essentials and managing surgical tools. Servo motors and relays enable precise handling, while a microphone, Bluetooth speaker [2], and OLED display provide interactive communication with healthcare staff. This architecture allows seamless task execution, enhancing efficiency in healthcare settings by automating patient monitoring and support functions [3].

The humanoid robot leverages an Arduino Mega and Raspberry Pi 3B+ for a robust control system. The Arduino collects and processes data from essential sensors (heart rate, temperature, ECG, PIR, and ultrasonic), allowing the robot to monitor patient vitals, detect motion, and navigate obstacles safely.

Meanwhile, the Raspberry Pi manages data transfer and high-level operations, such as delivering food and medicine, with servo motors and relays for precision in instrument handling. Communication is facilitated through a microphone, Bluetooth speaker, and OLED display, enabling the robot to interact with healthcare staff, enhancing workflow and patient care efficiency.

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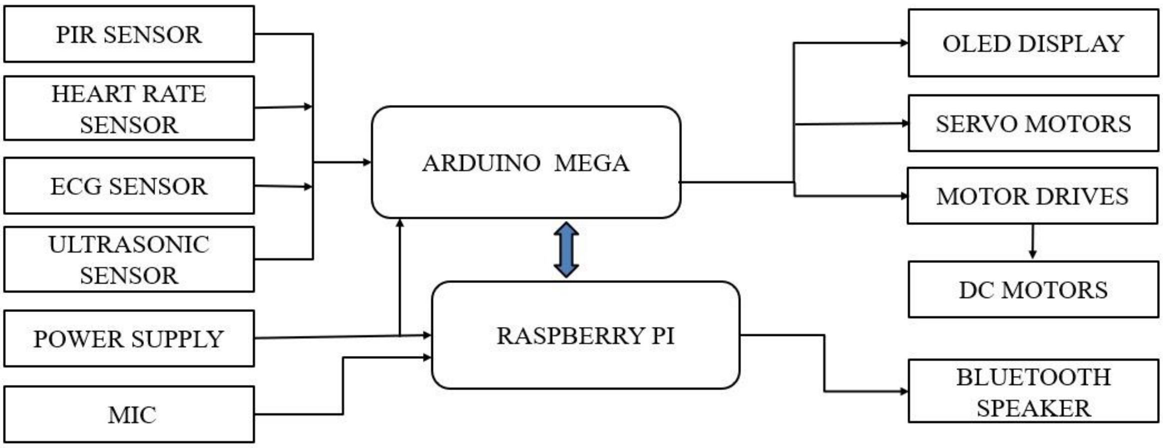

Figure 1**:** Block diagram of the proposed system

Key Components:

1. Main Controller:
- Raspberry Pi acts as the central processing unit managing inputs, outputs, and communication.
- Arduino mega: interfaces with additional sensors and modules for specific functions.

2. Sensors and Modules:
- Ultrasonic Sensor: Measures distance to obstacles for autonomous movement.
- PIR sensor: Detects motion by sensing infrared radiation changes.
- Heart rate sensor: Detects heart best by blood flow per minute.
- ECG sensor: Detects and records the electric activity of the heart.
- Temperature and humidity sensor: monitors the ambient temperature and relative humidity levels.
- OLED display:

3. Actuators:
- DC Motor: Drives the robot's wheels for movement.
- Servo Motor: Controls mechanisms like the first-aid box opening or other robotic arms.

4. Additional Modules:
- L298N motor driver: It is used to control the speed and direction of dc motors.
- Power supply module: Regulates electrical energy to provide a stable voltage and current to electronic circuits or devices.

5. Power System:
- Battery: Powers the entire system.
- Power Supply: Regulates voltage to ensure proper power delivery to all components.

6. Connections:
- Sensors and actuators are interfaced with the Arduino Mega, which processes the data and assists in managing servo motor. And the voice interaction is operated using raspberry pi 3B+
- Power is supplied to all components through a regulated power supply unit.

7. Materials:
- Hardware:
- Raspberry Pi 3B+
- Ultrasonic Sensor
- Servomotor
- DC Motors
- L298N Motor Drive
- Power Supply Module
- Arduino mega

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8. Software:
- Arduino IDE
- Raspbian OS
- Open CV
- Python

III. IMPLEMENTATION

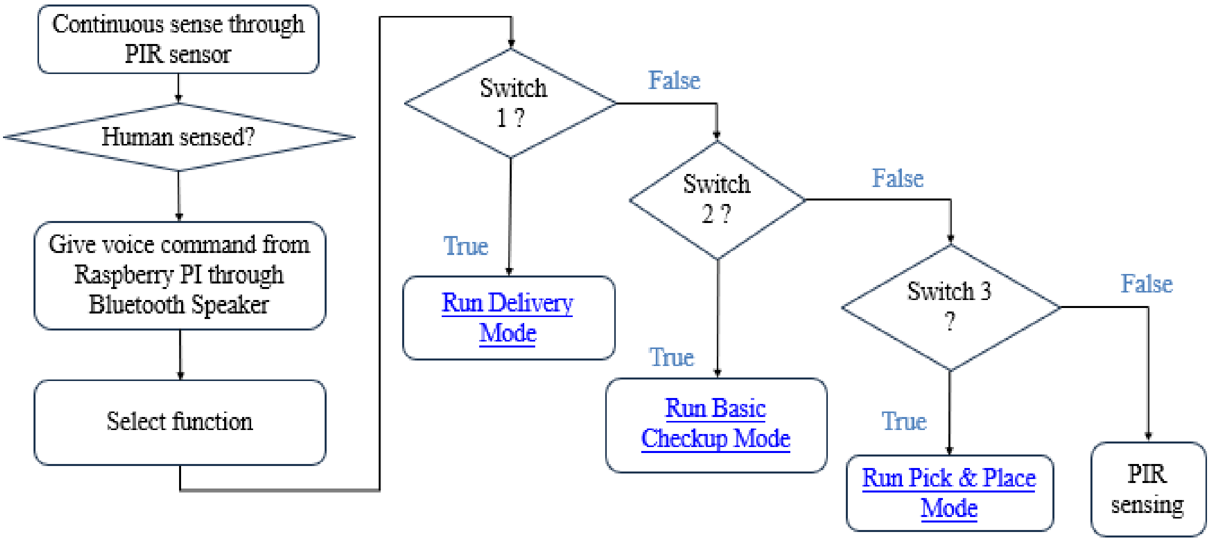

Figure 2: Flowchart of the proposed model

This flowchart represents a decision-making process for a system that utilizes a PIR (Passive Infrared) sensor and Raspberry Pi to execute different modes based on human detection and user input. Initially, the PIR sensor continuously monitors for human presence. If a human is detected, a voice command is issued via a Bluetooth speaker connected to the Raspberry Pi [4,5], prompting the user to select a function. The system checks the state of three switches sequentially to determine the desired mode of operation. If Switch 1 is active, the system runs the "Delivery Mode." If Switch 1 is inactive, it checks Switch 2; if active, the system executes the "Basic Checkup Mode." If Switch 2 is also inactive, it evaluates Switch 3; if active, the "Pick & Place Mode" is initiated. If none of the switches are active, the system loops back to continue PIR sensing.

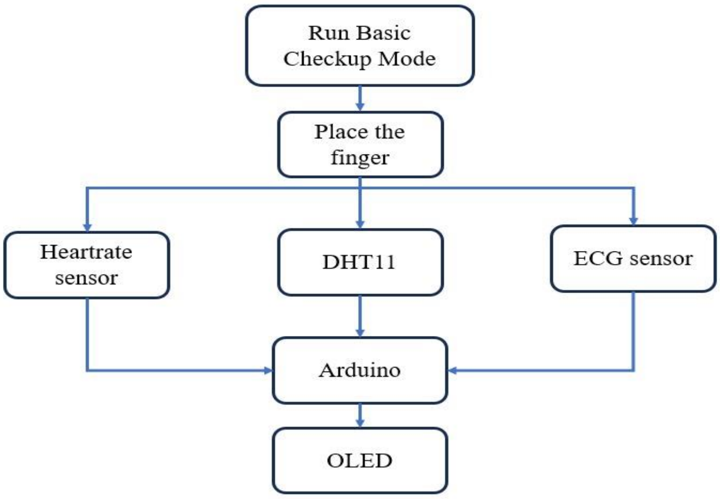

Figure 3: Flowchart of the basic checkup module

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This flowchart illustrates the process of a basic health checkup mode using sensors and an Arduino-based system. Initially, the system prompts the user to place their finger, enabling data collection. The DHT11 sensor measures temperature and humidity, while the heart rate sensor and ECG sensor collect pulse and electrocardiogram data, respectively. These sensors send their readings to the Arduino, which processes the inputs and transmits the results to an OLED display for real-time visualization. This setup provides a compact, efficient health monitoring solution.

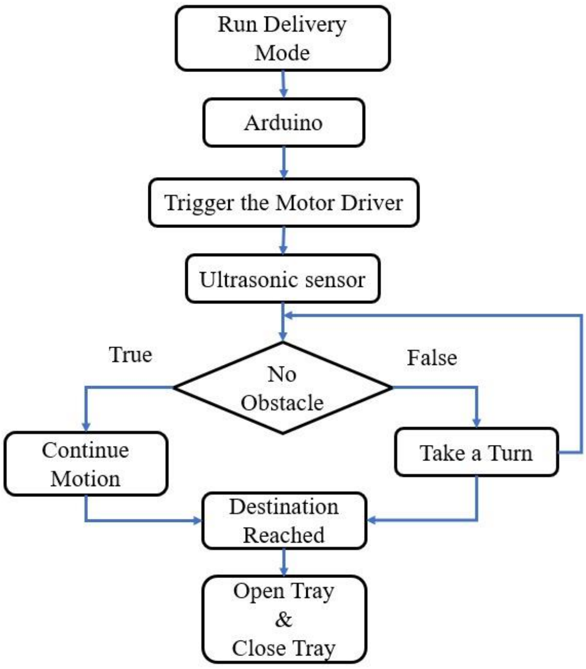

Figure 4: Flowchart of the delivery module

The above flowchart illustrates the Run Delivery Mode, where an autonomous system is designed to transport items to a destination while avoiding obstacles. The process begins with initiating the delivery mode, controlled by an Arduino microcontroller. The Arduino triggers the motor driver to activate the motors, allowing motion. An ultrasonic sensor continuously monitors the path for obstacles [6,7]. If no obstacle is detected, the system continues moving toward the destination. However, if an obstacle is identified, the system takes a turn to avoid it and resumes its path. Upon reaching the destination, the system opens the tray to deliver the item and then closes it, completing the operation.

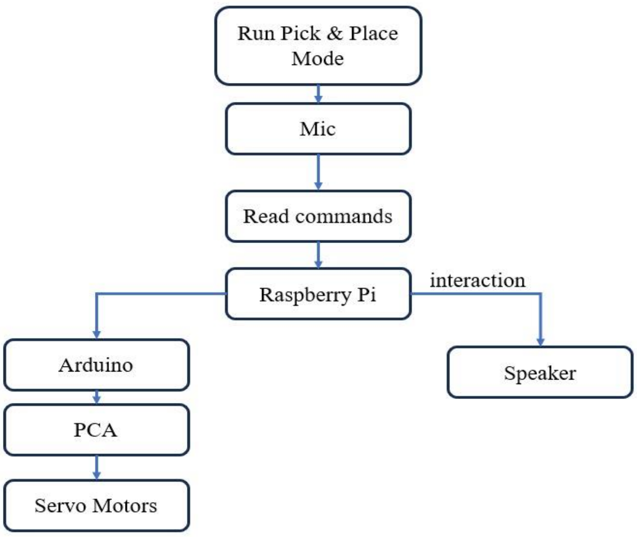

Figure 5: Flowchart of the pick and place module

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This flowchart represents the Run Pick & Place Mode, where a robotic system performs pick-and-place tasks based on voice commands [8]. The process starts with initializing the mode and capturing voice commands using a microphone [9]. These commands are processed by a Raspberry Pi, which coordinates the operations and provides audio feedback via a speaker for interaction. The Raspberry Pi communicates with an Arduino, which controls the hardware components. A Pulse Control Adapter (PCA) is used to manage servo motors, enabling precise movements to pick and place objects. This system integrates voice recognition, motion control, and interaction capabilities for efficient operation.

IV. RESULT

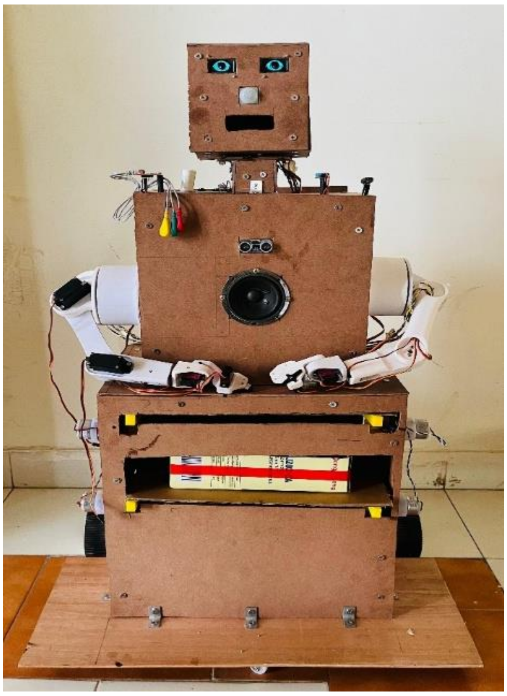

Figure 6.1: prototype of the model

This figure showcases a humanoid robot prototype designed for multi-functional purposes such as delivery, basic checkup tasks, and pick-and-place operations. The robot's structure is crafted from wood, with functional components including a PIR sensor for human detection, ultrasonic sensors for obstacle avoidance, and a speaker integrated into the chest for voice output. Its head features expressive eyes for interaction, and the robot's arms are equipped with servo motors for performing tasks. A storage compartment in the torso suggests the robot's use for delivery tasks. The design emphasizes modularity and functionality, suitable for various automation tasks in controlled environments.

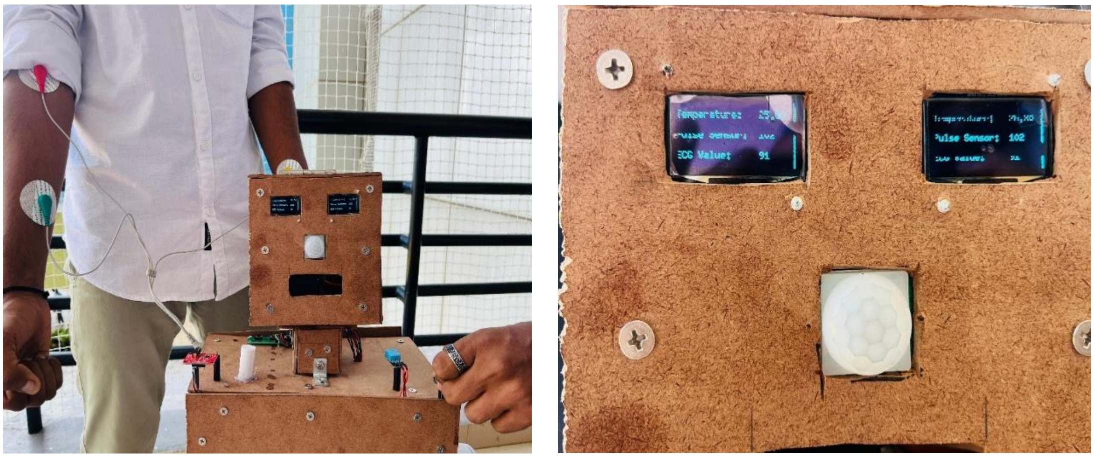

Figure 6.2: Sensing and displaying the readings

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The sensors such as the heart rate sensor, ECG sensor, temperature sensor effectively sense the readings of the patient and display the readings in the OLED.


Figure 6.3**:** Delivering food and medicine

The above fig succesfully depicts the open and close function of tray during the delivery process.


Figure 6.4**:** Navigation and movement

This model accurately senses the obstacle and avoid collision to reach the predefined destination seamlessly.

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Figure 6.5**:** Pick and place module

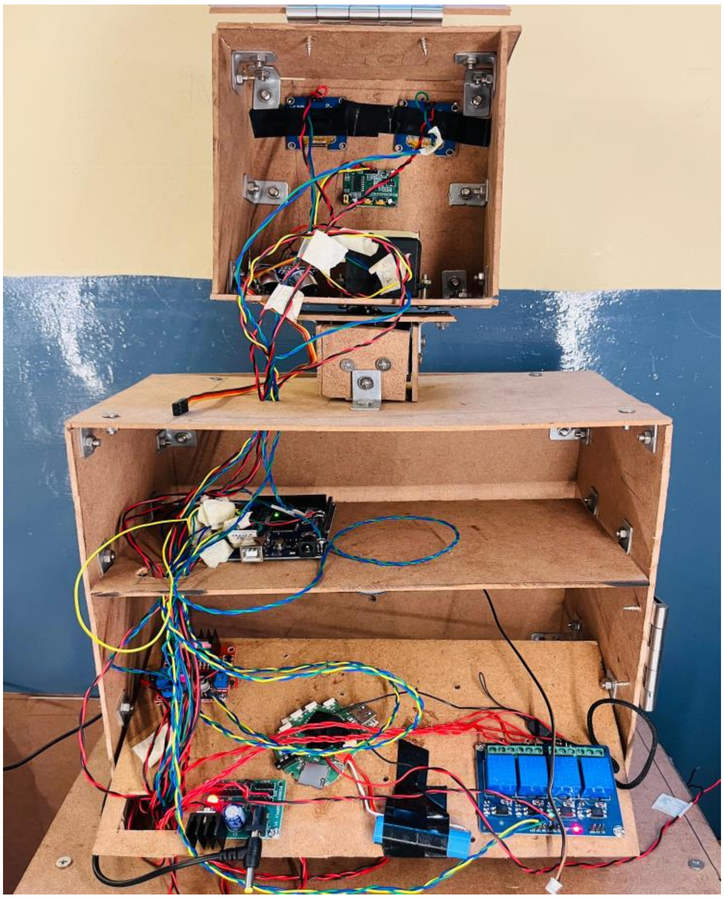

Figure 6.6**:** Internal circuit connection

V. CONCLUSION

This project successfully demonstrates an effective approach to improving healthcare using robotics and automation. This robot performs tasks like health checks, food and medicine delivery, and surgical assistance, ensuring safety and efficiency with advanced sensors such as PIR, ultrasonic, heartrate sensor and ECG.

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By integrating Raspberry Pi and Arduino, the project highlights how technology can provide affordable and adaptable solutions for hospitals. Integrate artificial intelligence and machine learning for smarter decision-making [10], personalized care, and efficient resource management. Enable cloud integration for better data sharing and emergency response features for critical situations.

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