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HUMANOID ROBOT

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Abstract: This project focused on the design, development, and implementation of a humanoid robot. The primary objective is to create an autonomous or semi-autonomous robotic system capable of performing human-like tasks and interacting with its environment in a naturalistic manner. The project addresses key challenges in robotics, including robust locomotion (bipedalism), advanced perception (computer vision and sensor fusion), sophisticated manipulation, and intelligent decision-making. The proposed humanoid robot integrates a mechanical structure for stability, sensors for awareness, actuators for movement, and onboard computing for real-time processing. Emphasis is on object recognition, grasping, and human-robot interaction. Applications include healthcare, service robotics, industrial automation, education, and entertainment

Keywords: Humanoid Robot, Robotics, Artificial Intelligence, Human-Robot Interaction, UV-C Disinfection

I. INTRODUCTION

Humanoid robots are rapidly evolving, moving beyond industrial automation to become interactive companions and service providers. This project introduces a novel humanoid robot designed to excel in dynamic event hosting while simultaneously ensuring public health through integrated disinfection capabilities. Unlike static disinfection systems or purely entertainment-focused robots, our creation offers a unique blend of engaging human interaction and essential environmental sanitization.

The core of this project lies in developing a humanoid platform capable of natural language processing and advanced social cues, allowing it to greet guests, provide information, and even lead segments of an event. Its ability to perceive and respond to human emotions and queries will create a truly immersive and personalized experience for attendees. Beyond its hosting prowess, the robot integrates strategically placed UV-C emitters. This innovative feature enables it to autonomously navigate event spaces, disinfecting surfaces and air pathways during breaks or in designated zones, significantly mitigating the spread of pathogens.

The design emphasizes user-friendliness and safety, incorporating robust navigation algorithms to avoid collisions and fail-safes for UV-C operation. This dual- purpose humanoid robot represents a significant leap forward in automation, offering a versatile solution for future events where both engaging interaction and stringent hygiene standards are paramount.

II. BLOCK DIAGRAM

This below diagram represents the key components and their interactions within the Humanoid Robot

1. Ultrasonic Sensor
Detects obstacles and measures distance. Provides input to Raspberry Pi for navigation and collision avoidance.

2. Camera
Captures images/video of the environment Used for computer vision tasks like human detection and interaction.

3. Microphone
Captures voice input for speech recognition and user interaction. Data goes to Raspberry Pi for processing.

4. Ultrasonic Sensor
Detects obstacles and measures distance. Provides input to Raspberry Pi for navigation and collision avoidance.

5. Camera
Captures images/video of the environment. Used for computer vision tasks like human detection and interaction.

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6. Microphone

Captures voice input for speech recognition and user interaction. Data goes to Raspberry Pi for processing.

7. Battery

Power source for the entire humanoid robot system. Supplies regulated voltage to Raspberry Pi, Arduino, motors, and other modules.

8. UV-C LEDs

Controlled by Raspberry Pi and Arduino. Emit UV-C light for disinfection of surrounding surfaces and air.

9. Raspberry Pi (Main Controller / Brain)

Central processing unit for high-level tasks. Handles image processing, speech recognition, navigation, and decision-making. Interfaces with Arduino, ESP32, and sensors.

10. ESP32 (Wireless Communication)

Provides Wi-Fi/Bluetooth connectivity. Connects the robot to a mobile app (Android Flutter) for remote monitoring and control.

11. Speaker

Connected to Raspberry Pi. Outputs voice responses, greetings, or alerts during event hosting.

12. Relay Module

Acts as a switch to control high-power devices like DC motors. Ensures safe isolation between low-power controllers and high-power actuators.

13. DC Motors (1–4)

Provide movement to the humanoid robot.Controlled via Arduino and Relay module for locomotion.

14. Arduino

Handles low-level hardware control like motors and sensors. Executes real-time control of actuators and receives commands from Raspberry Pi.Sends display messages to OLED Display.

15. OLED Display

Provides visual feedback (system status, results, user messages). Enhances interaction with users.

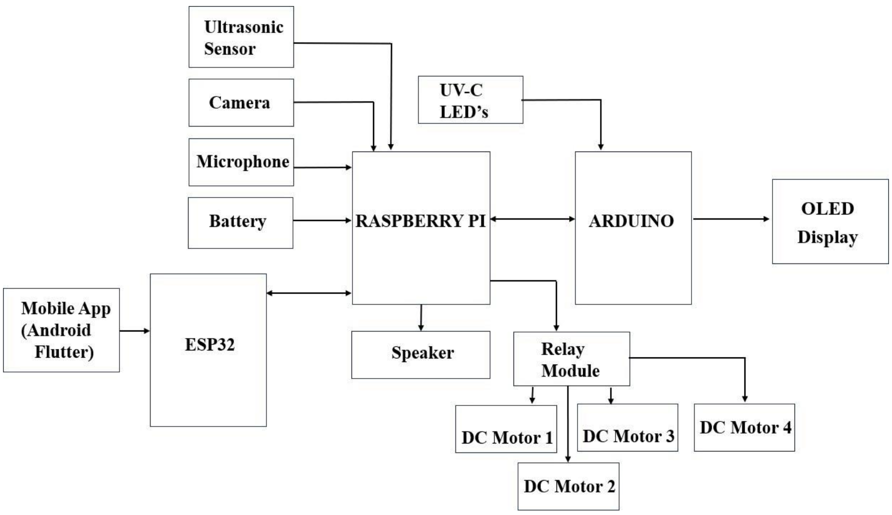

Fig 1. Block diagram

III. FLOW CHART

The robot detects a student, greets them, and asks for feedback in a conversational manner.It evaluates responses as Good, Very Good, or Excellent, and acknowledges with a thank-you message.Simultaneously, the robot can be controlled

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remotely via Bluetooth & Android Flutter app for movements. This ensures both autonomous interaction (greeting/feedback) and manual control (via app).

1. Start
The humanoid robot system is powered on.

2. Import Libraries
Required libraries for sensors, Bluetooth, and control modules are loaded into the program.

3. Initialize the Sensors
All sensors (camera, microphone, ultrasonic, etc.) are activated and made ready for detection.

4. Student Detected?
The robot continuously scans its surroundings using sensors/camera.If a student/person is detected → proceed to interaction.If not detected → loop back and keep checking.

5. Welcome Message
Once a student is detected, the humanoid robot greets the person with a welcome message (through speaker/display).

6. Ask Student Feedback
The robot then interacts further by asking for feedback (could be via speech, app, or input device).

7. Feedback Evaluation
Based on the student's response, the robot checks feedback levels in stages: Good? → If yes, display "Thank you for your valuable feedback." If not, it proceeds to next check.
Very Good? → If yes, same appreciation message.
If not, check further.
Excellent? → If yes, appreciation message again.
If no, it loops back to asking feedback again (ensuring interaction continues).

8. Bluetooth Support (Parallel Branch)
Checks if Bluetooth support is available on the connected system (mobile/ESP32). If not, requests the user to enable notifications/permissions. Once Bluetooth is connected, it allows control movements through Android Flutter mobile app. This enables remote/manual control of the humanoid robot.

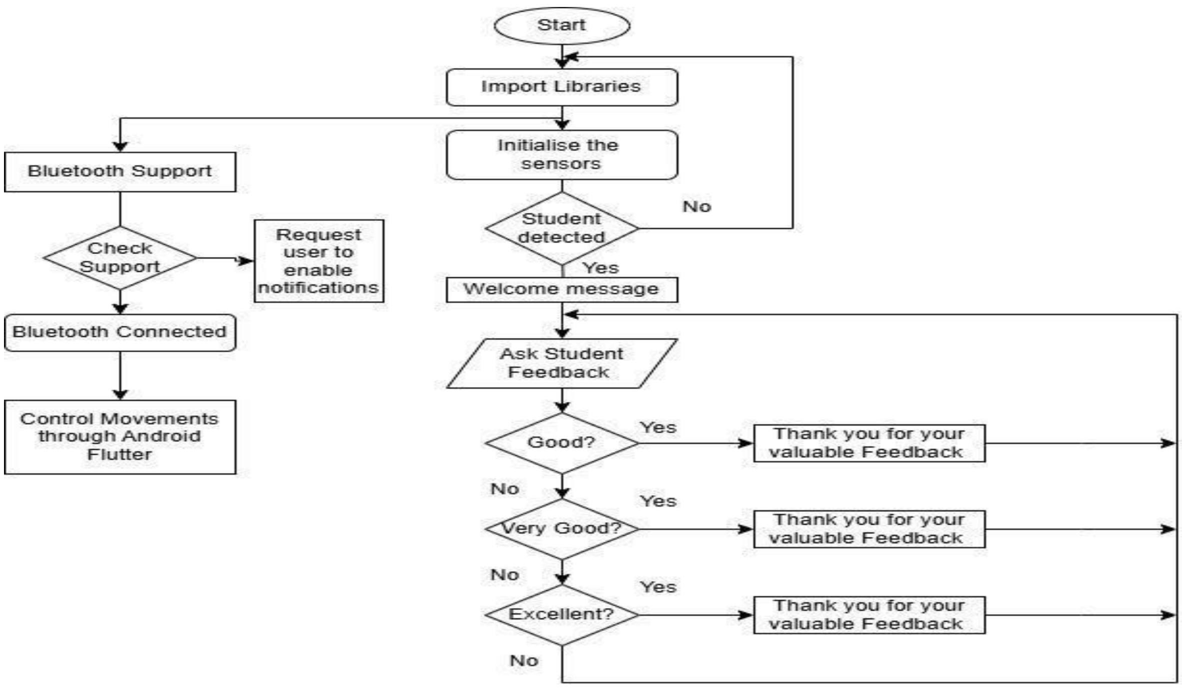

Figure: Flow Chart

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IV. RESULT

The humanoid robot effectively combined event hosting (greeting, feedback, interaction) and disinfection (UV-C sanitization), while being remotely controllable. This dual-purpose validation shows its potential in educational institutions, hospitals, malls, and public gatherings Our robot was successfully designed and implemented, achieving the intended objectives of combining interactive event hosting with automated disinfection. During testing, the robot was able to reliably detect and greet individuals using its integrated sensors and camera, while providing voice-based interaction and feedback collection through the speaker and OLED/TFT display. The system operated efficiently in both manual and autonomous modes, with smooth switching facilitated by the web interface and mobile application. Navigation tests demonstrated effective obstacle detection and avoidance using ultrasonic sensors, ensuring stable mobility in indoor environments. The UV-C disinfection module was activated during safe intervals, confirming its effectiveness in sterilizing surfaces and air without human exposure. These trials validated the dual functionality of the robot, proving it capable of enhancing user interaction while simultaneously contributing to hygiene and safety. The results indicate strong potential for deployment in sectors such as healthcare, education, hospitality, and public gatherings, where interactive engagement and sanitization are equally important.

Fig 9. Working model of Robot

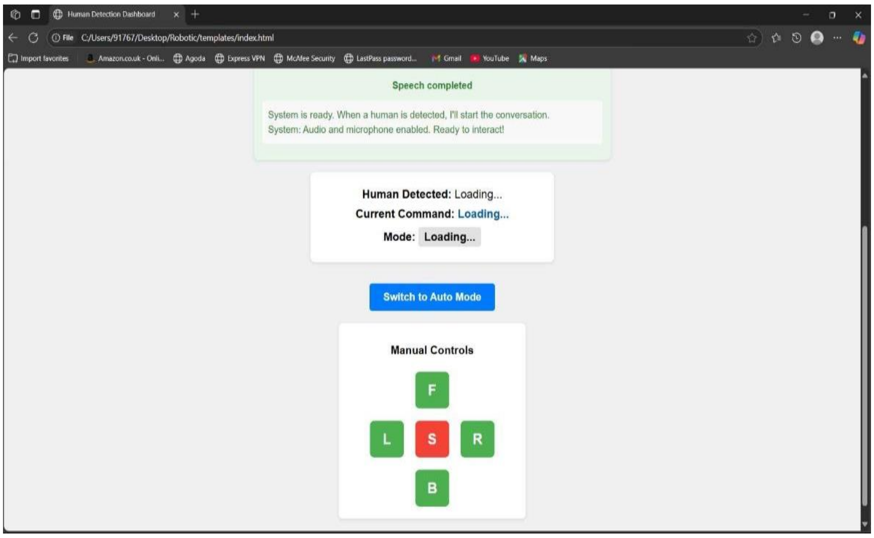

Fig 8. Control System

V. CONCLUSION

The humanoid robot developed in this project has successfully demonstrated the integration of interactive event hosting with autonomous UV-C disinfection, fulfilling its intended objectives. The system proved capable of greeting and engaging with users, collecting feedback, and providing real-time interaction through voice and display, while also

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performing reliable navigation with obstacle avoidance. In parallel, the UV-C disinfection module operated safely and effectively, validating its usefulness in maintaining hygiene. This dual-function approach highlights the potential of humanoid robots to address both social interaction and public health needs within a single platform. The project's results suggest practical applicability in domains such as healthcare, education, hospitality, and public gatherings, where human engagement and sanitation are equally important. Although challenges remain in optimizing battery life, enhancing natural interaction, and ensuring complete UV-C coverage, the robot lays a strong foundation for future developments. Overall, the work represents a step forward in designing versatile humanoid systems that can operate as both companions and service providers while contributing to safer and healthier environments.

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