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Tentative Title: Smart Human-Following Robot.

1.Background and present state of the problem:

In recent years, robotics has advanced significantly, transforming tasks that once seemed impossible into automated processes. Among these innovations, human-following robots have emerged as a promising technology designed to detect and follow humans or objects within a specific range. Known as "Smart Human Following Robot,"[2] these machines have the potential to enhance daily life in various sectors.

Human following robots can be used in shopping centers, hospitals, and homes, offering practical assistance by carrying items, delivering medicine, or supporting people without the need for remote control. For instance, in hospitals, these robots can function as trolleys for transporting medical supplies or medicines, providing a fast and accurate solution. In commercial settings, such as malls or restaurants, they can carry packages or groceries, reducing human effort and improving efficiency [1][2].The potential of this technology goes beyond day-to-day tasks—it could be utilized in defense, where robots could carry weapons or supplies for soldiers, navigating challenging terrains with ease[4].As people increasingly integrate robots into their lives, human-following robots are seen as valuable companions that can co-exist with humans and assist in a wide variety of tasks with precision and speed[2]. Future advancements could further enhance these robots by incorporating more sophisticated components like cameras, tracking systems, and improved designs, making them even more functional and aesthetically appealing[1]. These robots are poised to play a vital role in shaping our future, blending seamlessly into daily life and industry alike.

2.Justification of the study:

Developing a cost-effective, reliable human-following robot has immense practical value in fields like healthcare, logistics, and customer service. A robot that can autonomously navigate and follow a designated individual offers substantial assistance in these sectors. This study aims to contribute to the development of such robots using open-source platforms like Arduino, which are widely accessible and affordable for researchers, hobbyists, and professionals alike.

The study will explore the potential of using ultrasonic sensors for human detection and tracking, taking advantage of their simplicity, low cost, and ease of integration with Arduino systems[3]. The findings will help in creating a framework for further research into more advanced robotic systems.

3.Objectives with specific aims:

The primary objective is to design and implement a human-following robot using Arduino and ultrasonic sensors. The project will aim to:

- To develop a prototype that can autonomously detect and follow a human using ultrasonic sensors, ensuring real-time responsiveness.
- To develop an efficient control system that enables the robot to follow the human while avoiding obstacles in real-time
- To integrate Arduino as the central processing unit for controlling sensor data and motor functions, ensuring smooth and accurate movements.
- To evaluate the robot's ability to perform in various environments such as hospitals, shopping centers, and military settings, enhancing its adaptability.

4.Outline of Methodology:

This project will follow an iterative and experimental approach to develop the Arduino-based human-following robot. The methodology consists of the following key steps:

Literature Review: Conduct a comprehensive study of existing research on human-following robots, with an emphasis on sensor technologies, human detection algorithms, and obstacle avoidance techniques. This will inform the selection of sensors and the development of control algorithms.

System Design: Focus on the structural design of the robot, particularly on sensor placement and integration with the Arduino microcontroller. Ultrasonic sensors will be strategically positioned to detect the user and measure the distance between the robot and the target human.

Sensor Integration: Implement ultrasonic sensors for accurate human tracking. These sensors will relay real-time data to the Arduino, which will process the input to control the motors, ensuring responsive adjustments to the robot's movement.

Algorithm Development: Develop and implement a control algorithm to calculate the direction and speed of the robot based on the sensor input. The algorithm will handle dynamic conditions such as changing distances and obstacle detection, ensuring safe and efficient navigation.

Testing and Refinement: Test the robot in controlled environments to evaluate performance metrics such as tracking accuracy, obstacle avoidance, response time, and energy efficiency. Based on the results, iterative refinements will be made to improve system robustness and functionality.

5.Design Procedure:

Hardware Setup:

- Assemble the robot body.
- Attach DC motors to wheels.
- Install Arduino microcontroller and motor driver module.
- Integrate ultrasonic sensors on the front and sides of the robot for directional and distance sensing.
- Integrate infrared sensors.

Software Development:

- Write Arduino code for sensor data acquisition and motor control.
- Implement the human-following algorithm, which processes ultrasonic sensor data and translates it into motor actions for movement.
- Calibrate sensor sensitivity for optimal detection range and accuracy.

Integration and Testing:

- Test the robot's functionality in a controlled environment.
- Conduct tests with obstacles to evaluate avoidance capabilities.

Final Adjustments:

- Make adjustments based on test results to improve efficiency and reliability.
- Optimize power consumption and response times.

6.Expected outcome:

The expected outcomes of the project include:

- A functional human-following robot prototype using Arduino, ultrasonic sensors and Infrared Sensor.
- A robust algorithm capable of real-time human detection and tracking with efficient obstacle avoidance.
- Documentation detailing the design, development, and performance evaluation of the robot.

- A framework that can be further enhanced with more advanced sensors or used for similar robotic applications.

7.References:

[1] **Anjankar, P., Anjankar, V., & Deshmukh, M.** (2022). *Design and development of human following robot*. International Journal of Current Science Research and Review, 5(2), 432-438. https://rjpn.org/ijcspub/papers/IJCSP22A1123.pdf

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[3] **Circuit Digest.** (n.d.). *Human following robot using Arduino and ultrasonic sensor*. https://circuitdigest.com/microcontroller-projects/human-following-robot-using-arduino-and-ultrasonic-sensohttps://www.theseus.fi/handle/10024/747294

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