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Multi-functional Obstacle Avoidance Arduino Robot Car

Divyanshu Bisen[1], Ayushi Makode[2], Janvi Itiwale[3], Samiksha Warade[4], Prof.Trupti.Malewar[5]

Students, Department of computer Science and Engineering, Priyadarshini college of Engineering, Nagpur, India[1-4]

Guide, Department of computer Science and Engineering, Priyadarshini college of Engineering, Nagpur, India[5]

Abstract: The concept and development of a multipurpose robot car that avoids obstacles is presented in this project, which is built on the Arduino platform. The project's goal is to build an adaptable, autonomous robot that can go through many types of surroundings and instantly avoid obstacles. The robot uses a mix of motor control and sophisticated algorithms to assure obstacle avoidance, and it uses ultrasonic sensors to identify impediments. The main elements, the creation procedure, and the possibilities for future growth of this experimental and instructional platform are described in the abstract. In addition to providing a fantastic introduction to robotics, the multifunctional obstacle avoidance robot car lays the groundwork for upcoming robotic applications such as autonomous navigation, surveillance, and more. In addition to ultrasonic sensors for obstacle detection, the robot integrates an ESP32 camera coupled with YOLO (You Only Look Once) object recognition. The incorporation of the ESP32 camera enhances the robot's perception capabilities, allowing it to capture real-time visual data from its surroundings. The YOLO object recognition system further enables the robot to identify and categorize objects swiftly and accurately. This synergy between motor control, algorithms, ultrasonic sensors, ESP32 camera, and YOLO contributes to a robust obstacle avoidance mechanism.

Keywords: Arduino microcontroller, ultrasonic sensor, DC Motor, servo motor, esp32 camera, yolo, cnn.

I. INTRODUCTION

In the modern world, robotics is an exciting and quickly expanding industry. ROBOT is intelligent enough to occupy the entire available space. The area of robotics is dynamic and multidisciplinary, with an emphasis on the design, development, and use of robots. These machines, which frequently include sensors, actuators, and artificial intelligence built into them, can interact with their environment, carry out tasks, and make choices. The design and operation of these autonomous devices are made possible by the study of robotics, which incorporates elements of computer science, artificial intelligence, mechanical engineering, electrical engineering, and more. Robots can be found in a wide range of sizes and forms, from autonomous cars to industrial arms used in manufacturing to tiny educational robots intended to teach students the fundamentals of robotics. Robotics is still developing quickly, with new developments in software and hardware making it possible for robots to perform a wider range of complicated tasks. explains how an autonomous robot car that avoids obstacles by using an ultrasonic wave sensor was designed and put into operation for this thesis. It is possible to measure the obstacle avoidance distance by sending pulses. In order to implement the obstacle avoidance function, we can control the steering gear simultaneously. Front axle steering and rear wheel drive are used by the robot car. With gear reduction mechanisms, two DC motors drive two drive tires. Using MCUs for Arduino.

An Arduino-based multifunctional obstacle avoidance robot automobile is shown in this project, which details its concept and execution. The project's aim is to develop an adaptable, self-governing robot that can traverse diverse surroundings and promptly avoid impediments. In order to assure obstacle avoidance, the robot combines motor control with sophisticated algorithms in addition to ultrasonic sensors for obstacle detection. This experimental and instructional platform's main features, development methodology, and future growth prospects are all described in the abstract. Autonomous navigation, surveillance, and other robotic applications are just a few of the uses for the multipurpose obstacle avoidance robot car, which also makes a great introduction to robotics. Avoiding obstacles Robots are made to navigate through unfamiliar environments by dodging obstacles. Robot that avoids impediments in its route detects them, avoids them, and continues going. Robot navigation techniques include wall-following, edge recognition, line-following, and many others that are quite popular. Edge detection is the foundation of a more widely used and universal approach to obstacle avoidance. One drawback of edge-based obstacle avoidance is that the robot must halt in front of an obstruction to obtain a more precise measurement. Every mobile robot has some sort of collision avoidance, from simple algorithms that identify an obstruction and halt the robot to more complex systems that use complicated algorithms to prevent collisions. In the rapidly evolving field of robotics, the integration of cutting-edge technologies plays a pivotal role in advancing the capabilities of autonomous systems.

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The application of ESP32 camera and YOLO (You Only Look Once) object recognition represents a significant stride in enhancing the functionality of a multifunctional obstacle avoidance Arduino robot car. The ESP32 camera, integrated into the robot, serves as a dynamic visual sensor, enabling real-time capture of the surrounding environment. This visual data is then processed by the YOLO object recognition system, which imparts the robot with the ability to swiftly and accurately identify and categorize objects. By seamlessly combining these technologies with motor control, sophisticated algorithms, and ultrasonic sensors, the robot achieves a robust obstacle avoidance mechanism.

II. LITERATURE SURVEY

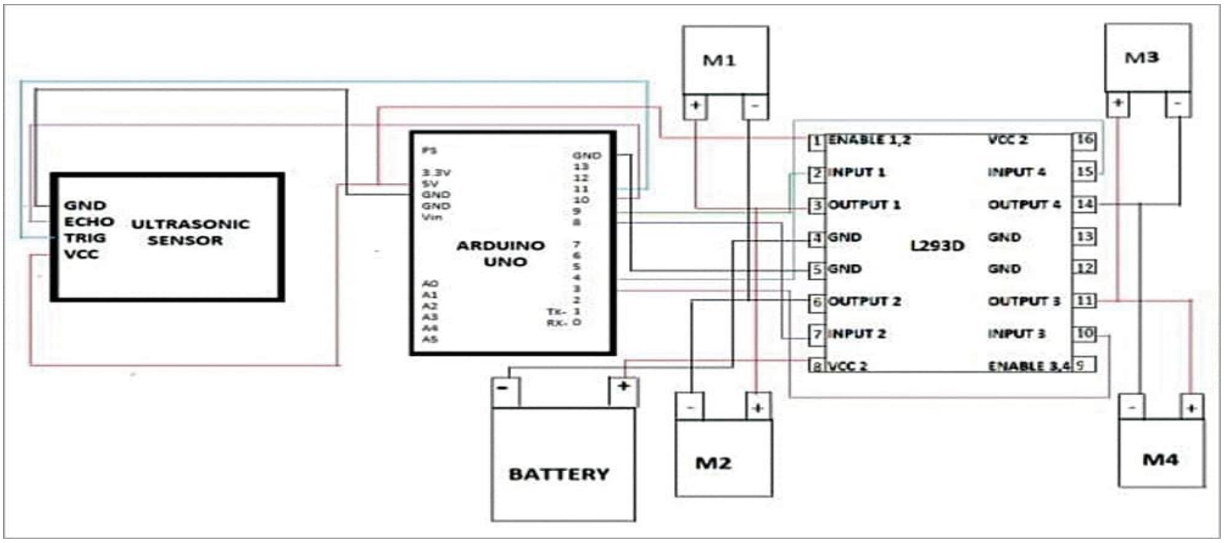
"An Ultrasonic line follower robot to detect obstacles and edges for industrial rescue operations" has been designed and developed by Vicky Barua, Md. Arif Isteik Neloy, Shahid Uddin Rahat, Mithun Das, Md. Shafiul Islam Joy, Abhijit Pathak and Nazmun Nahar. They developed a prototype of robot for industrial use. Their robot is smart and intelligent and has more benefits as it does not consume much power. While their approach effectively detects obstacles and edges along a predefined path, the integration of ESP32 camera and YOLO object recognition in our project introduces a more comprehensive and real-time visual perception to enhance obstacle avoidance capabilities. Their robot follows the pre-defined path(line), intelligently senses the obstacles and edge in its path. Then, it avoids the obstacle and navigates according to the behaviour that have been set for it [3].

"Obstacle Avoidance Robotic Vehicle Using Ultrasonic Sensor, Android and Bluetooth for Obstacle Detection" has been designed and developed by Vaghela et.al has mentioned that enormous amount of work has been done on wireless gesture controlling of robots. Various methodologies have been analyzed and reviewed with their merits and demerits under various operational and functional strategies. Thus, it can be concluded that features like user friendly interface,light weight and portability of android OS based smart phone has overtaken the sophistication of technologies like programmable glove etc., making them obsolete. Although recent researches in this field have made wireless gesture controlling a ubiquitous phenomenon, it needs to acquire more focus in relevant areas of applications like home appliances, wheelchairs, artificial nurses, table top screens etc. in a collaborative manner emphasizes wireless gesture control using technologies such as Android and Bluetooth. In our project, the ESP32 camera coupled with YOLO object recognition goes beyond traditional gesture-based control, providing the robot with the ability to intelligently recognize and navigate around obstacles, offering a more dynamic and adaptive solution. [3].

"line follower and obstacle avoidance bot using arduino" has been designed and developed by Aamir attar, Aadil ansari, Abhishek desai, Shahid khan, Dipashrisonawale to create an autonomous robot which intelligently detects the obstacle in its path and navigates according to the actions that user sets for it. The incorporation of ESP32 camera and YOLO in our project builds upon this foundation, providing a more sophisticated and efficient means of identifying obstacles through visual data processing, thereby enhancing the overall functionality of the robot.. So this system provides an alternate way to the existing system by replacing skilled labor with robotic machinery, which in turn can handle more patients in less time with better accuracy and a lower per capita cost.[2]

III. METHODOLOGY

The basic block diagram for the implementation of the project is as shown in figure1.



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In the process of creating, building, and programming an autonomous robot, to assess literature in the domains of engineering, mechatronics, and software development. Numerous studies on engineering, mechatronics, and software development have been conducted in relation to the creation of robotic cars. A variety of computer science topics have been covered as a result of exposure to comparable investigations concerning obstacle avoidance, including software creation and the assembly of diverse parts needed to complete the project work utilizing an organized circuit design. We developed an appropriate technique for the project and were able to have a solid understanding of the study.

The following conditions must be met in order to fulfill the goal of identifying barriers in an environment:
(a) The HR-SC04 Model ultrasonic sensor is the main component of the obstacle sensing unit.
(b) The Angle Scanning Unit is made up of a servomotor that is attached to a hanger and coupled to a sensor. The sensor is positioned both linearly and angularly by use of this rotary motor.

Features of Ultrasonic Sensor: Non-contact detection, All-weather operation ,Transparency detection, Wide range of detection distances, High accuracy, Low cost.
The following are necessary for the robot to do tasks utilizing the real-time system:

(a) The Comparator Unit sends the output voltage to the microcontroller, which is the robot's decision-making unit, after comparing the sensor voltage with a reference value.
(b) Signal Processing Unit: composed of a microcontroller with function software pre-installed to assist in decision-making.

Other component : Esp32 Camera for Yolo object recognition.
The ESP32 camera was strategically incorporated to provide real-time visual data capture, allowing the robot to interpret its surroundings dynamically. This addition significantly expanded the robot's perceptual capabilities, serving as a key component in the obstacle sensing unit. Concurrently, the YOLO (You Only Look Once) object recognition system was employed to swiftly and accurately identify and categorize obstacles. This approach involved integrating the camera and YOLO within the Angle Scanning Unit, enhancing both linear and angular positioning through a servo motor.

Moreover, the real-time decision-making process was bolstered by the Comparator Unit, which compared the output voltage from the obstacle sensing unit with a reference value. The microcontroller, acting as the robot's decision-making unit, received this information and determined the appropriate course of action. The Signal Processing Unit, comprising a pre-installed function software on a microcontroller, played a crucial role in assisting the robot in decision-making based on the received sensor data. These advancements, involving the ESP32 camera and YOLO object recognition, not only contributed to the fulfillment of the project's goal but also enriched the robot's adaptive capabilities in navigating diverse environments. References to relevant literature and studies in engineering and mechatronics informed and validated these technological integrations, ensuring a comprehensive and well-informed methodology for the development of the multifunctional obstacle avoidance robot.

IV. APPLICATION

Obstacle avoiding robots can be used in almost all mobile robot navigation systems. They can be used for household work like automatic vacuum cleaning, It can be used as a movable Surveillance System, It can be controlled by voice and Bluetooth, It does not require Man Power, It can be used for critical application like flood, bomb disposal, Fire, Terrorist attack, Earth quake, Spying, Obstacle avoidance robot car is design to allow robot to navigate in unknown environment by avoiding collisions, Obstacle avoiding robot car senses obstacles in the path ,avoid it and resumes its running. They can also be used in dangerous environments, where human penetration could be fatal.

V. PROPOSED SYSTEM & FLOWCHART

Diagram showing the obstacle avoidance robot's process flow. It checks obstacles that are 30 cm away at first. It will stop traveling, pivot to the left, and look for anything that is closer than 30 cm if there is an obstruction. It might be either yes or no depending on the check. In other words, yes, there is an item that is closer than 30 cm. That is to say, nothing within 30 cm has been found. The robot can go without obstruction if there is nothing within a 30-centimeter radius. Robotic obstacle avoidance is required if there is anything closer than thirty centimeter, Robot halt. This is the first step toward avoiding obstacle. The robot is about to crash if you don't stop it now.

Sensing by camera to show obstacle and then deciding to moving ahed or not. Yolo recognizes object which are found. We are using some components to fulfil the robot car respectively, Arduino uno board , L293D motor driver, ultrasonic sensor, Bluetooth module, servo motor, gear motor, robot wheel, Li-ion battery and holder, jumper wires, Foam board or cardboard.

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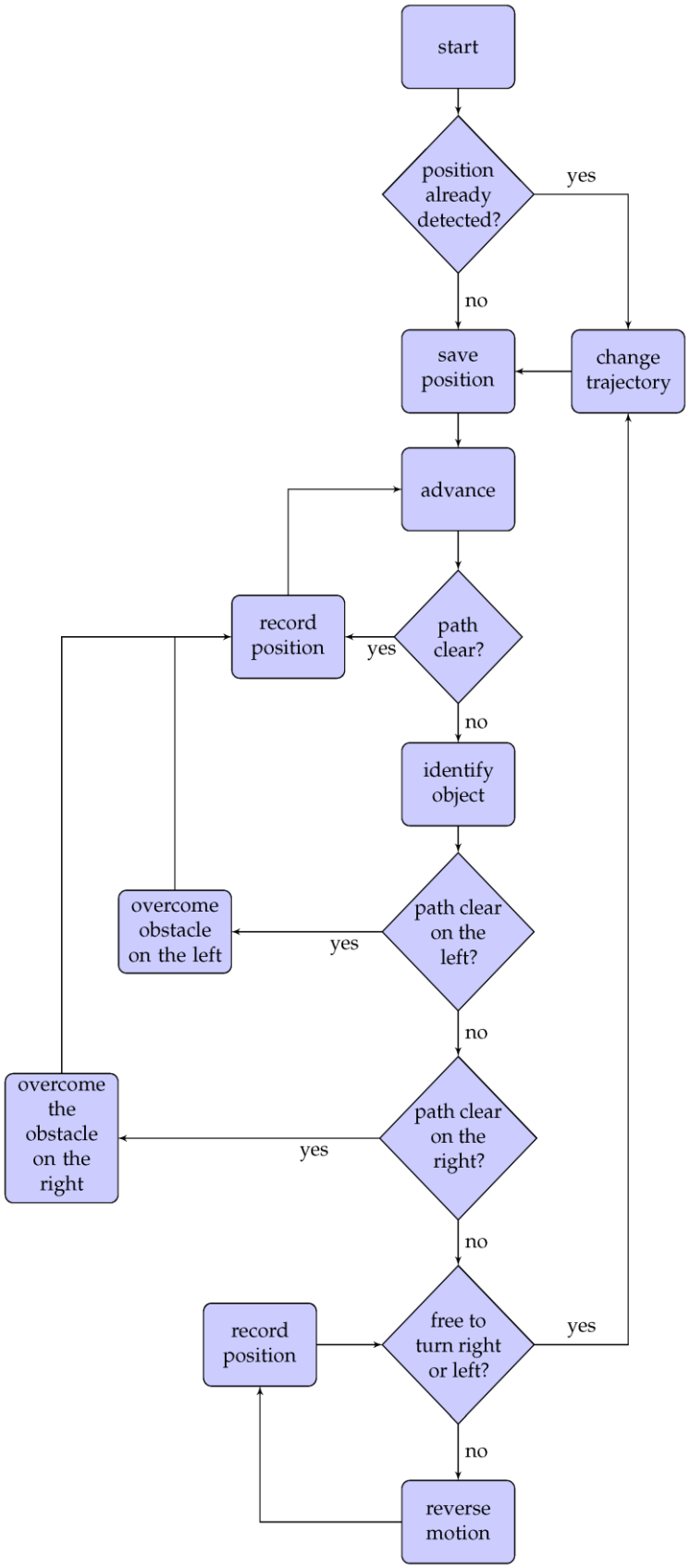

Fig. 2. Flow chart of obstacle avoidance robot

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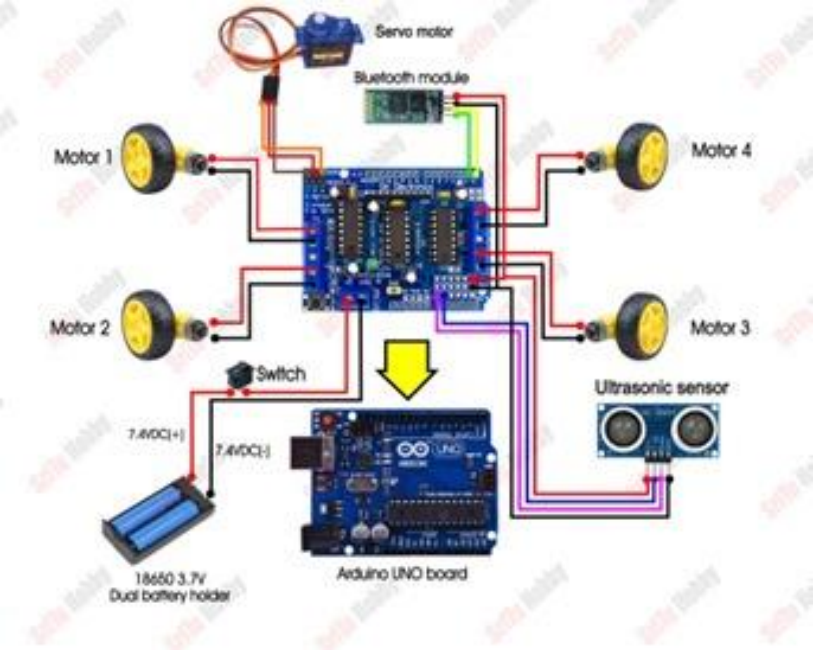
After the car starts moving and identifies a path to proceed, it employs ultrasonic sensors for obstacle detection. If an obstacle is detected, the robot utilizes the ESP32 camera in conjunction with the YOLO algorithm to recognize and categorize the obstructing object. Depending on the recognition results, the robot dynamically adjusts its movement strategy, deciding whether to move forward, turn right, turn left, or move backward. In the absence of obstacles, the robot continues its forward, right, left, or backward movement. This process repeats cyclically, ensuring that the robot responds promptly to obstacles detected by the ultrasonic sensor and analyzed by the ESP32 camera with the YOLO algorithm.



VI. RESULT

The product of this thesis is a basic robot vehicle that is driven by an Arduino board and travels about, identifying and dodging obstacles. The ultrasonic sensor projects an ultrasound wave to the left , right , and front when the robot is in operation. The wave bounces back after hitting an obstruction, storing the distance in its front, right, and left positions. Subsequently, the microcontroller applies its algorithm to the values and decides whether to proceed or alter course. navigating its environment with the capability to detect and evade obstacles.

A pivotal addition to this system is the integration of an ESP32 camera and YOLO (You Only Look Once) object recognition. In conjunction with the ultrasonic sensor, which emits ultrasound waves to the left, right, and front during the robot's operation, the ESP32 camera plays a crucial role in expanding the robot's perceptual range. By capturing real-time visual data, the ESP32 camera enhances the robot's ability to identify obstacles with greater precision and in a broader field of view.

The fusion of ultrasonic sensors, ESP32 camera, and YOLO object recognition within the robot's control system underscores a holistic approach to obstacle avoidance. The robot's microcontroller utilizes a sophisticated algorithm, integrating data from ultrasonic sensors, ESP32 camera, and YOLO, to make informed decisions on navigation, contributing to an adaptive and responsive robotic system.

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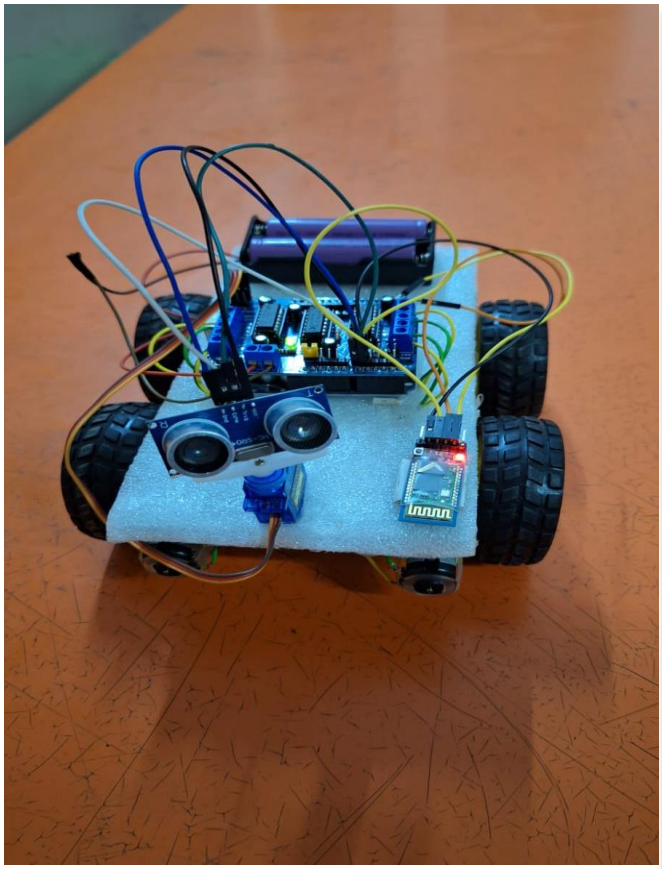

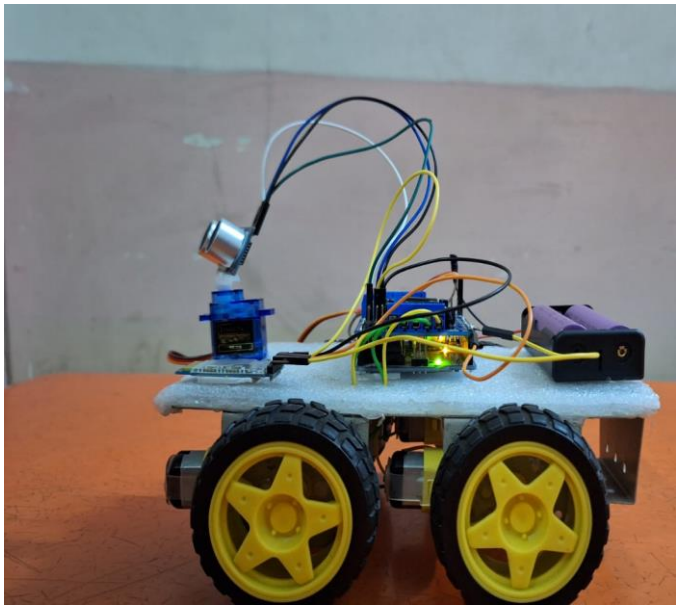

VII. CONCLUSION

In conclusion, our project has successfully achieved the goal of creating a multifunctional Arduino robot car with voice and Bluetooth control, integrating ESP32 camera and YOLO object detection for advanced obstacle recognition. The autonomous robot, designed to recognize and navigate around obstacles, demonstrates flawless functionality, particularly excelling in interpreting voice instructions. The incorporation of an ESP32 camera and YOLO object detection significantly enhances the robot's intelligence, allowing it to precisely identify and avoid obstacles in its path.

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This project lays the foundation for autonomous robotic applications, and by extending the range and integrating additional cameras, the concept can be further refined for applications in military and home security. The successful implementation of two gear motors provides the fundamental walking motions, contributing to the robot's seamless motility or agility. The use of advanced technologies such as ESP32 camera and YOLO object detection showcases the potential for creating highly intelligent robots capable of intricate obstacle avoidance.

The combination of voice and Bluetooth control, along with advanced obstacle avoidance capabilities, establishes a robust platform for the exploration of diverse applications, making this project a significant step forward in the development of intelligent and adaptable robotic systems.

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