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OBSTACLE AVOIDING ROBOTIC VEHICLE

Mr. P. MANI MOHAN*,V. GURU VENKATA NARAYANA**, K. CHITTI BABU***, A. HARI****,

K. GANESH*****,P. BHARATH KUMAR******

(Associate Professor, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India)1

(B.Tech. IV Year Student, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India) 2
(B.Tech. IV Year Student, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India) 3
(B.Tech. IV Year Student, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India) 4
(B.Tech. IV Year Student, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India) 5
(B.Tech. IV Year Student, ECE Dept, Siddartha institute of science and Technology, Puttur, A.P, India) 6
(Email.id: -kchittibabu2003@gmail.com)

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Abstract:
The project is design to build an obstacle avoidance robotic vehicle using ultrasonic sensors for its movement. A Raspberry pi is used to achieve the desired operation. A robot is a machine that can perform task automatically or with guidance. Robotics is a combination of computational intelligence and physical machines (motors). Computational intelligence involves the programmed instructions. The project proposes robotic vehicle that has an intelligence built in it such that it directs itself whenever an obstacle comes in its path. This robotic vehicle is built, using a raspberry pi. An ultrasonic sensor is used to detect any obstacle ahead of it and sends a command to the microcontroller. Depending on the input signal received, the micro-controller redirects the robot to move in an alternate direction by actuating the motors which are interfaced to it through a motor driver.

Keywords **—**Raspberry-pi, Ultrasonic Sensor, Bluetooth Module, Motor Driver

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I. INTRODUCTION

The aim of this project is to design and develop an obstacle-avoiding robotic vehicle utilizing the capabilities of Raspberry Pi 4. With a focus on autonomy and environmental adaptability, the vehicle will navigate through predefined paths while dynamically avoiding obstacles in its path. This endeavour merges hardware integration, software development, and algorithmic innovation to create a robust and versatile robotic platform. By harnessing the power of Raspberry Pi 4, coupled with motor drivers and ultrasonic sensors, the vehicle will exhibit intelligent decision-making capabilities, enhancing its efficiency and efficacy in real-world scenarios.

Central to this project is the integration of Raspberry Pi 4 as the brain of the robotic vehicle, orchestrating its movements and responses. The hardware setup encompasses the incorporation of motor drivers for precise control over wheel movements, as well as the mounting of ultrasonic sensors to facilitate obstacle detection and avoidance. Simultaneously, software development involves the implementation of algorithms for sensor data processing, enabling the vehicle to make informed decisions based on real-time inputs. Leveraging the versatility of Python programming language and the capabilities of a real-time operating system, the software stack will be tailored to ensure optimal performance and responsiveness.

Furthermore, this project involves crafting and integrating navigation algorithms, enabling the vehicle to independently navigate through its surroundings while sidestepping obstacles. Stringent testing protocols will be implemented to assess the durability of the vehicle's navigation and obstacle evasion systems across various environments. Extensive documentation will accompany the project, covering hardware schematics, software architecture, assembly guidelines, and testing methodologies.

II. LITERATURE SURVEY

P. Narendra Ilaya Pallavan, S. Harish, C. Dhachinamoorthi [1] "Voice Controlled Robot with Real Time Barrier Detection and Advertising" The study proposes a voice-controlled robot with real-time obstacle detection capabilities and integrated advertising features. User voice commands initiate the robot's movements and activities. Utilizing sensors, the robot identifies barriers or obstacles in its path, adjusting its route to navigate safely. Concurrently, it scans its surroundings for advertising opportunities through image recognition technology. Upon recognizing suitable advertising spaces, the robot showcases targeted advertisements on its built-in display screens or through audio announcements. An algorithm prioritizes navigation, ensuring safe traversal while optimizing advertising exposure. This system offers functional assistance and advertising services across various environments.

M. Çavaş and M. B. Ahmad [2] in their work "A Review on Spider Robotic System," introduce a robot that responds to vocal commands and is equipped with capabilities for real-time obstacle avoidance and built-in advertising features. The robot follows user instructions for movement and other tasks, utilizing integrated sensors to detect and navigate around obstructions. Concurrently, it uses image recognition to scan its surroundings for potential advertising locations. When it identifies appropriate spots, it can display custom advertisements either on its screens or through audio messages. The system incorporates a prioritization algorithm that ensures the robot navigates safely while effectively maximizing exposure to advertising opportunities. This system offers both functional aid and promotional functionalities in various environments.

S. Lai, M. Lan, and B. M. Chen [3] "Model Predictive Local Motion Planning with Boundary State Constrained Primitives" The innovative concept of Model Predictive Local Motion Planning with Boundary State Constrained Primitives combines model predictive control (MPC) with boundary state constraints to advance motion planning in robotics. This approach utilizes predictive modelling to anticipate future states of a robotic system and generate optimal trajectories while respecting predefined boundary constraints. By integrating primitives, representing fundamental motion elements, with boundary constraints, the system can efficiently navigate intricate environments while ensuring safety and feasibility. This method shows great potential across various applications, including autonomous vehicles and robotic manipulation tasks, where precise and adaptable motion planning is crucial. Its capability to dynamically consider constraints makes it highly suitable for dynamic and uncertain environments, presenting a flexible solution to the complexities of robotic motion planning.

M. B. Ahmad et al. [4] "The Various Types of Sensors Used in the Security Alarm System"Security alarm systems rely on a range of sensors to detect and respond to potential threats. These include motion sensors for detecting movement, door and window sensors for monitoring entry points, and glass break sensors sensitive to the sound of breaking glass. Contact sensors detect openings and closures, while vibration sensors signal tampering or forced entry.

Pressure sensors monitor changes in pressure, and smoke, heat, carbon monoxide, and flood sensors provide early warning of hazards like fires or flooding. Outdoor sensors, such as motion detectors, extend coverage to outdoor areas, ensuring comprehensive security against diverse risks.

Hirose, F. Xia, R. Martín-Martín, A. Sadeghian, and S. Savarese [5] Deep Visual MPC-Policy Learning for Navigation represents a pioneering approach that marries deep learning techniques with model predictive control (MPC), facilitating autonomous navigation in intricate surroundings. This method harnesses the power of deep neural networks to analyse visual data captured by onboard cameras and construct predictive models of the environment. By fusing MPC with policy learning, the system can swiftly formulate optimal control strategies in response to real-time visual inputs, enabling agile and adaptable navigation. This innovative methodology holds tremendous potential across a spectrum of robotic applications, spanning from autonomous vehicles to drones, where precise perception and rapid decision-making are indispensable for navigating safely and efficiently amidst diverse and dynamic environments.

III. PROPOSED SYSTEM

The suggested robotic system incorporates an ultrasonic sensor as a key feature for detecting obstacles. Positioned strategically on the robot, the sensor uses ultrasonic waves to measure distances and pinpoint obstacles in its path. This capability is crucial for enabling the robot to navigate autonomously and avoid obstacles efficiently. The ultrasonic sensor provides instant feedback to the robot's control system, empowering it to make timely and informed movement decisions.

To improve the robot's versatility and control, a Bluetooth communication interface is integrated. This addition allows for remote control of the robot, providing a convenient method for users to guide its movements. Users can wirelessly send instructions to the robot via Bluetooth, directing it to execute specific manoeuvres or alter its path upon encountering obstacles.

BLOCK DIAGRAM:

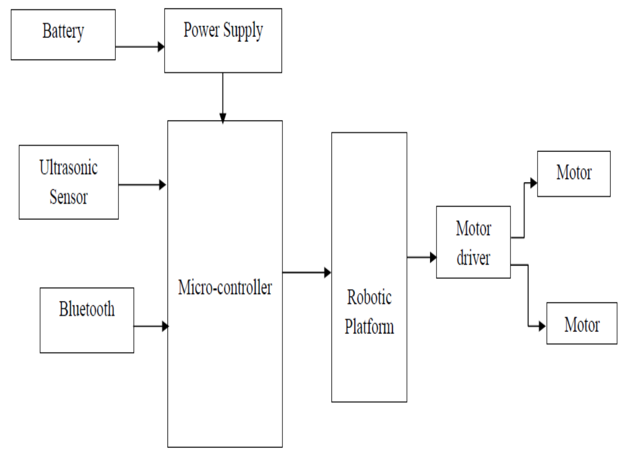

Fig: Block diagram of Proposed System

Implementation Method:

To construct an obstacle-avoiding robotic vehicle using a Raspberry Pi 4, begin by assembling the chassis, attaching the motors, wheels, and ultrasonic sensors. Connect both the motors and the sensors to the GPIO pins on the Raspberry Pi. Develop Python scripts to activate the sensors and manage the motor operations. Employ the ultrasonic sensors to detect any obstacles in the path of the vehicle. Design a logic system that enables the vehicle to navigate away from obstacles by varying the motor speeds as necessary. Constantly gather and analyse sensor data to dynamically adjust the direction of the vehicle in real time. Utilize PWM signals for precise control over the motor's speed and direction. Conduct trials in a controlled setting to optimize the vehicle's ability to avoid obstacles. Once satisfactory performance is achieved, the robotic vehicle can be deployed for practical uses such as conducting surveillance or carrying out exploration tasks.

IV. HARDWAREDESCRIPTION

1.**Robotic Platform:**
The robotic platform serves as the base structure of the vehicle, providing a foundation for mounting all other components. It typically consists of a rigid frame that supports the motors, wheels, sensors, and the control system.

2.**Battery Socket:**
The battery socket is a crucial component that supplies power to the entire robotic system. It must be compatible with the battery type used (e.g., Li-ion, NiMH) and securely hold the battery in place to ensure a steady power supply under various operating conditions.

3. **Motors and Wheels:**
Motors provide the necessary mechanical power to drive the wheels, thus enabling the mobility of the robotic vehicle. The choice of motors (such as servo motors, stepper motors, or DC motors) depends on the required precision, speed, and torque. Wheels are attached directly to the motors and are critical for maneuvering and stabilizing the robot.

4.**Motor Driver:**
A motor driver acts as an interface between the Raspberry Pi and the motors. It regulates the power from the battery to the motors based on the commands sent from the Raspberry Pi. This component is essential for controlling the speed and direction of the motors.

5. **Ultrasonic Sensor:**
Ultrasonic sensors are used to detect obstacles by emitting ultrasonic waves and measuring the time it takes for the echoes to return. This sensor is fundamental for the obstacle avoidance capability of the robot, providing data to help the robotic system navigate around or through obstacles.

6.**Raspberry Pi:**
The Raspberry Pi is a small, powerful microcomputer that functions as the brain of the robotic platform. It processes inputs from the ultrasonic sensor and other sensors, and sends commands to the motor driver to control the robot's movements. The Raspberry Pi can run complex algorithms for navigation and can be programmed using Python or other programming languages suited for real-time control.

7.**HC-05 Bluetooth Module:**
The HC-05 Bluetooth module facilitates wireless communication between microcontrollers and Bluetooth-enabled devices. It supports Bluetooth 2.0 with up to 3 Mbps speed and can function as either a master or slave device. Configurable via AT commands, it allows adjustment of settings like device name and baud rate. Typical range is approximately 10 meters, but can extend with a clear line of sight. This module is essential for projects requiring simple, effective wireless communication.

Each of these components plays a vital role in ensuring the functionality and efficiency of the robotic platform, making it capable of performing tasks such as surveillance, exploration, or automated transport in a variety of environments. By integrating these components effectively, the robotic platform can operate autonomously, react to its environment, and perform tasks as programmed.

V. SOFTWARE DESCRIPTION

Python:

Python is an integral part of the Raspberry Pi ecosystem due to its simplicity and power. It's an interpreted, high-level programming language that emphasizes code readability and simplicity, making it ideal for beginners and professionals alike. Python's comprehensive standard library supports a wide range of programming tasks from basic arithmetic to complex computing.

Python Implementation:

Python serves as the backbone of our OBSTACLE AVOIDING ROBOTIC VEHICLE project, facilitating seamless communication and control between its various components. Operating on the Raspberry Pi, Python scripts manage the HC-05 Bluetooth Module, enabling wireless control of the vehicle. Additionally, Python efficiently processes data from the ultrasonic sensor, ensuring timely obstacle detection and navigation adjustments. Through PWM signals, Python governs the motor driver, dictating precise motor movements based on sensor inputs and remote commands. Python's versatility and extensive library support make it indispensable for orchestrating the intricate interactions within our robotic vehicle, ensuring its smooth and efficient operation.

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VI. RESULTS:

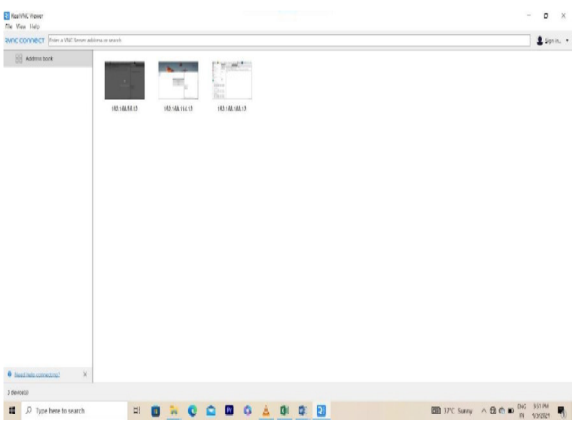

Fig: Project interface

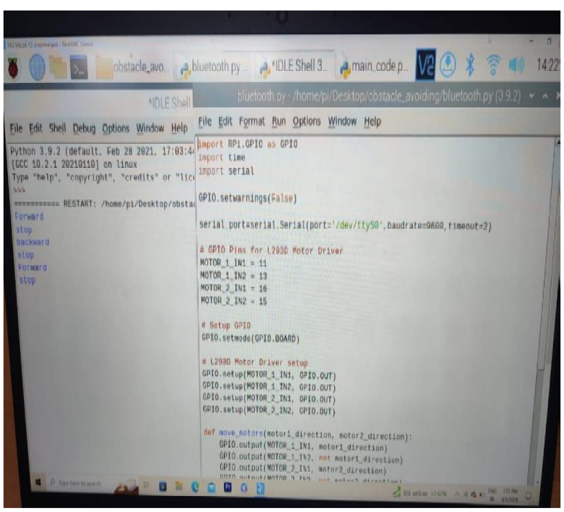

Fig: Python code interface

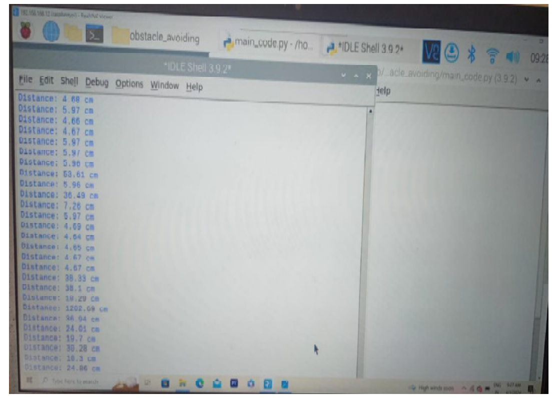

Fig: 5.3 output distance measured

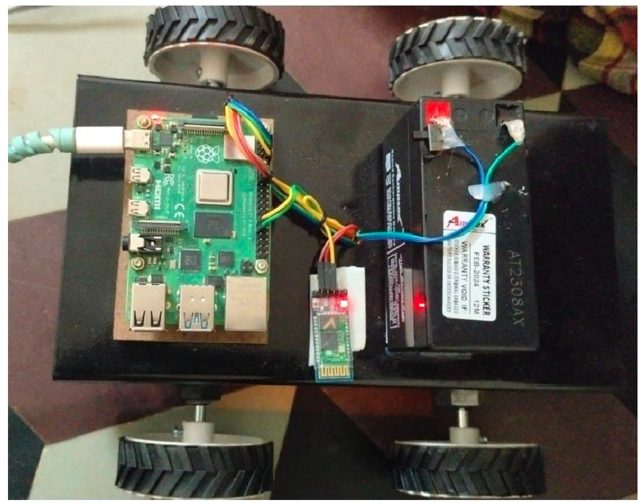

Fig: Obstacle avoiding robotic vehicle kit

VII. CONCLUSION& FUTURE SCOPE

The proposed modular design strategy for implementing the firefighting robot demonstrates its effectiveness in aiding people during critical situations. Capable of moving in multiple directions and equipped with obstacle avoidance capabilities, it significantly reduces human efforts and helps protect property. Looking ahead, employing Raspberry Pi 4 or similar platforms in obstacle-avoiding robotic vehicles holds immense promise. Future advancements may focus on enhancing sensing capabilities with technologies like LiDAR and thermal imaging, integrating machine learning for intelligent navigation, and implementing multi-agent systems for collaborative tasks. Additionally, advancements in autonomous navigation, IoT integration, and swarm intelligence can further improve functionality and scalability. Emphasizing energy efficiency, sustainability, and enhancing human-robot interaction will be crucial for developing more capable and widely applicable robotic systems in the future.

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