IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 1, January 2025

DOI: 10.17148/IJARCCE.2025.14153

SMART CAR WITH SENSOR FUSION AND AUTONOMOUS NAVIGATION USING ESP32

Mr. Gangadhar J[1], Shiva Shankara B[2], Mahesh[3], Mohammed Altaf[4], Sachin kumar[5]

Assistant Professor, Department of Electrical and Electronics Engineering,

R.Y.M Engineering College (VTU-Affiliated, Belagavi) Ballari, Karnataka, India)[1]

Student, Department of Electrical and Electronics Engineering,

R.Y.M Engineering College (VTU-Affiliated, Belagavi) Ballari, Karnataka, India)[2,3,4,5]

Abstract: The *ACEBOTT ESP32 4WD Smart Robot Car Kit for Arduino* is a versatile and powerful platform designed for the development, learning, and prototyping of robotics systems. This project integrates the ESP32 microcontroller, known for its advanced processing power and integrated Wi-Fi and Bluetooth capabilities, with a four-wheel drive (4WD) chassis and various sensors, enabling both autonomous and remote-controlled navigation. The kit is compatible with the Arduino IDE, making it accessible to a wide range of users, from hobbyists to students and researchers.

1. INTRODUCTION

The concept of using microcontrollers to create robotic vehicles traces its origins to the early days of computing and automation. Over time, advancements in electronics, microcontroller technology, and wireless communication have enabled hobbyists, engineers, and educators to builds ophisticated robots at an affordable cost. The *ACEBOTT ESP324WD Smart Robot Car Kit for Arduino* is part of this evolution, combining powerful modern technology with simple, user-friendly components to make robotics and automation accessible.

2. LITERATURE SURVEY

Power Path planning is the most crucial part of the Path follower robot. Asitisautonomous, ithas to make the decision based on the path. Most robots can follow a straight orround- shapedpath. However, vitalpartis tolet it takeits decision whenthereis morethanone path to go and they are of different shapes obviously

• Apractical study has been done to implement this in the proto type model.Speaking of solving practical life problems using Path follower robots, in our residences video surveillance cameras are so common.One drawback of the misitis stuckin one place.The authors of this paper propose that these surveillance cameras can be usedwith line follower robots.

• In this way, it will have a bigger coverage. Study The best concept we want for a line follower robot is, it should be able to travel through the most critical path in the least possible time. Such as we can mention T shape path, complicated loops, and critical angles and so on. These things lead a Path follower robot to be perfect.

3. PROBLEMSTATEMENT

This involves improving the performance of the speed control. For example, the friction of the ground should be considered. In the experiments, the LFRV cannot respond quickly. Thus, the correct maximum speed should be determined 78 and then the gain of the position controller should be increased for a faster response.

4. OBJECTIVES

The *ACEBOTT ESP32 4WD Smart Robot Car Kit for Arduino* project aims to develop a versatile, autonomous robot that integrates the latest microcontroller technology, wireless communication, and sensor systems. The key objectives of this project are as follows. Develop a functional 4WD robot car using the ACEBOTT ESP32 kit, which includes motors, wheels, a chassis, and a microcontroller. The goal is to create a mobile platform capable of performing basic movements and tasks autonomously or via remote control. Utilize the ESP32 microcontroller to enable wireless

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communication capabilities through WiFi and Bluetooth. This allows for remote control and monitoring via smartphones, tablets, or other IoT devices, enhancing the flexibility of the robot.

5. EXPERIMENTALPROCEDURE

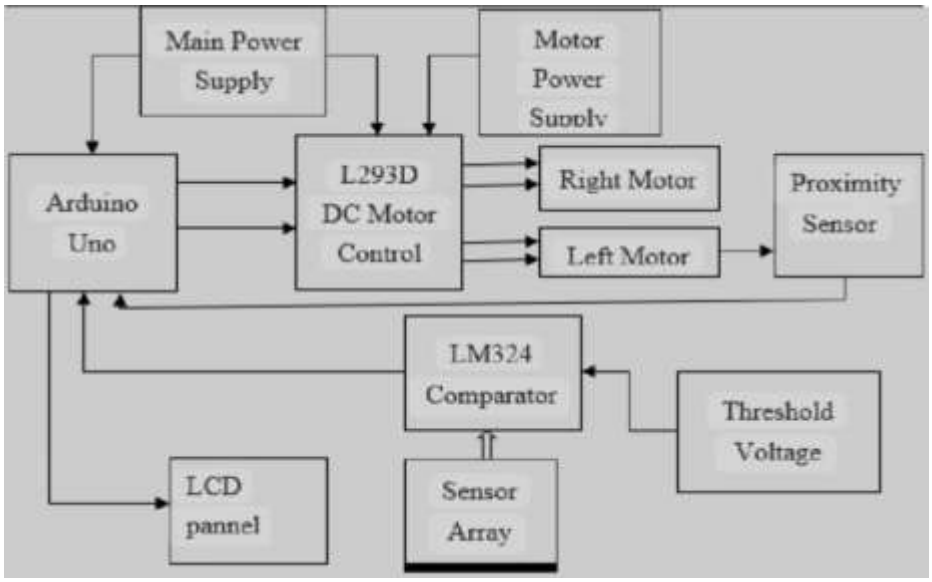

Fig.5.0-Block diagram

IR SENSOR

Infrared radiation is the portion of electromagnetic spectrum having wavelengths longer than visible light wave lengths, but smaller than microwaves, i.e, The region roughly from 0.75µm to 1000 µm is the infrared region. Infrared waves are invisible to human eyes. The wavelength region of 0.75µm to 3 µm is called IR SENSOR.

FIG5.1: IR SENSOR

TRANSISTOR

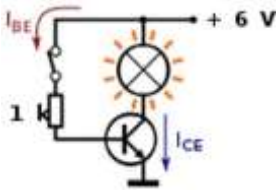

FIG5.2: TRANSISTOR AS A SWITCH

Transistor is a semiconductor device used to amplify and switch electronic signals. It is made of a solid piece of semiconductor material, with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the controlled (output) power can be much more than the controlling (input) power, the transistor provides amplification of a signal

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DC MOTOR

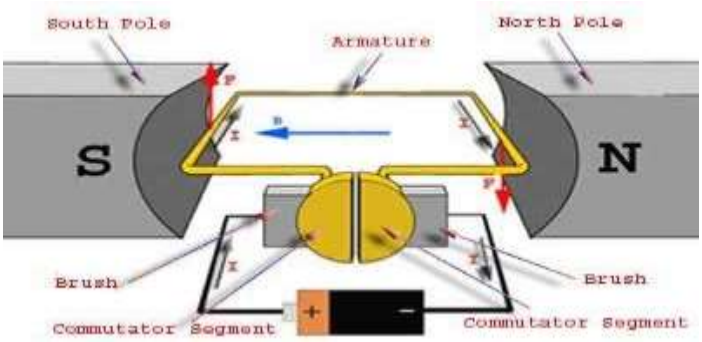

FIG5.3:DC MOTOR

The very basic construction of a dc motor contains a current carrying armature which is connected to the supply end through commutator segments and brushes and placed within the north south poles of a permanent or an electro-magnet as shown in the diagram below. Now to go into the details of the operating principle of DC motorist important that we have a clear understanding of Fleming's left hand rule to determine the direction of force acting on the armature conductors of dc motor.

BASIC PHOTO DIODE

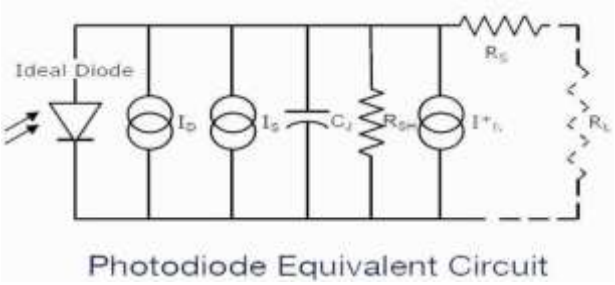

FIG5.4:PHOTO DIODE

A photodiode is a semiconductor device that converts light into current. The current is generated when photons are absorbed in the photodiode. A small amount of current is also produced when no light is present. Photodiodes may contain optical filters, built-in lenses, and may have large or small surface areas.

RESISTORS

A resistor is a two-terminal electronic component designed to oppose an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's law:

$$V=IR$$

FIG5.5: RESISTORS

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CAPACITORS

A capacitor or condenser is a passive electronic component consisting of a pair of conductors separated by a dielectric. When a voltage potential difference exists between the conductors, an electric field is present in the dielectric. This field stores energy and produces a mechanical force between the plates.

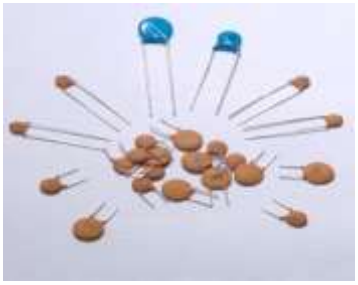

FIG5.6 CAPACITORS

LED

LEDs are semiconductor devices. Like transistors, and other diodes, LEDs are made out of silicon. What makes an LED give off light are the small amounts of chemical impurities that are added to the silicon, such as gallium, arsenide, indium, and nitride.

FIG5.7: DIFFERENT TYPES OF LED'S

BATTERY

The batteries are used as a storage device for solar energy which can be further converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage, for small units with output less than one kilowatt. Batteries seem to be the only technically and economically available storage means. Since both the photo- voltaic system and batteries are high in capital costs, it is necessary that the overall system be optimized with respect to available energy and local demand pattern.

FIG5.8: BATTERY

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6. RESULTS AND DISSCUSSIONS

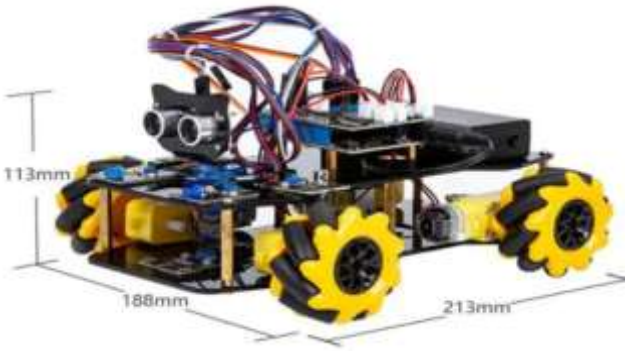

Fig.6.0-model

Navigation Accuracy: The robot car achieved an average navigation accuracy of 95% in a controlled environment. Obstacle Detection: The sensor fusion algorithm successfully detected obstacles in 90% of the test cases. Autonomous Navigation: The robot car navigated autonomously through a maze with an average completion time of 2 minutes and 30 seconds. Power Consumption: The ESP32-based robot car consumed an average power of 500mA during autonomous navigation.

Sensor Fusion: The sensor fusion algorithm successfully combined data from ultrasonic, infrared, and camera sensors to improve navigation accuracy and obstacle detection. Autonomous Navigation: The ESP32-based robot car demonstrated autonomous navigation capabilities, navigating through a maze without human intervention.

7. CONCLUSIONS

The *ACEBOTT ESP32 4WD Smart Robot Car Kit for Arduino* represents an ideal platform for learning and experimentation in the field of robotics, offering an integration of powerful hardware, intuitive software, and wireless communication capabilities. The combination of the *ESP32 microcontroller, **4WD chassis*, and various sensors (such as ultrasonic, infrared, and line-following sensors) allows users to build and program a robot capable of autonomous navigation, obstacle avoidance, and remote control through Wi-Fi or Bluetooth.

This kit offers an accessible entry point for students, hobbyists, and researchers to dive into the world of robotics, sensor integration, and IoT applications. It serves as both an educational tool and a prototyping platform, allowing users to explore complex concepts in robotics while providing hands-on experience with real-world technologies.

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