ROBOTIC CAR

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Abstract— ***This capstone project presents the design and development of Robotic car, an intelligent robotic system designed with a compact car-like structure. The objective of the project is to create a functional robotic platform capable of performing basic automated tasks while demonstrating the practical application of robotics, embedded systems, and mechanical design.***

The robot is developed using a microcontroller-based control system integrated with sensors, motors, and a custom-designed outer body (car cover) to provide protection and structural stability. The mechanical chassis and shell are designed to ensure durability while maintaining an aesthetic and compact appearance. The system operates through programmed instructions that allow the robot to move, respond to environmental inputs, and perform predefined operations.

This project demonstrates how robotics can be implemented in small-scale automated systems and provides insights into the integration of hardware design, electronics, and programming. The development of Robotic car highlights the importance of practical engineering solutions in modern technological applications.

INTRODUCTION

Robotics has become one of the most important fields in modern technology, combining mechanical engineering, electronics, and computer programming to develop machines that can perform tasks automatically. Robotic systems are widely used in industries, healthcare, manufacturing, transportation, and research because they improve efficiency, accuracy, and safety.

The purpose of this capstone project is to design and develop a **robotic car**, a compact robotic system capable of performing automated movements using a microcontroller-based control system. The project focuses on integrating different components such as motors, sensors, electronic circuits, and a protective outer body to create a fully functional robotic platform.

The robotic car is designed to demonstrate the practical application of embedded systems and robotics concepts. The system receives programmed instructions through the controller and converts them into physical movement using motors and mechanical components. Sensors are used to interact with the surrounding environment, allowing the robot to respond to obstacles or other external inputs.

This project also emphasizes the importance of structural design by incorporating a custom-built outer shell that protects internal components while maintaining a compact and visually appealing structure. Through the development of this robotic car, the project showcases how different technological elements can be integrated to build a small-scale automated system.
Overall, the project aims to enhance understanding of robotics, system integration, and real-world engineering applications while providing hands-on experience in designing and building an intelligent robotic platform.

LITERATURE SURVEY

Overview of Robotic Vehicle Research

Robotic vehicles have been widely studied in the field of robotics and automation. These systems combine mechanical structures, electronic components, sensors, and embedded software to perform autonomous or semi-autonomous operations. Mobile robots such as robotic cars are commonly used as experimental platforms for studying navigation, obstacle avoidance, and intelligent control systems.

According to **Thrun et al. (2006)**, autonomous vehicles rely heavily on sensor fusion and real-time data processing to navigate complex environments safely. Their research demonstrated how robotic vehicles can integrate sensors and algorithms to operate without human intervention.

Similarly, **Siegwart and Nourbakhsh (2011)** discussed the fundamental principles of mobile robotics including perception, localization, and motion control. Their work explains how robots collect environmental information through sensors and convert it into movement commands using embedded controllers.

Research by **Borenstein and Koren (1991)** focused on obstacle avoidance techniques for mobile robots. They proposed the Vector Field Histogram (VFH) method which allows robots to detect obstacles and select a safe direction of movement in real time.

These studies show that robotic cars serve as an effective platform for understanding autonomous navigation, sensor integration, and control systems.

METHODOLOGY & IMPLEMENTATION

Step 1: Start the system and initialize all hardware components such as camera, lighting system, and processing unit.

Step 2: Capture the PCB image using the camera module.

Step 3: Perform image preprocessing which includes noise removal, grayscale conversion, and contrast enhancement.

Step 4: Apply image processing or deep learning algorithm to analyze the PCB image.
Step 5: Extract features or classify defects using trained machine learning or deep learning models.

Step 6: Compare detected results with reference PCB standards.

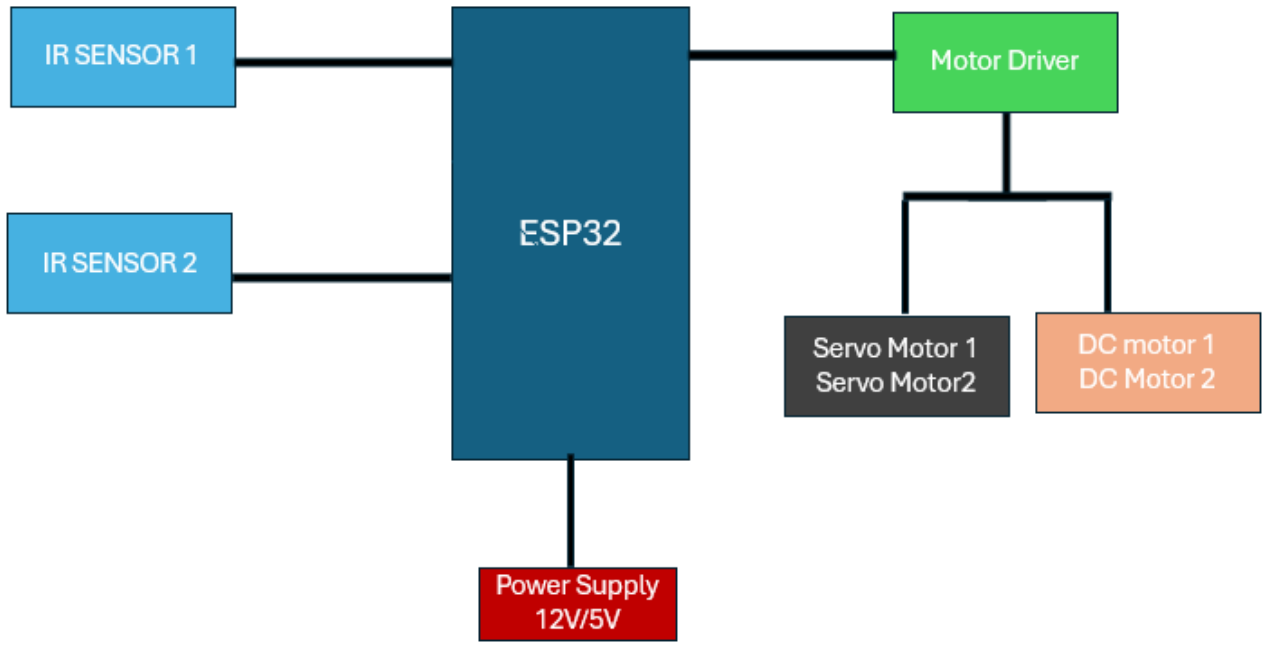
Step 7: If defects are detected, display the defect type and location on the screen and store the data in the database.

Step 8: If no defects are detected, mark the PCB as accepted.

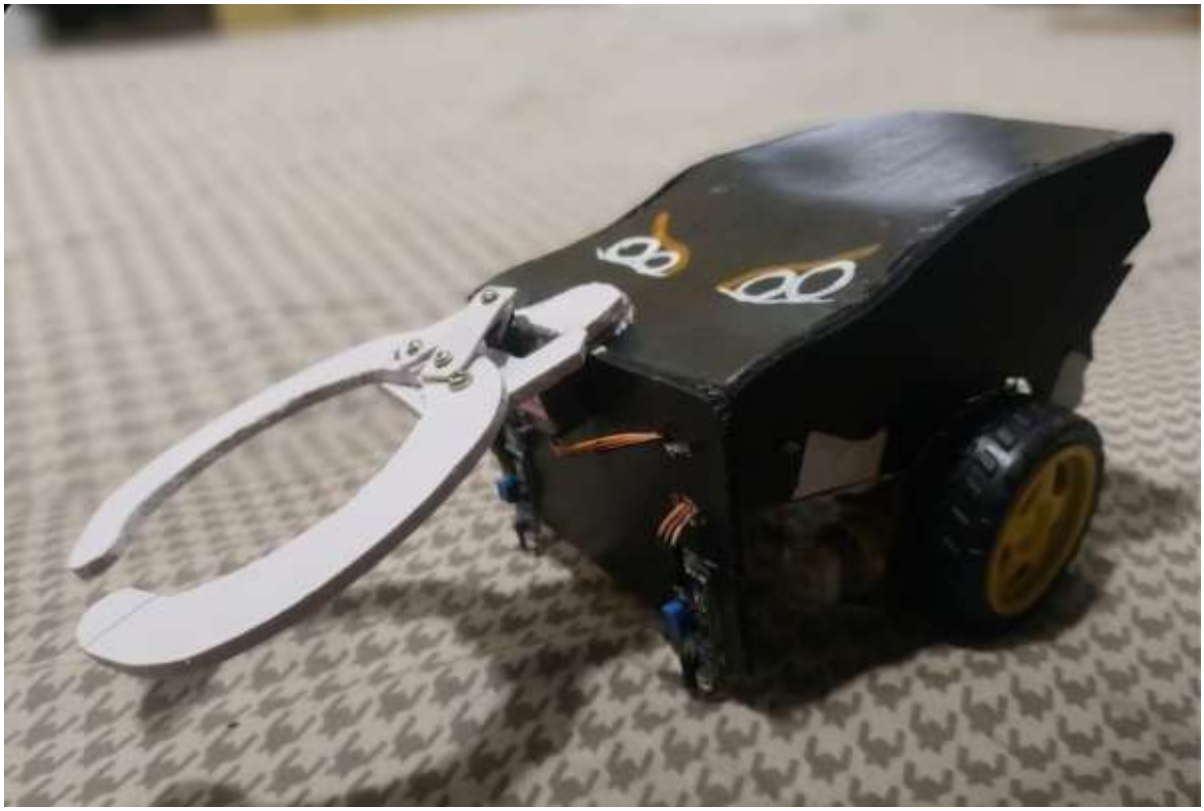
Step 9: Repeat the process for the next PCB.

Step 10: Stop the system when the inspection process is completed.

A. Block Diagram



RESULTS



OUTPUT

Conclusion

PCB inspection is a crucial process for maintaining product quality and manufacturing reliability. Traditional inspection methods are simple but inefficient for modern electronic systems. Image processing and machine learning techniques have improved automation and accuracy, while deep learning-based approaches represent the most advanced solution with superior performance. Although challenges related to cost and data availability still exist, continuous advancements in artificial intelligence and computing technologies are expected to make automated PCB inspection systems more accessible and efficient in the future.

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