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PICK AND PLACE ROBOTIC ARM VEHICLE USING ESP32 CONTROLLED BY BLUETOOTH

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ABSTRACT :
With the rapid development of technology, people are trying to swap out almost all of human jobs with robots. Robots outperform humans in terms of speed, efficiency, and accuracy. Robots are frequently utilized for tasks that are hazardous, repetitive, or unpleasant. A Pick and Place Robotic Arm vehicle is an automated system, which manipulates objects via a ESP32 and Bluetooth control. With the help of servo motors, which allow for multi-axis movement, the arm can precisely pick up, move, and reposition objects. iOS or Android app sends commands over Bluetooth to a microcontroller, like AT89C51 or ESP32. It increases productivity, decreases manual work, and shows how wireless communication and embedded systems can be used for real-time control.
Keywords: ESP32 micro-controller, LiPo battery

INTRODUCTION:

A pick-and-place robotic arm vehicle is a mobile robotic system intended to carry out autonomous object manipulation and transportation. By combining a robotic arm and a motorized vehicle, it can pick up, move, and precisely arrange objects in a range of scenarios. These systems are widely used in hazardous processes where human involvement is either unsafe or insufficient, such as material handling, warehousing, and industrial automation. The robotic arm's multiple degrees of freedom (DOF), which enable flexible movement and object manipulation, are provided by servo motors. The vehicle itself is driven by DC motors, controlled by wired or wireless communication protocols like Bluetooth, Wi-Fi, or RF modules, and overseen by a motor driver circuit such as the L298N. An embedded controller, such as an ESP32, processes commands and executes motion sequences to make sure seamless coordination between mobility and arm actuation.

Advances in automation, artificial intelligence (AI), and sensor integration have led to an increase in the autonomy, accuracy, and efficiency of pick-and-place robotic arm vehicles. This study aims to explore the design, implementation, and optimization of such robotic systems with a focus on control mechanisms, efficiency improvements, and real-world applications. This research focuses on the hardware design, software implementation, and overall system performance of the robotic arm. The study also highlights the potential for future advancements, such as integrating artificial intelligence and computer vision for enhanced functionality.

LITERATURE REVIEW:

Aishwarya N. Reganti, B. Chiranjith Viswa Mohan, R. Mounica, V.K. Mitta1, and Surekha Ananthapalli [1] proposed a robotic arm that has four degrees of freedom (D.O.F.) and controlled wirelessly with four different methods: voice control, smartphone tilt control, remote control, and hand gestures. The QCRA has a maximum payload of 420 grams and an 11-meter Bluetooth range, among other restrictions and specifications. The results of the performance evaluation are encouraging, and possible uses are investigated. The effectiveness of an interactive Quad Control Robotic Arm (QCRA) that can help with picking up and placing objects at far-off places is examined in this study. The effectiveness of the Hand- Gesture Recognition System is evaluated by completing.

Aastha Sharma and Akratic Kaushik [2],presented a paper that addresses sensors which offer a way for collecting data about industrial operations and procedures. In order to transform a physical stimulus into an electronic signal that the manufacturing system can use, sensors are commonly used.

B. O. Omijeh and R. Uhunmwangho[3], proposed Design Analysis of a Remote Controlled 'Pick and Place' Robotic Vehicle. They presented an in-depth examination of a robotic system intended for remote operation in dangerous situations. The vehicle can move through a variety of terrains and carry out activities including grabbing, lifting, placing, and releasing goods thanks to its five-degree-of-freedom robotic arm that is mounted on a mobile platform with four operating wheels.

Md. Anisur Rahman, Alimul Haque Khan, Dr. Tofayel Ahmed, and Md. Mohsin Sajjad[4], presented a five-degree-of- freedom (5-DOF) robotic arm that replicates human arm movements .The study addressed here is based on the robotic arm's kinematic structure, control systems, torque calculations, and mechanical design.

Priyambada Mishra, Riki Patel, Trushit Upadhyaya, and Arpan Desai [5]presented the design and implementation of a robotic arm controlled via an Arduino Uno microcontroller.Because cardboard is used in its construction, the robotic arm is inexpensive and lightweight. With the help of four servo motors that function as joints, it has four degrees of freedom (DOF). These servo motors, which rotate between 0 and 180 degrees, were chosen because they require little torque and can handle light things. The project's focus on accessibility and simplicity is further highlighted by the use of low-torque servos and cardboard.

Shotaro Gushi, Hiroki Higa, Hideyuki Uehara, and Takashi Soken [6] proposed a movable robotic arm for patients with severe impairments is described in this study. A computer, a display device, and an internet camera make up its user interface. The trial's findings demonstrated that the robotic arm system could successfully transfer more than 82% of the soup and water from the soup bowl. To reduce the amount of soup that stays in the bowl, the eat-up signal should be strengthened and the bowl tilted. Future research will require additional trials involving individuals with severe disabilities.

Rovný Oliver and Belda K [7] developed a model predictive control (MPC), a sophisticated local motion control technique for articulated robot arms used in manipulation operations. It provided kinematics and dynamics mathematical models and explains MPC design. The suggested solution is energy-efficient centralized control that recognizes the motion of the robot arm as a challenging task. The movable underframe will be the subject of modeling and experimental validation in later studies, and the final model will be incorporated into the overall control target.

Mohammed Hayyan Alsibai, Abdul Nasir Abd Ghafar, and Mohannad Farag [8] Expanded the application of computer vision to robotic grasping and positioning. A SCARA robot was used as a hardware platform with a Chameleon3 USB3 camera to locate circular holes in an input image.

Wenfu Xu, Guo Yang, Peng Wang, Liang Han, and Peng Kang [9] proposed a novel design for a multipurpose mobile robot manipulation system . This device consists of a mobile platform and a seven-DOF robotic arm that can be adapted to the task by changing the manipulator's end effector. The control system's hardware and software are also displayed, and numerous tests verify the system's operation. There are several disadvantages, though, such as a slow movement rate and an outdated control system.

OBJECTIVE:

The primary objective of this project is to develop and construct a robotic arm vehicle for pick-and-place that may be operated remotely with an ESP32 and a Bluetooth application. Among the main objectives are:

Automation of Object Handling: Design a robotic arm that can accurately grasp, lift, move, and position objects in predetermined areas.

Wireless Control via Bluetooth: Increase flexibility and usability by enabling remote control of the Bluetooth application

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PROPSED METHODOLOGY:

The pick-and-place robotic arm vehicle is a mobile robotic device that picks, moves, and positions objects using a robotic arm that is mounted on a wheeled platform and controlled via Bluetooth. Four servo motors, two DC motors, an L298N motor driver, and an ESP32 microcontroller are used in the system's construction to provide precise motion control and wireless operation. The ESP32 4P Dev Module is chosen as the main controller due to its many PWM-enabled GPIO pins, powerful processor, and built-in Bluetooth connectivity. This makes it ideal for real- time control of the robotic arm and vehicle's movement. It interprets commands from a mobile Bluetooth terminal app and uses them to control the actuators. The robotic arm's four servo motors are responsible for gripper operation, elbow bending, shoulder movement, and base rotation. The arm can be precisely positioned for precise object placement and picking thanks to these motors. The servos are controlled by PWM signals from the ESP32, ensuring smooth and coordinated motion. The wheels are driven by two DC motors, which enable the system to move forward, backward, left, and right.An L298N motor driver regulates the speed and direction of these motors using H- Bridge electronics. PWM signals are integrated to enable speed control, while ESP32 logic signals determine the movement's direction. Power is supplied by a rechargeable Li- ion or LiPo battery (7.4V–12V), and voltage regulators keep the ESP32 and servo motors at a constant 5V while delivering enough current to operate the motors. Appropriate power management is essential to avoid voltage swings that can affect motor performance. As part of the Bluetooth Serial Communication-based communication system, a user controls the robotic arm and vehicle using a mobile terminal app (like an Arduino Bluetooth Controller or Bluetooth Serial Monitor). Commands like "F" for forward motion, "B" for backward motion, "L" for left turns, and "R" for right turns are used to control the vehicle. 'O' opens the gripper, and 'C' closes it.The procedure is carried out step-by-step. First, the hardware is assembled, with the servos, motor driver, ESP32, and power connections all checked for correct wiring. During the software development stage, an embedded program is created using the Arduino IDE or ESP-IDF to implement motor control, servo actuation, and Bluetooth connectivity.

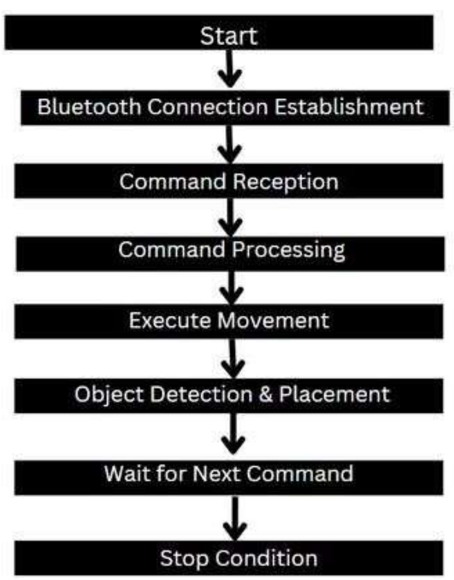

Fig 1. Working Flow diagram

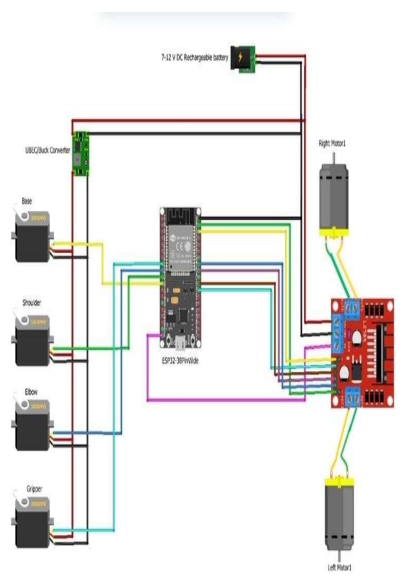

Fig 2. Circuit Diagram

RESULTS AND CONCLUSION:

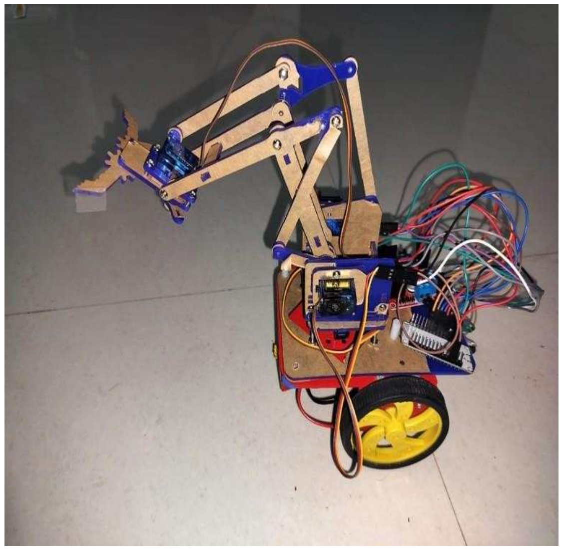

Fig 3. Working Model

An ESP32, four servo motors, two DC motors, and Bluetooth control were used to successfully demonstrate the pick- and-place robotic arm vehicle's wireless movement and object manipulation capabilities. The system precisely AND complied with Bluetooth commands. Real-time movement control of the robotic arm and the vehicle was achieved without signal disruptions. The servo motors provided steady, smooth movement for grasping and positioning objects. The L298N motor driver effectively controlled the DC motors, ensuring smooth navigation in all directions.

The ESP32-based pick-and-place robotic arm vehicle successfully demonstrated remote- controlled object manipulation thanks to its compact and cost-effective design. The system was suitable for use in industrial automation, warehouse logistics, and hazardous environment handling because it could perform simple automation tasks by combining servo-driven arm movements with DC motor-driven mobility.

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