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Design and development of Bluetooth controlled pick and place robotic vehicle

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Abstract: **This paper presents the design of Bluetooth controlled pick and place robotic vehicle which can be controlled using an android application. The proposed structure uses Arduino Nano, HC-05 Bluetooth Module, L293D motor driver, DC gear motors to control the robot. A mechanical arm and chassis make up the mechanical parts. The proposed robot's base can spin360 degrees, pick up and hold objects, and it can move in the desired direction. The payload capacity of the robot is maximum 200g. It can be operated via an android application. This type of robot can be useful for assisting differently abled people and in industrial applications.**

Keywords: **Arduino, Bluetooth, Pick and Place Robot, Vehicle, Wireless.**

I. INTRODUCTION

In this rapidly changing world, inefficient use of time and labour are major obstacles to completing tasks on a wide scale. In most of the routine and frequently performed tasks, robots play a significant role in reducing the need for human labour. Robots are intelligent machines that can be programmed and employed in a variety of settings, including business, manufacturing, assembly lines, healthcare and many more. These robots labour diligently, accurately, and in a hazardous environment to make human lives easier. They can work nonstop for 24 hours, and their performance is more efficient and precise than that of humans. Picking and arranging objects from source to destination is one of the main and most often done (H. Kareemullah et al. 2023; S. Sentil Kumar,2015).
Several studies have been conducted in order to create this project by various researchers. They employ different technologies and serve a different purpose, though. Here are some of those papers along with a description of their technology and application.
Muneera, et al., (2022) proposed the design and implementation of a robot that can recognise objects based on their characteristics, specifically their colour.
Arpit et al., (2014) examined the motion-capture technology utilised by an Android smartphone with a built-in accelerometer and Bluetooth module.
Mohammad Ibrahim, et al. (2022) proposed a system to use speech recognition to operate a car. Meenakshi, et al. (2021) focused on designing a pick and place robotic arm which can be controlled using a smartphone.
Ranjith Kumar Goud and B. Santosh Kumar (2014) in the paper focused on designing pick and place robot for diffusing a bomb remotely with safety.
This paper presents the design of Bluetooth controlled pick and place robotic vehicle. The proposed robot is a microcontroller-based mechatronic device that moves an object from one location to another. Pick and place robots automate the process of selecting an item and putting it in another location. By automating this process, production rates can be increased. Pick and place robots complete tedious tasks, freeing up human workers to focus on more difficult tasks. These have become widely used in a variety of industries for moving tasks.

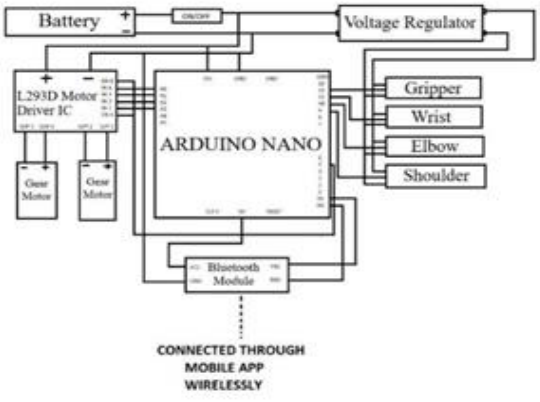

Figure 1. Block diagram of the circuit

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II. DESIGN METHODOLOGY

Fig 1 shows the block diagram of the proposed robotic vehicle. The block diagram consists of Arduino Nano, L293D motor driver, HC-05 Bluetooth module, voltage regulator, DC gear motors for movement of different parts, switch, and a battery.

II.A DESIGN

Mechanical Design: The robot has a rectangular base of length 30cm and breadth 50cm. DC gear motors directly drive the robot's degrees of freedom. Each joint, or point where the arm can bend or rotate, represents a degree of freedom. Hardwood base is chosen because of its availability, easy to be produced, cheap, robust and can handle the motor weight and movement. The robotic arm is constructed using servo brackets that are made of wood because its light and stiff to mimic the bone structure of a human arm. The robot gripper is made of wood.

Electrical Design: The electrical components are as follows:

Arduino NANO: The Arduino NANO is an open-source microcontroller designed by arduino.cc and based on the Microchip

ATmega328P microcontroller. It has somewhat the same features as the Arduino Duemilanove but comes in a different package. It just lacks a DC power jack and operates with a Mini-B USB connection as opposed to a regular one.
HC-05 Bluetooth: This module can communicate over Bluetooth with any device or with two microcontrollers like Arduino. The HC-05 can operate in two different modes: data mode and AT command mode. In data mode, the device can send and receive data from other Bluetooth devices and adjust the device's default settings.

L293D Motor Driver: An integrated circuit chip known as a motor driver is typically used to operate motors in autonomous robots. An Arduino and the motors are connected by a motor driver. Two H-bridges make up L293D. The simplest circuit for managing a motor with a low current rating is an H-bridge.
DC Gear Motors: A gear motor combines a motor and gearbox into one unit. When a gearbox is added to a motor, the speed is decreased but the output of torque is increased. In terms of gear motors, speed (rpm), torque (lb-in), and efficiency (%) are the most crucial variables.

II.B USER INTERFACE

Several communication interfaces, including USB, Wi-Fi, and Bluetooth, are available on Android devices and can be used to connect to the robot. We utilise the Android platform since it is the most widely used and powers the most smartphones globally.

Fig 2. shows the mobile application which is used to control the robot. The MIT App Inventor was used to create this app. This software creator ignites a revolution in robotics and embedded systems.

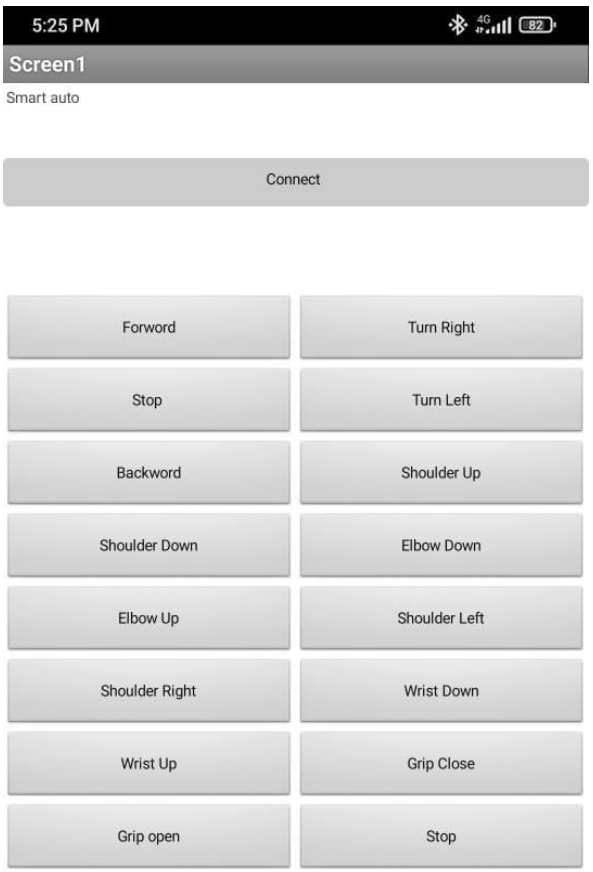

Figure 2. Mobile Application

The app invented search for the Bluetooth devices along with their MAC addresses.

The user only needs to choose the specific MAC Address. The screen displays "Connected" as the status when a certain MAC is chosen. All the buttons are now functional, and the app has established a connection with the robot so that a mobile device may operate it.

The mobile application consists of 14 buttons for movement which are Forward, Backward, Turn Left, Turn Right, Shoulder Up, Shoulder Down, Elbow Up, Elbow Down, Shoulder Left, Shoulder Right, Wrist Up, Wrist Down, Gripper Open, Gripper Close and the other 2 buttons are Connect and Stop.

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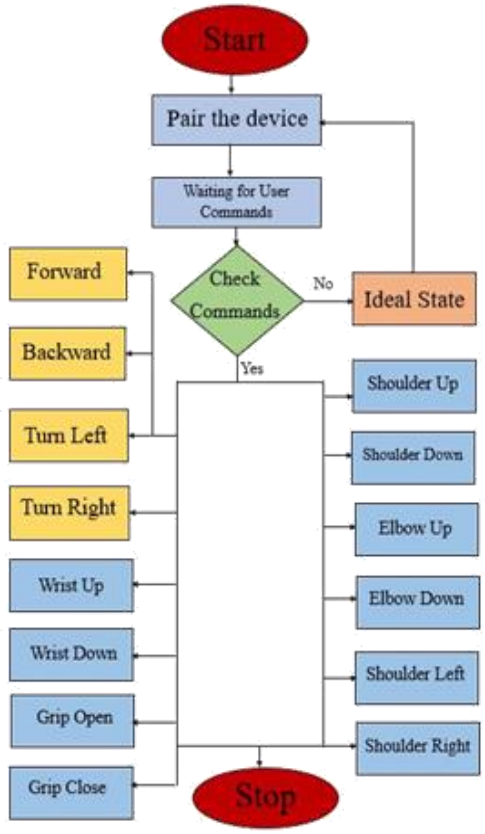

Figure 3. Flowchart of the robot

II.C FLOWCHART

Fig 3. shows the flowchart of the robot. It represents the working of the robot. The robot is first paired with the smartphone,

which consists of the application, using Bluetooth. Then, the commands are fed to the robot and then the Arduino NANO checks the commands.

According to the commands which are fed by the user, the Arduino NANO sends the commands to the different parts of the robot for achieving the desired functionality. The functionality of the robot depends upon the program fed to the Arduino NANO.

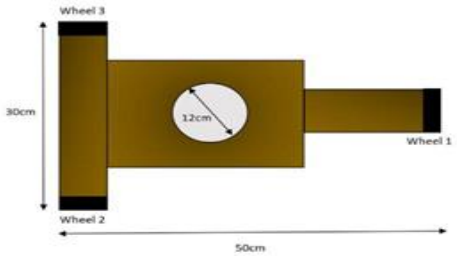

Figure 4. Base Specifications

1. BASE SPECIFICATIONS

Wood as a material is used for the preparation of the base. The diagram in Fig 4. represents the specifications of the base of the robot.
The robot consists of 3 wheels, one wheel at the front and two at the back. Wheel 1 is of ball type which can rotate 360 degrees and diameter of wheel 2 and 3 is 7cm each.

2. ARM SPECIFICATIONS

The arm consists of four joints namely shoulder, elbow, wrist, and gripper. The motors used are DC gear motors.

Shoulder	Diameter of shoulder base: 12cm Length of shoulder arm: 25cm Shoulder base spin: 360 degrees Vertical Movement: 130 degrees
Elbow	Length of elbow arm: 20cm Rotation: 360 degrees
Wrist	Length of wrist arm: 10cm Rotation: 360 degrees
Gripper	Maximum length of opening: 13cm

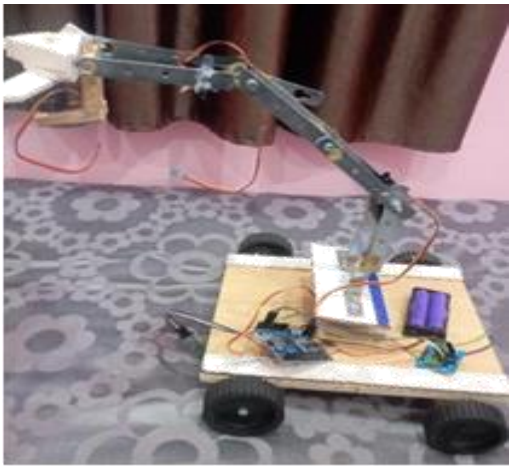

Figure 5. Previous prototype with arm made up of steel

III. EXPERIMENTAL PROTOYPE

The previous prototype had a mechanical arm made up of steel attached to a wooden chassis. The various components of the arm were connected by servo motors. The idea behind using the servo motors were to move the arm from various joints.

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They were applied with the intention of achieving rapid arm mobility. Steel was used to bolster the arm's strength so that the robot could lift more weight. Fig 5. represents the previous prototype. But the previous model did not work out. The main reasons behind the failure of the testing of the previous model are as follows:

Figure. 6 Finalized model

i. Because of using steel as a material in order to build the arm, the arm of the robotic vehicle was too heavy to function properly.

ii. Use of steel was affecting the performance as well as the overall weight of the robot.

iii. The servo motors failed to take that much load and eventually got burnt.

Due to the failure of the previous model, new model is proposed. The idea behind new model is to reduce the weight of the overall structure especially the weight of the arm. So, in order to achieve this, the following changes have been done:

i. Wood is now being used to construct the new arm of the robot.

ii. Instead of servo motors, gear motors are used as it can keep up with more.

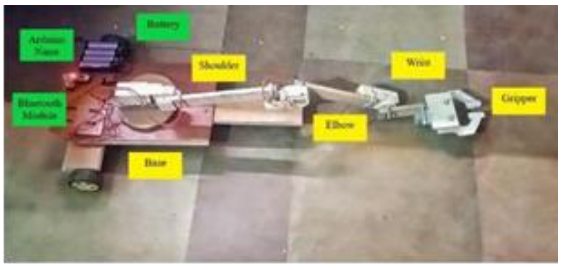

Figure. 7 Top view of the proposed robot

The whole development process of the robot consists of preparation of the arm and the chassis. The different parts of the arm are connected with the help of the gear motors. Fig. 6 and Fig. 7 shows the pictures of the proposed model.

IV. CONCLUSION

This paper presents the design and development of Bluetooth controlled pick and place robotic vehicle which can pick and place objects and can be controlled using Bluetooth via an android application.

The proposed robot is having 5 joints it can move in 14 different ways which includes forward, backward, left, right, shoulder up, shoulder down, shoulder right, shoulder left, elbow up, elbow down, wrist up, wrist down, gripper close and gripper open. The arm has 5 joints connected though 5 motors. These joints include shoulder, elbow, wrist and gripper. Each joint can move to a certain angle. Horizontally shoulder can move up to 360 degrees, vertically shoulder can move up to 130 degrees, elbow can move up to 360 degrees, wrist can also move up to 360 degrees and gripper can open up to 13 centimetres. It is capable of lifting weight up to 200gm.

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