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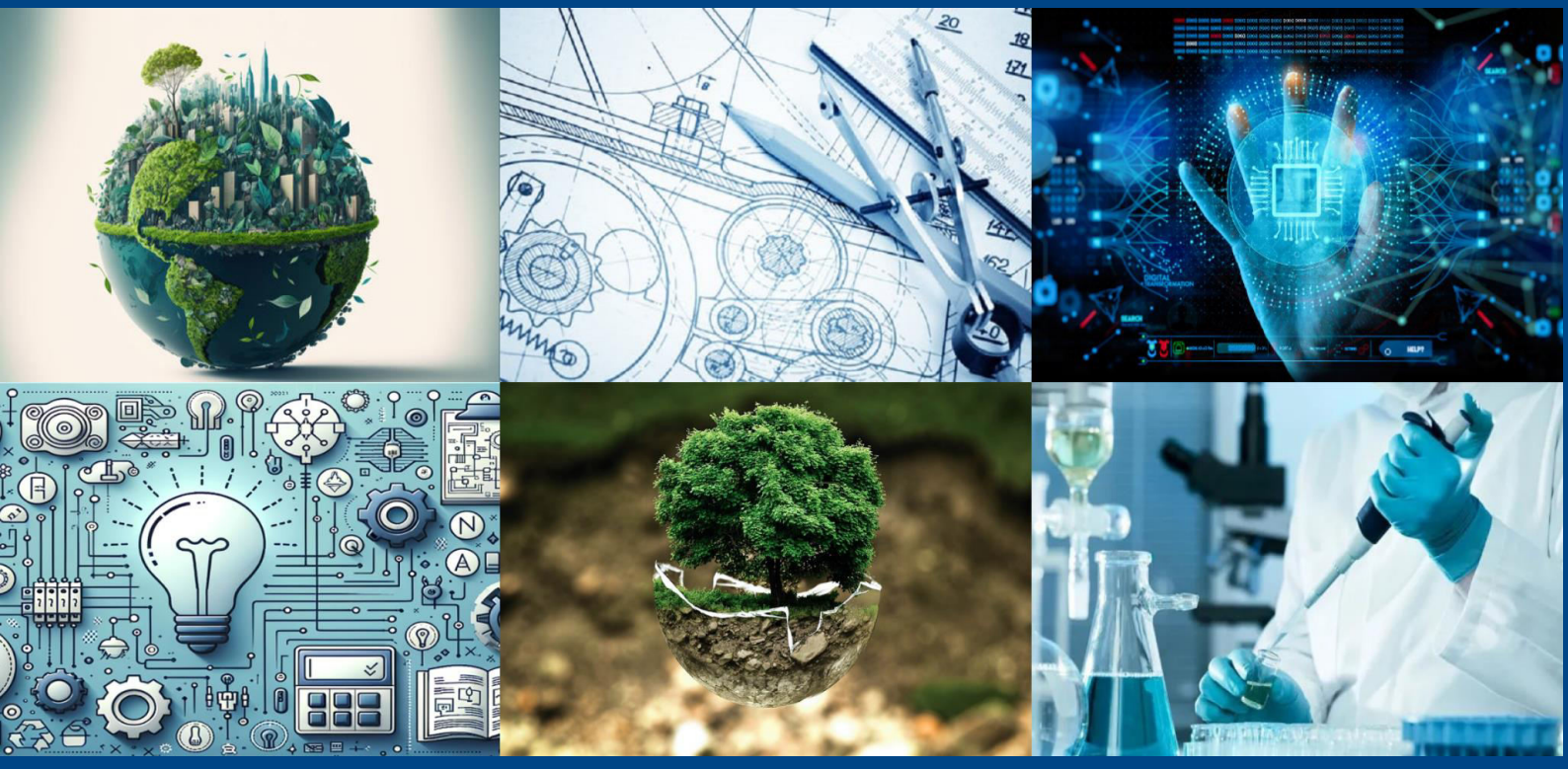

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6 DOF Robotic ARM

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ABSTRACT: This paper presents the design, implementation, and control of a 6 Degrees of Freedom (DOF) programmable robotic arm, developed for educational, research, and prototyping applications. The robotic arm features a CNC-cut PVC alloy body and is actuated by six semi-metal gear standard servos, enabling precise and smooth articulation. Designed for versatility and ease of use, the arm is fully programmable through a dedicated PC interface, allowing users to create, simulate, and deploy movement sequences with minimal technical expertise. Generated control programs are compatible with the Rhino Robot Controller Board, Arduino, or any microcontroller capable of PWM output for RC servos.

The system also supports wireless control via an optional Bluetooth module, expanding its range of applications. With a reach of 350 mm and a maximum payload capacity of 100 grams, the robotic arm is ideal for demonstrating automated pick-and-place operations and other basic manipulations. While the core kit includes essential components such as servos, gripper, and connection cables, external modules like a power supply, servo controller board, and step-down voltage regulator must be sourced separately. The arm operates on a 7.4V DC power supply with a minimum current requirement of 4A. This project highlights the integration of mechanical design, embedded control, and user-friendly programming tools to offer an accessible, scalable, and cost-effective solution for robotics enthusiasts and developers.

KEYWORDS: Robotic Arm, 6 DOF, Servo Control, Arduino, PC Programmable, Bluetooth Control, CNC Body, DIY Robotics

I. INTRODUCTION

Robotic arms have become essential tools in the fields of automation, education, and prototyping due to their ability to replicate precise human-like movements. As advancements in embedded systems and open-source platforms like Arduino continue to evolve, programmable robotic systems have become more accessible and affordable for students, hobbyists, and researchers alike.

This paper presents a low-cost, 6 Degrees of Freedom (DOF) robotic arm that is fully programmable and controllable via PC software. Designed with a CNC-cut PVC alloy body and powered by six standard semi-metal gear servos, the arm offers reliable performance for light-duty tasks such as pick-and-place operations. It supports multiple control options, including direct PC control, standalone operation through Arduino or Rhino Robot Controller Board, and wireless control using an optional Bluetooth module.

The system emphasizes ease of assembly, user-friendly programming, and flexible control, making it ideal for STEM education, robotics training, and experimentation. This project bridges the gap between mechanical design and embedded electronics, demonstrating a complete, customizable robotic solution that balances functionality, simplicity, and cost.

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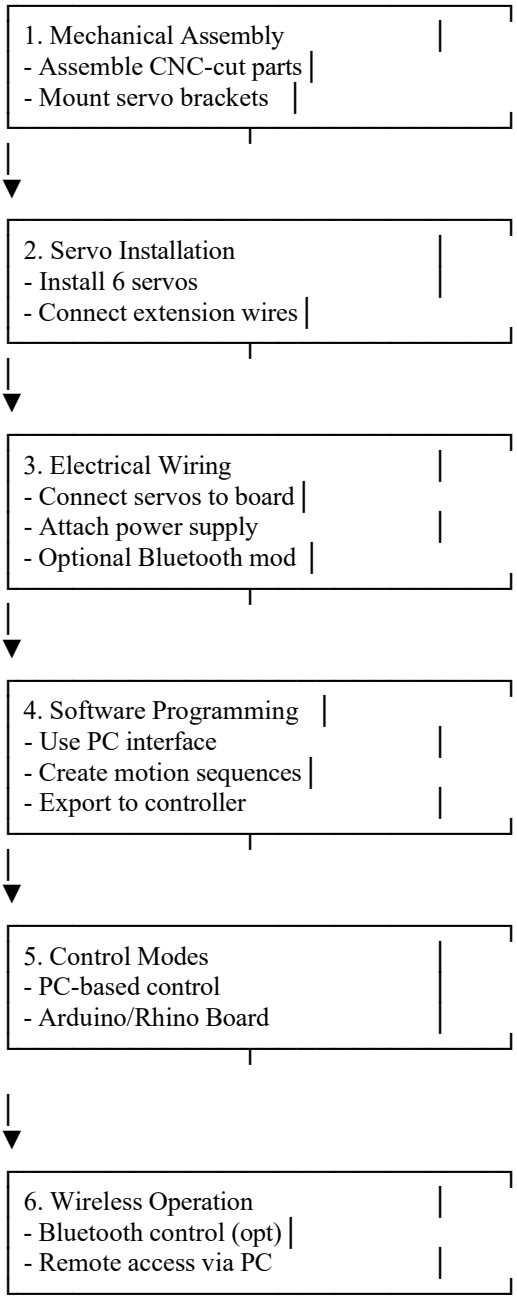
II. STEPS INVOLVED IN 6 DOF ROBOTIC ARM

Following are the steps which are followed in 6 DOF Robotic Arm as shown in Fig. 2.



III. MATERIALS USED IN 6 DOF ROBOTIC ARM

The 6 Degrees of Freedom (DOF) Robotic Arm is an accessible and versatile robotic system designed for educational and prototyping applications. The arm utilizes six semi-metal gear servos to provide movement across various axes, including base rotation, shoulder, elbow, wrist pitch, wrist roll, and gripper control. It is controlled via a microcontroller such as Arduino or the Rhino Robot Controller Board, which processes the control signals and executes programmed sequences.

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The system is designed to be fully programmable using PC-based software, allowing users to create, simulate, and modify movement sequences. Once programmed, the robotic arm can operate independently, without the need for a connected PC. In addition, the system supports wireless control through an optional Bluetooth module, providing flexibility and ease of use in remote applications.

IV. APPLICATIONS OF 6 DOF ROBOTIC ARM

The 6 DOF robotic arm has a wide range of applications in both industrial and educational settings. In industrial automation, it is commonly used for tasks such as pick-and-place operations, packaging, material handling, and assembly line work. Its precise control and flexibility make it ideal for handling delicate components and repetitive tasks, improving efficiency and reducing human error. In addition to industrial use, the robotic arm is highly beneficial in research and development environments, where it serves as a platform for testing algorithms in motion control, machine learning, and robotics programming. In educational settings, it provides a hands-on learning experience for students and hobbyists, helping them understand the principles of robotics, control systems, and mechatronics. Furthermore, the robotic arm is used in simulation-based training for professionals in automation and robotics, as it offers an accessible way to explore and practice robotic control without the complexity and cost of large-scale industrial robots. With its versatility, ease of programming, and customizable design, the 6 DOF robotic arm is an essential tool for a variety of applications in both commercial and academic fields.

V. CONCLUSION

6 Degrees of Freedom (DOF) robotic arm is a versatile and highly capable robotic system commonly used in industrial automation, manufacturing, and various research fields. The six degrees of freedom allow the arm to perform complex tasks, mimicking the motion range and precision of a human arm, making it ideal for operations such as pick-and-place, assembly, welding, and more. The ability to move in three-dimensional space and rotate along multiple axes ensures that the robotic arm can reach a wide variety of positions and orientations, enhancing its flexibility and efficiency.

With advancements in control algorithms, machine learning, and AI, modern 6 DOF robotic arms have become more autonomous, adaptable, and precise. The integration of sensors, such as cameras and force-torque sensors, further enhances their performance, enabling them to interact with objects and environments intelligently.

VI. FUTURE SCOPE

The future scope of 6 DOF robotic arms is vast, with advancements set to enhance automation, healthcare, logistics, and more. These robots will improve precision in industrial tasks, assist in surgeries and rehabilitation, and support household chores and personal assistance. In logistics, they will automate sorting and picking, while AI integration will allow for greater autonomy and flexibility. Additionally, they will play a role in space exploration, agriculture, and environmental sustainability. As technology progresses, 6 DOF robotic arms will become more adaptable, efficient, and essential across various industries.

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