

# Servo Arm

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## I. INTRODUCTION

### 1. Problem Definition

Traditional robotic arms rely on joysticks or buttons, which can be complex and unintuitive. This project addresses the need for a simpler control mechanism by using a secondary arm to replicate human movements, enabling easier operation and greater accessibility for industrial and educational use.

### 2. Problem Definition

The objective of this project is to design an industrial servo arm controlled by a secondary arm, providing an intuitive, cost-effective, and precise solution for automation tasks. The project focuses on creating a user-friendly system that mimics natural movements for improved control and efficiency.

## II. METHODOLOGY

The development of the industrial servo arm project was carried out in several structured steps, ensuring precise functionality and ease of use:

### 1. Component Selection:

Key components, including servo motors, 10k potentiometers, an Arduino Nano, and a sunboard frame, were chosen for their affordability, reliability, and compatibility. Four servo motors (S1-S4) were designated for specific functions:

- S1: Claw movement
- S2: Joint 1 movement
- S3: Joint 2 movement
- S4: Rotary arm rotation

### 2. Circuit Design:

The potentiometers were connected to the Arduino Nano's analog pins (A0-A4) to capture user input from the secondary arm. These inputs were mapped to corresponding servo motor movements via digital pins (D2-D5). Each potentiometer controlled one servo, ensuring direct and intuitive control.

### 3. Frame Construction:

A lightweight sunboard was used to construct the frame, offering stability and portability. The secondary arm was mounted securely for ease of operation, while the primary arm was designed for smooth movement and durability.

### 4. Programming:

The Arduino IDE was used to program the system. The code processed analog signals from the potentiometers mapped them to servo angles, and controlled the motors' movements. Calibration was performed to ensure smooth and accurate operation within the mechanical limits of the servos.

### 5. Assembly and Testing:

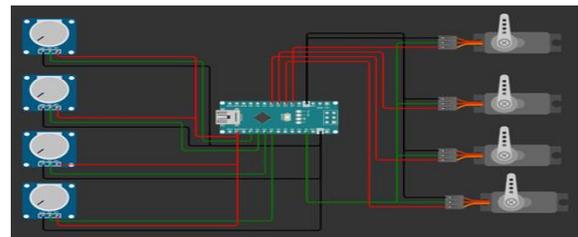
All components were assembled, and the system was tested for accuracy and reliability. Repeated calibration ensured precise movements and prevented misalignment or over-rotation. The secondary arm was tested for responsiveness, and the overall system was fine-tuned for optimal performance.

### 6. Final Implementation:

The completed servo arm was subjected to various tasks, such as gripping, lifting, and rotating objects, demonstrating its functionality and versatility for industrial and educational purposes.

This methodology ensured a robust, intuitive, and efficient servo arm design suitable for diverse applications.

## III. SCHEMATIC DIAGRAM



1. Power Supply:
  - A. The system is powered using the Arduino Nano's 5V output, which provides sufficient power for the potentiometers and servo motors.
  - B. A common ground (GND) is shared between all components to ensure proper signal flow and avoid voltage discrepancies

### 2. Potentiometer Connections:

Four 10k potentiometers are used as input devices to control the servo motors.

- Each potentiometer has three terminals:
  - VCC: Connected to the Arduino Nano's 5V pin.
  - GND: Connected to the Nano's ground pin.
  - Signal Pin: Connected to the analog pins on the Nano to read input voltage.
- The potentiometer connections correspond to the following analog pins and servo motors:
  - A0 → S1 (Claw)
  - A1 → S2 (Joint 1)
  - A2 → S3 (Joint 2)
  - A3 → S4 (Rotary Arm)

### 3. Servo Motor Connections:

Four servo motors (S1, S2, S3, S4) are connected to the Arduino Nano's digital pins:

- D2 → S1 (Claw)
- D3 → S2 (Joint 1)
- D4 → S3 (Joint 2)
- D5 → S4 (Rotary Arm)
- Each servo motor has three wires:
  - Signal Wire: Connected to the respective digital pin.
  - Power Wire: Connected to the Arduino Nano's 5V pin.
  - Ground Wire: Connected to the Arduino Nano's ground.

### 4. Control Mechanism:

- The potentiometers act as variable resistors, changing the voltage output based on their rotation.
- The Arduino Nano reads the voltage via its analog pins and maps it to a range of 0° to 180°, which corresponds to the servo motor's rotation.
- PWM signals are generated on the digital pins to control the servo positions with precision.

### 5. Frame and Testing:

- The components are mounted on a sunboard frame for stability and portability.
- Calibration ensures the potentiometers cover the full range of motion for the servos. The system is tested repeatedly to ensure smooth, lag-free operation.

## IV. RESULTS

The industrial servo arm successfully demonstrated precise and intuitive control using the secondary arm mechanism. Each potentiometer accurately controlled the corresponding servo motor, enabling smooth movements for the claw, joints, and rotary arm. The system performed tasks such as gripping, lifting, and rotating objects with stability and reliability. The lightweight sunboard frame provided durability, and repeated testing ensured the servo arm's efficiency for industrial and educational applications.

## V. CONCLUSION

The industrial servo arm project effectively combines precision, simplicity, and innovation. Using a secondary arm for intuitive control eliminates the complexity of traditional interfaces like joysticks or buttons. Integrating potentiometers, servo motors, and the Arduino Nano ensures smooth and precise operation, while the sunboard frame provides a lightweight yet sturdy structure.

The project successfully demonstrates the potential for creating affordable, user-friendly robotic systems suitable for industrial, educational, and research applications. Rigorous calibration and testing validated its performance, making it reliable and efficient for tasks like gripping, lifting, and rotating objects.

This project serves as a foundation for further advancements in robotics, with opportunities to integrate AI, IoT, and machine learning for enhanced functionality. It highlights the importance of accessible and scalable solutions in automation, paving the way for future innovations in the field.

## REFERENCES

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