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# Robotics, Kinematics, Dynamics and Motion Control

**Course Code:** BCSE421L

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**Programme:** B.Tech.Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

**School:** School of Computer Science and Engineering

# Gesture Control Robotic Arm

**Introduction**

In recent years, the integration of robotics with advanced control systems such as gesture recognition has garnered significant interest. This project aims to develop a robotic arm that can be controlled through hand gestures, providing a more intuitive and natural user interface. By leveraging servo motors, an Arduino microcontroller, and a camera for gesture recognition, the project seeks to create a functional and responsive robotic arm that can be applied in various fields such as automation, healthcare, and remote operations.

**About the Project**

The robotic arm is designed with multiple degrees of freedom, allowing for precise movements and the ability to perform complex tasks. The key components of the project include:

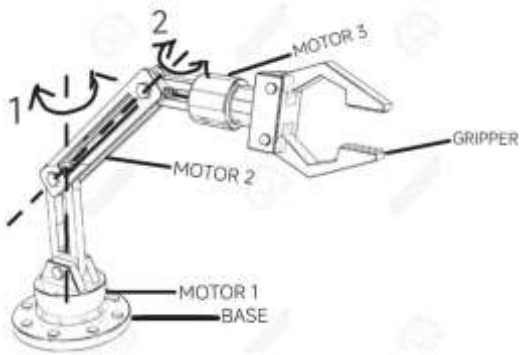
1. **16-Channel 12-bit PWM/Servo Driver I2C Interface (PCA9685):** This module is used to control up to 16 servo motors simultaneously, providing the necessary pulse-width modulation signals for smooth and accurate movements.

2. **Arduino Uno:** The Arduino Uno serves as the main microcontroller, responsible for processing input signals from the gesture recognition system and controlling the servo motors accordingly.

3. **Phone Camera:** The phone camera is utilized for gesture recognition. By capturing the user's hand movements, the system can interpret specific gestures and translate them into corresponding actions by the robotic arm.

4. **Servos:**
    - **Tower Pro MG995 Plastic Gear Servo Motors (180° Rotation):** These servos provide a high torque of approximately 11 kg/cm at 6V, contributing to the arm's lifting capacity.
    - **SG90 Micro Servo Motors:** These smaller servos offer a torque of approximately 1.6 kg/cm at 6V, suitable for finer movements and adjustments.

5. **Battery (LIPO 7.4V 3300mAh):** The battery supplies power to the entire system, ensuring consistent operation over extended periods.



**Torque Specifications and Lifting Capacity**

The combined torque from all the servo motors is 37.8 kg/cm. This torque translates to the robotic arm's lifting capacity, allowing it to lift approximately 37.8 kg at a 1 cm distance from the pivot point.

**Work Progress**

To date, the following milestones have been achieved in the project:

1. **Component Procurement:** All necessary components, including the PCA9685 servo driver, Arduino Uno, servo motors, and battery, have been procured and tested for functionality.
2. **Initial Assembly:** The robotic arm has been partially assembled, with the servo motors mounted and connected to the Arduino Uno via the PCA9685 servo driver.
3. **Gesture Recognition Integration:** The phone camera has been successfully integrated into the system, and basic gesture recognition algorithms have been implemented to control the arm's movements.
4. **Testing:** Preliminary testing of the arm's movement and response to gestures has been conducted, demonstrating the feasibility of the project.

**List of components purchased**

| S.NO | NAME | QUANTITY | INDIVIDUAL PRICE | TOTAL PRICE (QUANTITY*INDIVIDUAL PRICE) |
|---|---|---|---|---|
| 1 | 16-Channel 12-bit PWM/Servo Driver I2C interface PCA9685 | 1 | 242 | 242 |
| 2 | Arduino Uno | 1 | 500 | 500 |
| 3 | Phone Camera | 1 | - | - |
| 4 | TowerPro MG995 Plastic Gear Servo Motor (180° Rotation) | 3 | 224 | 672 |
| 5 | Sg90 Micro servo Motor 9g | 3 | 200 | 600 |
| 6 | Battery 7.4V 3300mAh | 1 | 1269 | 1269 |

**Work to be Carried Out in Future**

1. **Final Assembly:** The robotic arm needs to be fully assembled, with all components securely mounted and properly aligned.

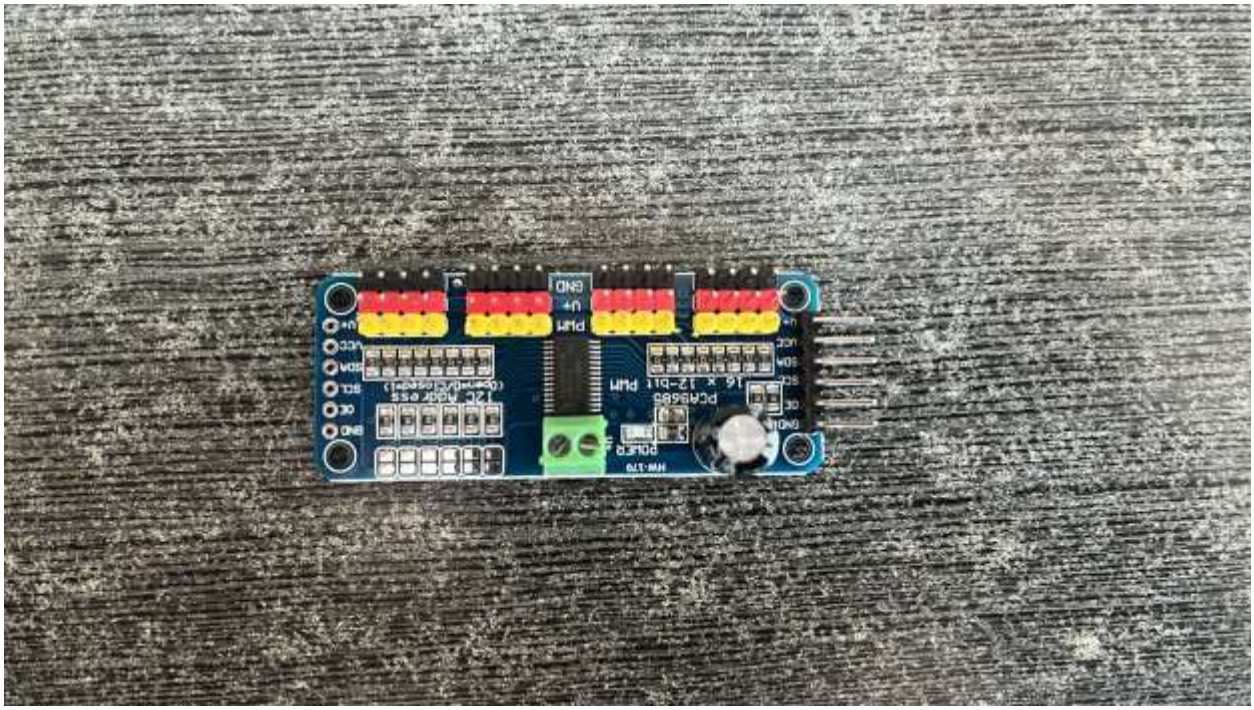
2. **Advanced Gesture Recognition:** Further refinement of the gesture recognition algorithms is necessary to improve accuracy and responsiveness, particularly in complex gestures.

3. **Calibration:** The servo motors need to be calibrated to ensure precise and smooth movements of the robotic arm.

4. **Load Testing:** The lifting capacity of the arm will be tested under different conditions to validate the torque calculations and ensure safe operation.

5. **Documentation and Final Testing:** Comprehensive documentation will be prepared, detailing the design, assembly, and operation of the robotic arm. Final testing will be conducted to ensure all systems are functioning as intended.

**Picture of our Robotic Arm:**


GND
V+
PWM
VCC
SDA
SCL
OE
GND
PCA9685
16 x 12-bit PWM