

# Hand Tracking Robot Arm User Manual

## Overview

The Hand Tracking Robot Arm is a versatile robotic system that uses hand movements to control a five-servo robotic arm in real-time. This system is based on hand tracking via a webcam and communication between a PC and a standalone ATmega328P microcontroller via Bluetooth. The servos on the robot arm correspond to various movements of the hand, allowing precise control and interaction.

## System Components

### 1. Robot Arm

- Composed of 5 servos.
  - **Servo 1:** Gripper open/close
  - **Servo 2:** Wrist rotation.
  - **Servo 3:** Elbow rotation.
  - **Servo 4:** Shoulder rotation.
  - **Servo 5:** Base rotation (90° horizontal movement).

### 2. Hand Tracking via Webcam

- Utilizes MediaPipe python library for real-time hand landmark detection.
- Tracks specific points on the hand and converts these coordinates into servo movements.

### 3. Standalone ATmega328P Microcontroller

- The brain of the robot arm that receives commands via Bluetooth and controls the servos.

### 4. Bluetooth Module

- HC-05 Bluetooth module connected to ATmega328P for wireless data reception from the PC.

## Setup and Operation

### 1. Hardware Setup

- Connect the 5 servos to the ATmega328P microcontroller using designated output pins.
- Ensure the Bluetooth module is connected to the ATmega328P for wireless communication with the PC.
- Power up the ATmega328P and servos using an external power supply.

### 2. Software Setup

- Install the necessary Python libraries (e.g., OpenCV, MediaPipe, PySerial) on your PC.
- Ensure the correct COM port is selected for Bluetooth communication with the robot arm.

- Open the hand tracking Python script, which uses MediaPipe to detect hand landmarks via your webcam.

### 3. Operating Instructions

1. **Power On** the robot arm and ensure the Bluetooth module is connected to the PC.
2. **Run the Python Hand Tracking Script** on your PC. If the robot hand establishes a proper connection “Bluetooth connected” will be displayed.
3. Position your hand in front of the webcam. If tracking of the hand landmarks is processed and transmitted correctly, “Coordinates sending...” will be displayed.
4. Movements and the nature of your hand will be detected and processed into corresponding values and applied to the corresponding robot arm servos.
  - Gripper of the robot arm is controlled by touching your index and thumb fingertips together.
  - Wrist of the robot arm is controlled by moving your entire palm vertically.
  - Elbow of the robot arm is titled by moving your ring finger.
  - Shoulder of the robot arm is controlled by moving your middle finger.
  - Base of the robot arm is rotated by moving your palm horizontally.
5. The robot arm will respond to the hand's tracked coordinates in real-time.

### 4. Troubleshooting

- **Bluetooth not connecting:** Ensure the Bluetooth module is powered and paired correctly with the PC.
- **Servos not moving:** Check servo connections to the ATmega328P and ensure the power supply is adequate.
- **Hand tracking issues:** Ensure the webcam is properly positioned and that the environment has adequate lighting.

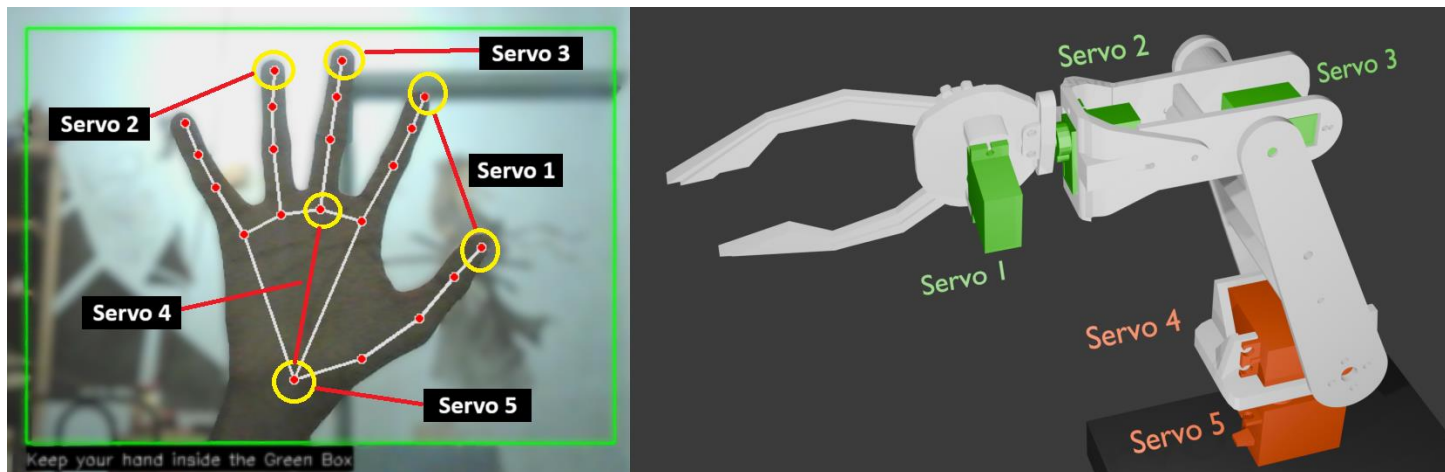


Figure 1: Real time hand tracking window(left) and corresponding servo arrangement of the robot arm(right)

