## Objective

How to build a robotic arm.

## How we get this idea?

We select this project because we are inspired by the well-known industry robots. The goal is to develop an open source robotic arm to use in private or small industries and make robot development available for everyone.

Industrial robots are expensive and dangerous and for that, not suitable for using at home and schools. An open source robot can build, used and developed by everyone. Robots are still expensive and hard to operate but this must not be the case.

## Why robotic arm?

We want that our project will simply the unique one among the other classmates and also our requirement of being useful and contribution to the society is successfully fulfilling by selecting this project.

## Applications

1) painting (cars)
2) soldering (cars)
3) pick and place (most industries, a lot for food industry)
4) third hand: the arm carries the object and the operator can work on it easily
5) act in a human-designed environment: send the arm on a mobile base to a damaged/radioactive building and use the arm to open the door and manipulate the tools (by itself or remote controlled)

# Electrical design

## Components

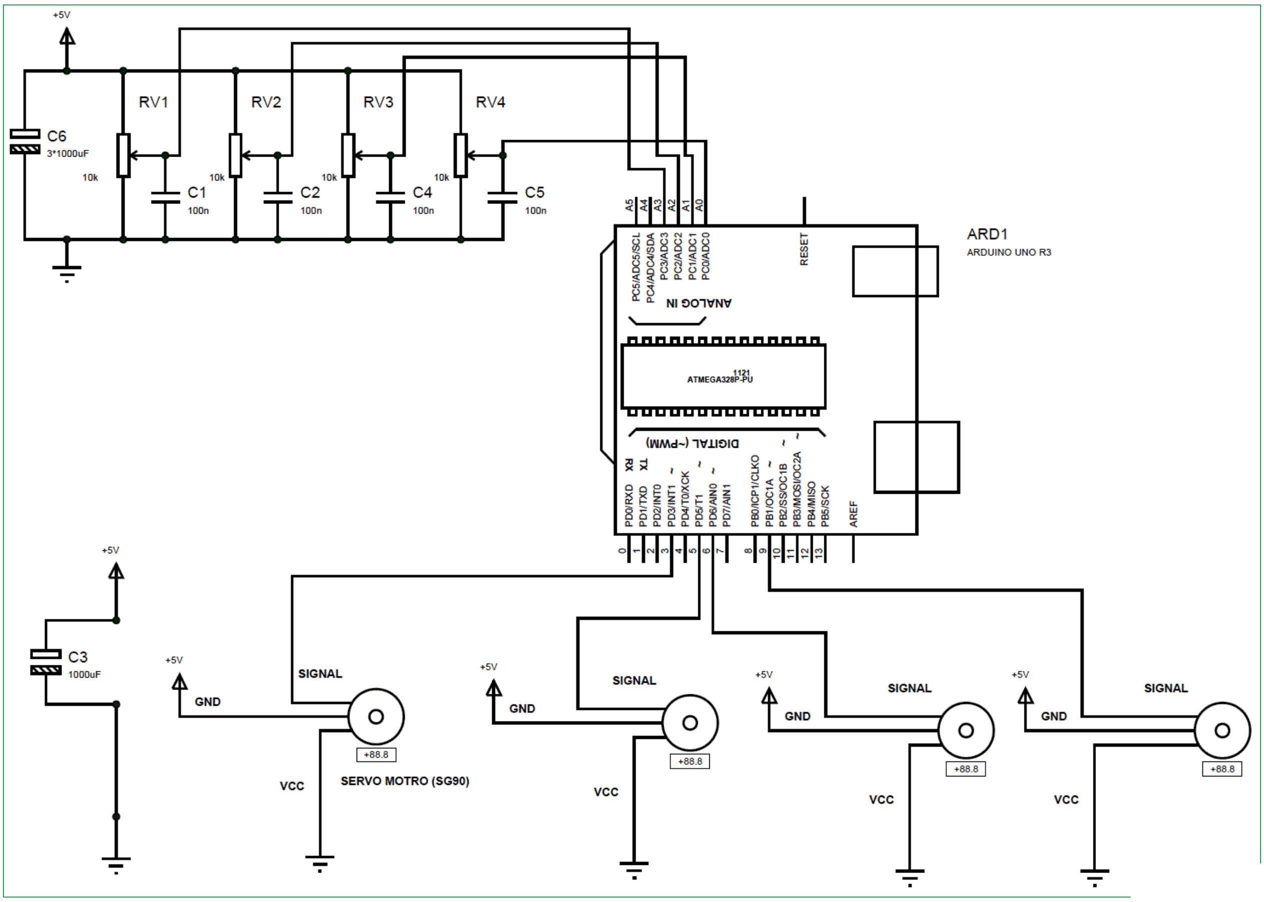
- Arduino Due
- 1000uF Capacitor (4 pieces)
- 100nF Capacitor (4 pieces)
- Servo Motor (3 pieces)
- 10K pot- Variable Resistor (4 pieces)
- Power Supply (5v- preferably two)

## Actuator

First we talk a bit about Servo Motors. Servo Motors are excessively used when there is a need for accurate shaft movement or position. These are not proposed for high speed applications. Servo motors are proposed for low speed, medium torque and accurate position application. So these motors are best for designing robotic arm.

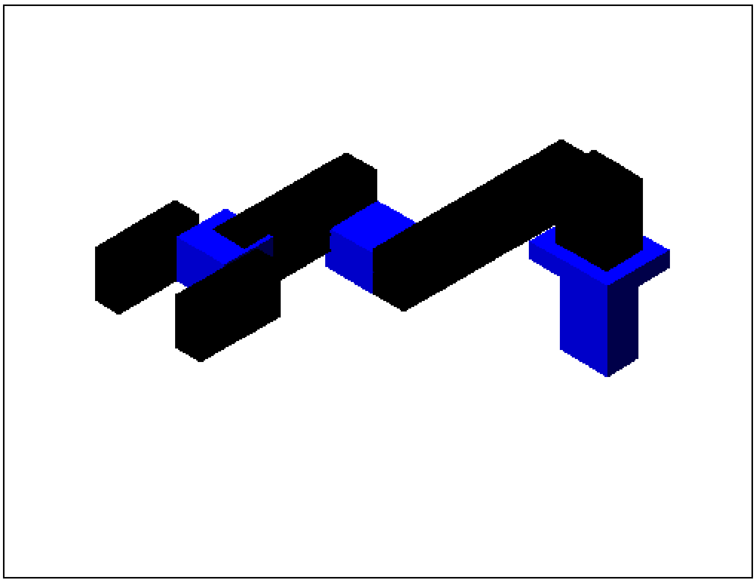
Servo motors are available at different shapes and sizes. We are going to use small servo motors, here we use four SG90 servos.

## Circuit diagram

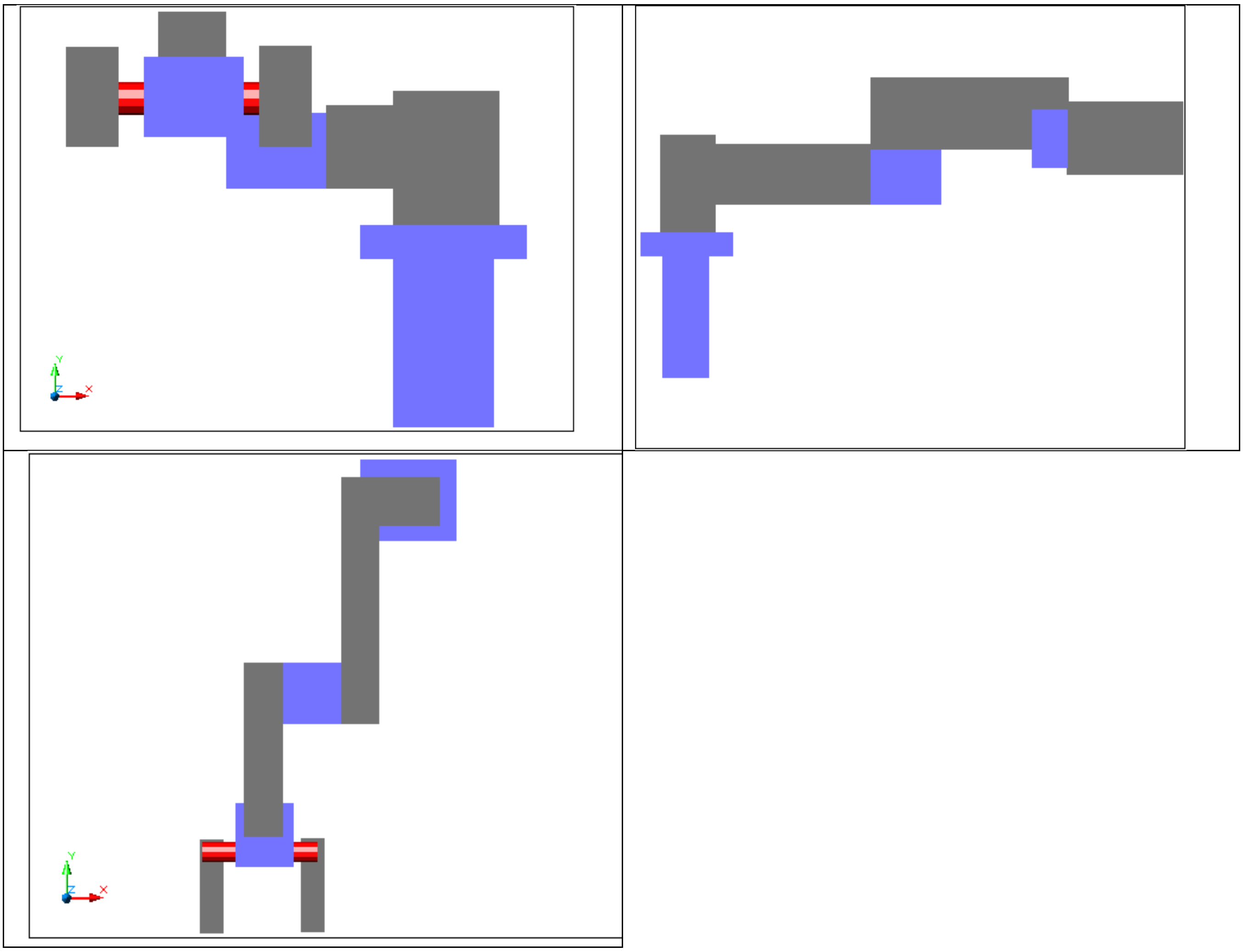



## Mechanical design

## 3D model



## CAD model



## Parameters

- **Gripper Servo 1 (Gripping) Total weight: 200g**

  Object to be lifted - 200g (maximum)

- **Gripper Servo 2 (Rotating the wrist) Total weight: 500g**

  Gripping servo 1 - 50g

  Gripper - 250g

  Object to be lifted – 200g

- **Joint Servo 2 Total weight: 600g**

  Gripper servo 1 – 50g

  Gripper servo 2 – 50g

  Gripper – 200g

  Object to be lifted – 200g

Material – 100g (includes body and servo brackets)

- **Base Servo 1 (Moving Up and Down) Total weight: 700g**

Gripper servo 1 – 50g

Gripper servo 2 – 50g

Gripper – 200g

Object to be lifted – 200g

Joint servo – 50g

Material – 150g (includes body and servo brackets)

- **Base Servo 2 (Moving Sideways) Total weight: 800g**

Gripper servo 1 – 50g

Gripper servo 2 – 50g

Gripper – 200g

Object to be lifted – 200g

Joint servo – 50g

Base servo 1 - 100g

Material – 150g (includes body and servo brackets)

- **Length of link 1: 5 inches each**
- **Length of link 2: 5 inches**
- **Acceleration required:**

Gripper Servo 2: 50 deg/sec$^2$

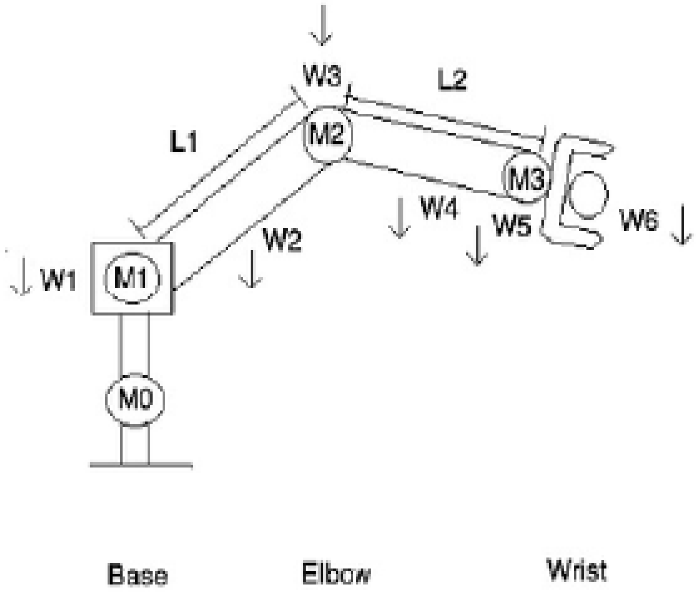
Joint Servo: 50 deg/sec$^2$

Base Servo 1: 50 deg/sec$^2$

- **W1:**
  Weight of the base servo 1: 0.98N
- **W2:**
  Weight of joint servo: 0.98N
- **W3:**
  Weight of the joint: 0.49N
- **W4:**
  Weight of the joint: 5.88N
- **W5:**
  Weight of the Gripper servos (Rotating & Gripping) = 0.98 N
- **W6:**
  Weight of the object lifted + Gripper = (1.96+1.96) N
- **L1:** Length of the joint 1 = 5 inches = 12.7 cm
  **L2:** Length of the joint 2 = 5 inches = 12.7 cm

- **M0:** Base servo 2 (Sideways movement)

**M1:** Base servo 1 (Upwards movement)
**M2:** Joint servo
**M3:** Gripper servos (Rotating & Gripping)




- **Joint 1: M0 (Tracking arm)**
  L1/2 * W2 + L1 * W3 + (L1 + L2/2) * W4 + (L1 + L2) * (W5+W6)
  (12.7/2)(0.98) + (12.7)(0.49) + (12.7 + 12.7/2)(5.88) + (12.7 + 12.7)(0.98 + 3.92)
  **2.5 N.m : 12.56 Kg-cm : 127.8 oz-in**

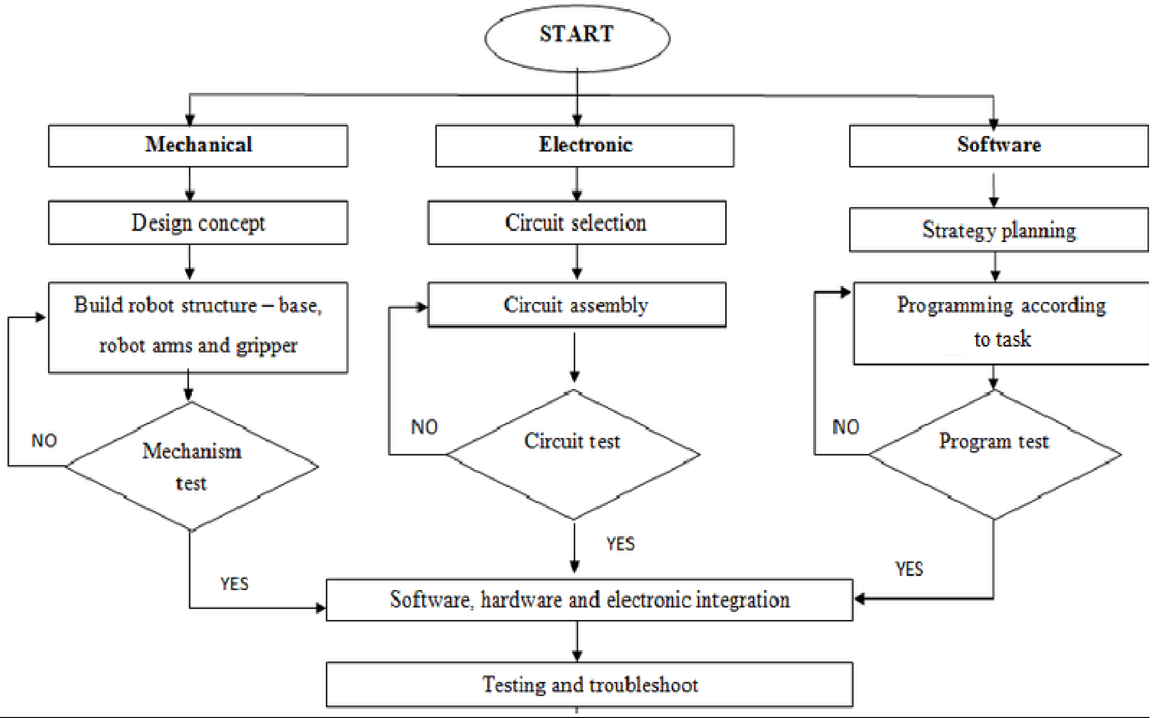
- **Joint 1: M1 (User-controlled arm)**
  L1/2 * W2 + L1 * W3 + (L1 + L2/2) * W4 + (L1 + L2) * (W5+W6)
  (12.7/2)(0.98) + (12.7)(0.49) + (12.7 + 12.7/2)(5.88) + (12.7 + 12.7)(0.98 + 3.92)
  **2.5 N.m : 12.56 Kg-cm : 127.8 oz-in**
  The torque for the 'user-controlled' arm at Joint 1 is lesser than the 'tracking arm' as it is not lifting the object. But in order to simplify the calculations, similar servos are used in both the arms at Joint 1.

- **Joint 2: M2**
  L2/2 * W4 + L2 * (W5+W6)
  (12.7/2)(0.98) + (12.7)(0.98 + 3.92)
  **0.96 N.m :- 10.02 Kg.cm :- 125.75 oz-in**

- **Joint 3: M3**

  **0 N.m (distance is 0)**

## Flow Chart




## Algorithm

- **Step1:** select catching angle for M1(Base)
- **Step2:** select catching angle for M2(Arm-1)
- **Step3:** select catching angle for M3(Arm-2)
- **Step4:** select catching angle for M4(Gripper)
- **Step5:** select lifting angle for M3(Arm-2)
- **Step6:** select lifting angle for M2(Arm-1)
- **Step7:** select dropping angle for M1(Base)
- **Step8:** select dropping angle for M2(Arm-1)
- **Step9:** select dropping angle for M3(Arm-2)
- **Step10:** select dropping angle for M4(Gripper)

## Cost of project

| Components | Quantity | Price |
|---|---|---|
| Servo motors | 3 | 1560 |
| Acrylic sheet | 1ft$^2$ | 160 |
| Jaw cutting and assembling | 1 | 300 |
| | **Total** | **2130** |

***Other components are used from our toolkits.**