4-DOF Pick-and-Place Robotic Arm

Problem statement

To build and demonstrate a pick-and-place robotic arm that has 4 degrees of freedom.

Components

1. 4 Servo Motors
2. Robotic arm
3. Arduino UNO
4. Servo PWM module
5. Bread board power supply
6. Bread board

Theory

A Robotic arm has links and joints. Each of these joints can rotate in a certain plane. This dictates the robotic arm's degrees of freedom – how many planes of orientation can the end-effector of a robot with links and joints reach? It is found that the number of degrees of freedom is same as the number of dimensions in the configuration/ working space. In the case of this project, that sums up to **four** in number.

- The robot base that moves in x-y plane
- The robot arm-first link that moves in z plane- 2 DOF
- The manipulator/ end effector for the claws

Servo motors are electric actuators with electric distribution system acting as its power supply. They rotate with the input value in degrees. They have a feedback system as well. The servo motor typically accepts the angle of rotation in values. The relation as given:

0 degrees = 150; 180 degrees = 600;

Schematic
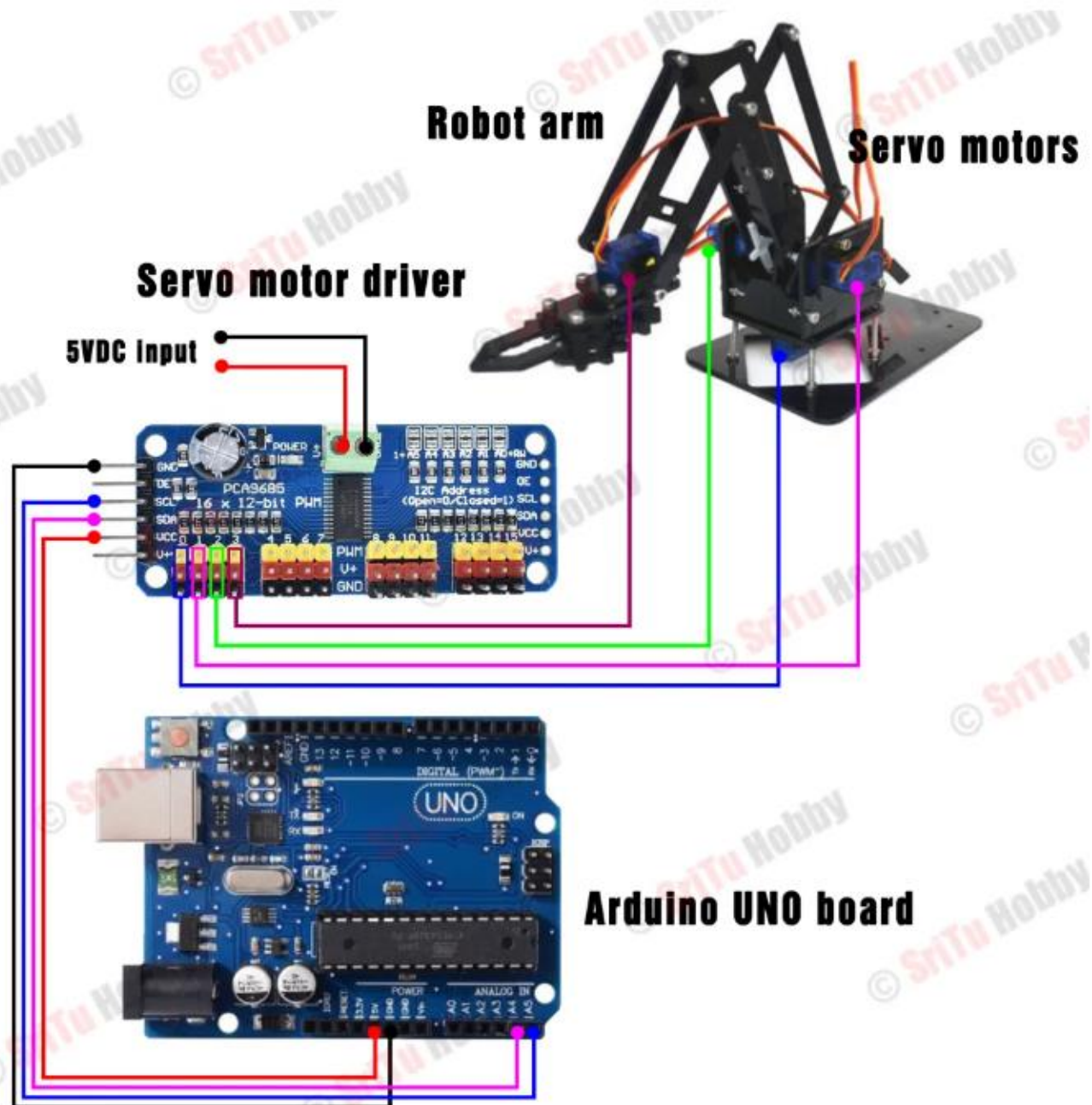
Code

```
#include <Wire.h>
#include <Adafruit_PWMServoDriver.h>

Adafruit_PWMServoDriver PWM = Adafruit_PWMServoDriver();

#define servo1 0
#define servo2 1
#define servo3 2
#define servo4 3


void setup() {
  Serial.begin(9600);
  PWM.begin();
  PWM.setPWMFreq(60);
  PWM.setPWM(servo1, 0, 480);
  PWM.setPWM(servo2, 0, 150);
  PWM.setPWM(servo3, 0, 300);
  PWM.setPWM(servo4, 0, 200);
  delay(3000);
}

void loop() {

  for (int S1value = 480; S1value >= 300; S1value--) {
    PWM.setPWM(servo1, 0, S1value);
    delay(10);
  }

  for (int S2value = 150; S2value <= 380; S2value++) {
    PWM.setPWM(servo2, 0, S2value);
    delay(10);
  }

  for (int S3value = 300; S3value <= 380; S3value++) {
    PWM.setPWM(servo3, 0, S3value);
    delay(10);
  }

  for (int S4value = 200; S4value <= 350; S4value++) {
    PWM.setPWM(servo4, 0, S4value);
    delay(10);
```

```
}
/////////////////////////
delay(2000);
for (int S4value = 350; S4value > 200; S4value--) {
  PWM.setPWM(servo4, 0, S4value);
  delay(10);
}

for (int S3value = 380; S3value > 300; S3value--) {
  PWM.setPWM(servo3, 0, S3value);
  delay(10);
}

for (int S2value = 380; S2value > 150; S2value--) {
  PWM.setPWM(servo2, 0, S2value);
  delay(10);
}

for (int S1value = 300; S1value < 550; S1value++) {
  PWM.setPWM(servo1, 0, S1value);
  delay(10);
}
/////////////////////
for (int S2value = 150; S2value <= 380; S2value++) {
  PWM.setPWM(servo2, 0, S2value);
  delay(10);
}

for (int S3value = 300; S3value <= 380; S3value++) {
  PWM.setPWM(servo3, 0, S3value);
  delay(10);
}

for (int S4value = 200; S4value <= 350; S4value++) {
  PWM.setPWM(servo4, 0, S4value);
  delay(10);
}

for (int S4value = 350; S4value > 200; S4value--) {
  PWM.setPWM(servo4, 0, S4value);
  delay(10);
}
//////////////////
```

```
for (int S3value = 380; S3value > 300; S3value--) {
  PWM.setPWM(servo3, 0, S3value);
  delay(10);
}

for (int S2value = 380; S2value > 150; S2value--) {
  PWM.setPWM(servo2, 0, S2value);
  delay(10);
}

for (int S1value = 550; S1value > 480; S1value--) {
  PWM.setPWM(servo1, 0, S1value);
  delay(10);
}
}
```

Explanation

The base servo is servo 0, right and left are respectivel servo 1 and 2, while the end-effector servo is labeled servo 3, as per the connections to the PWM servo motor driver.

The first motion is the base. Servo 1 moves to predesignated spot to collect an object. The right and left servos move the robot link arm up or down in a set-up manner. The end effector opens its claws, the object is given, and closes after a delay.

The next is the place/ drop part. The base servo moves by an angle designated for a particular drop spot, and the end-effector opens. The object is dropped, following immediately the end-effector closes and the next iteration continues.

Individual Contribution

1. Anurag Vallur – Assembly of robotic arm
2. Soumyadipto – Servo motor control directions and coding in Arduino

References

1. Robotic systems – Unit 1 slides

2. Robotic arm assembly - https://youtu.be/Q9JOKQaIR1w

3. Schematic - https://srituhobby.com/how-to-assemble-and-control-a-robot-arm-with-an-arduino/