Robot Arm:
Remote Control vs. Master/Slave Control

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for

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1. Purpose of Project

• We'll be using the Science Olympiad Robot Arm Challenge to showcase our robot arm and different control systems

• The challenge has teams make a robot arm and score as many point in three minutes by moving stacks of pennies

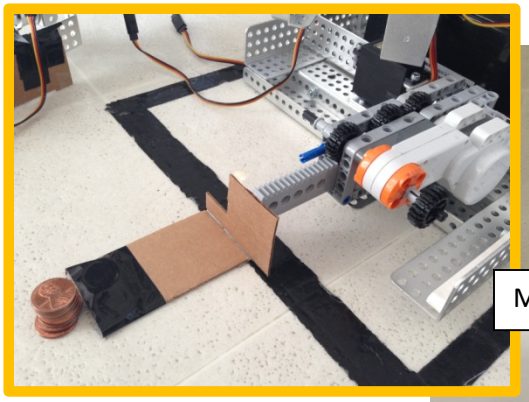
•Playing field is a 75 cm x 75 cm square with an archery target containing five concentric circles of different radii

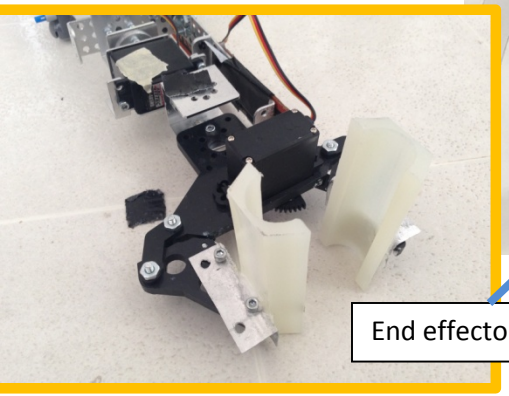
• Five stacks of pennies, with 10 pennies each, heads side up, are placed such that one stack is tangent to, and outside of each of the west, north, east, and south edges of the outer circle

• If placed tails up, teams receive twice the point value listed

•Key of this challenge is incorporating an arm with smooth and accurate movement control

2. Robot Arm Hardware Building





12V Battery Pack

Mini Assistant Arm

TETRIX Motor Controller

Servo Motor (elbow)

Servo Controller

Servo Motor(shoulder)

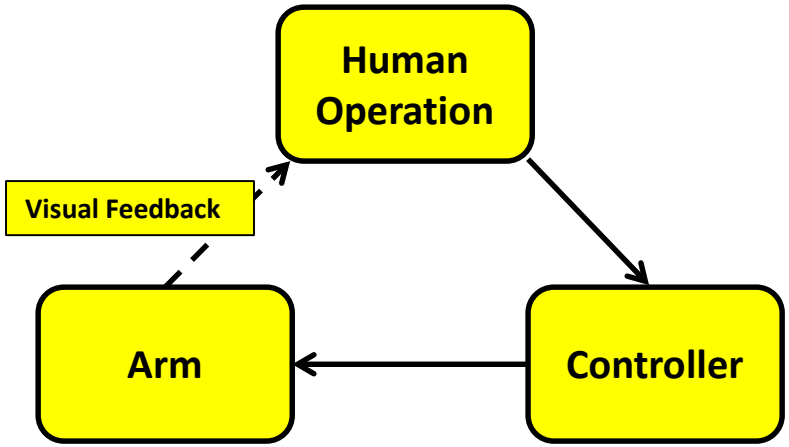
Servo Motor(hand)

Servo Motor(base)

Penny sweeper

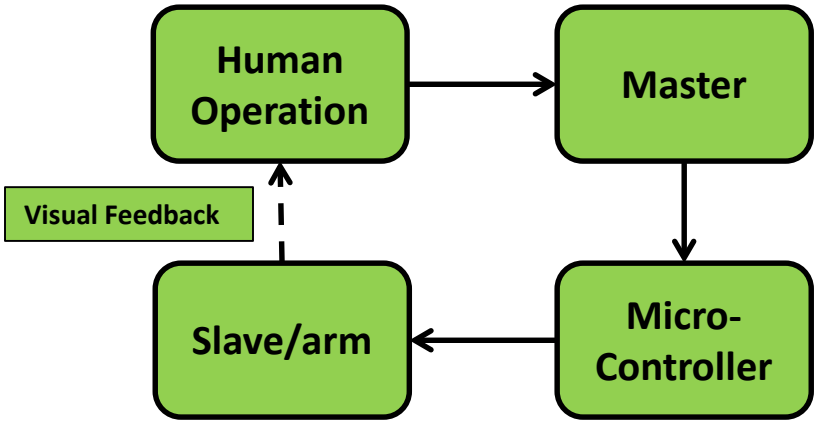
End effector (claw)

3. Robot Arm Control Systems



Pros:
-simple design
-commercially available controller (EV3/IR)
-graphics programming (EV3-G)

Cons:
-needs servo controller
-immobile
-hard to control
-slow motion due to sequential control

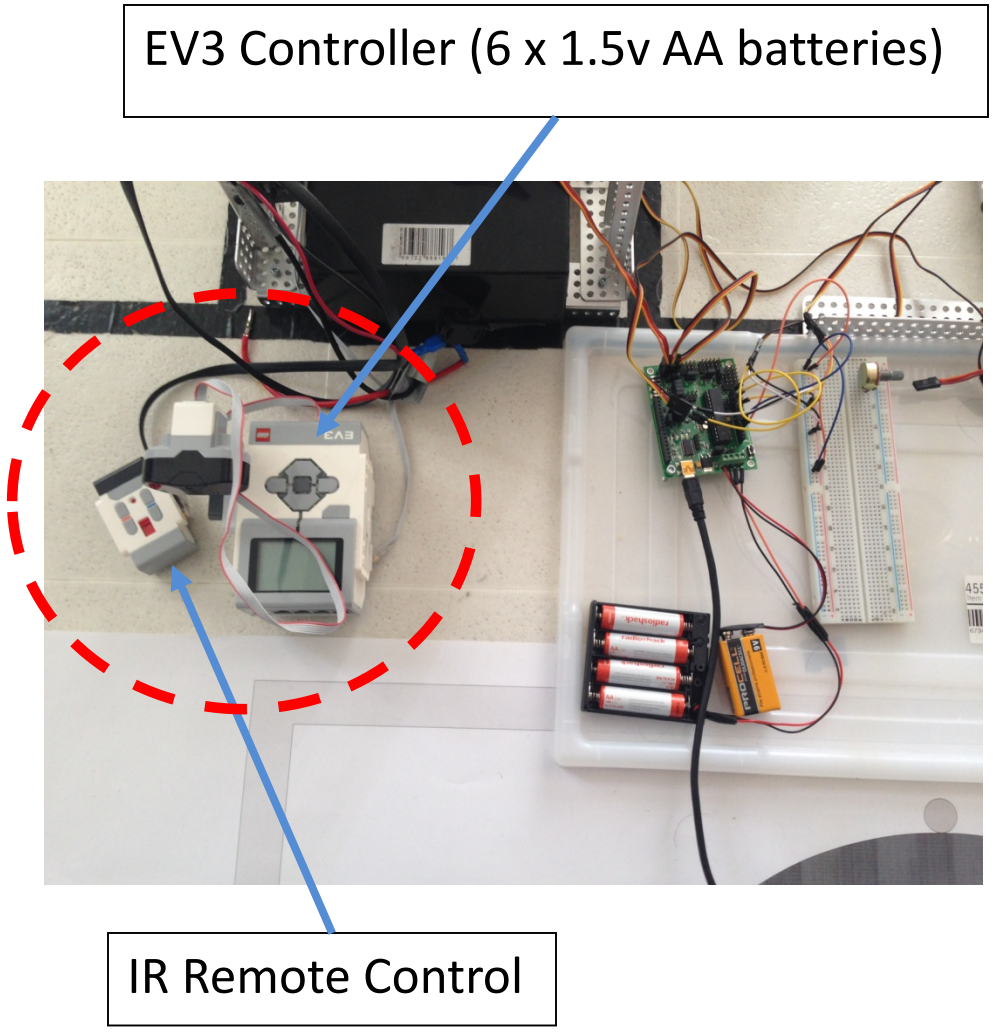


Pros:
-intuitive movement
-simulates hand-like motions
-flexibility
-enhanced maneuverability

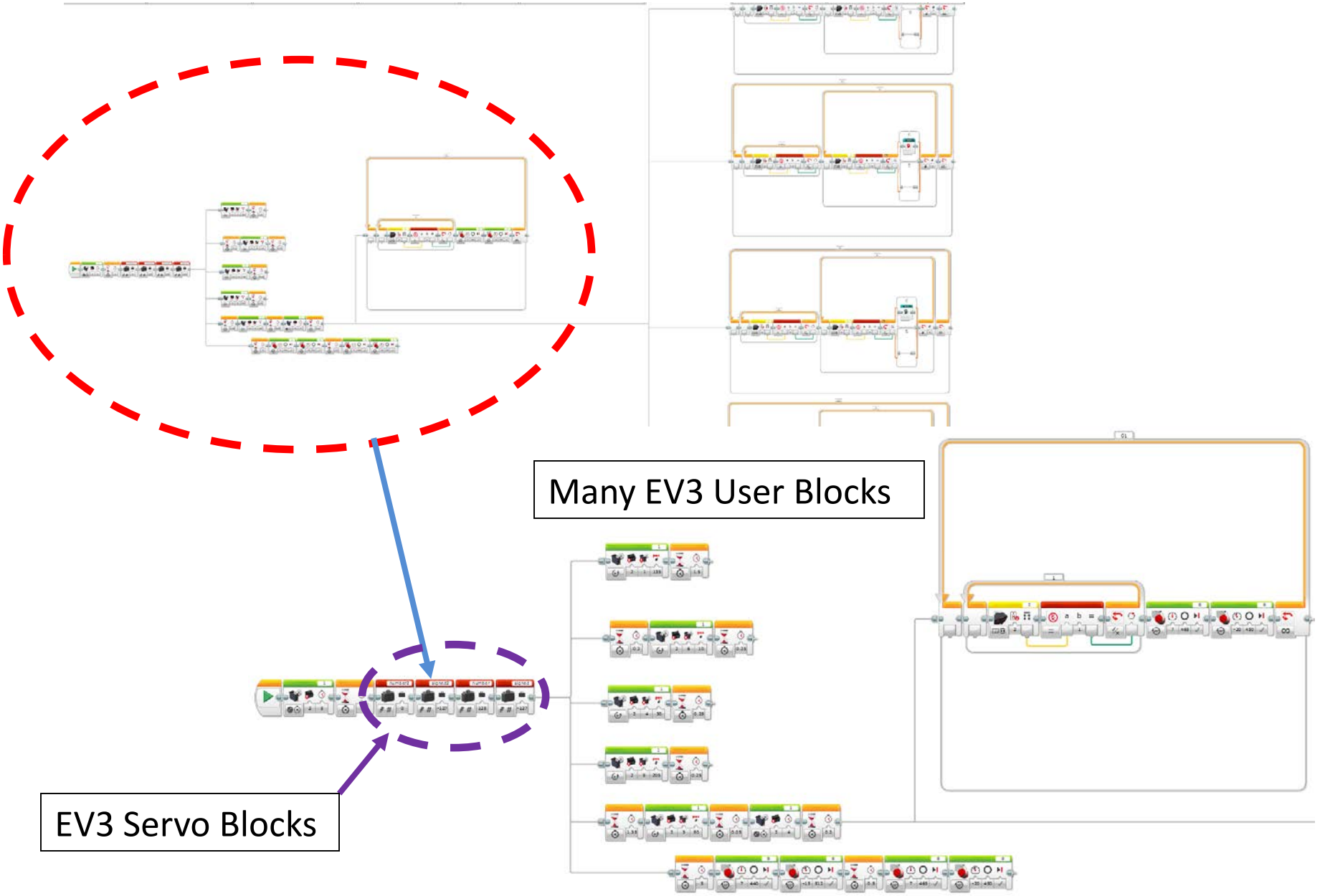
Cons:
-higher cost
-Knowledge of electrical circuits
-text based programming (C/C++)

(1) Remote Control System

- EV3 brick and Tetrix servo controller
- 5 servos (2 x MG 995, 3 x HS-485HB)
- Lego Infrared remote controller
- 12V Battery pack for Tetrix system, and 6 x AA battery pack for EV3
- EV3 based programming w/ EV3 block for Tetrix servo controller

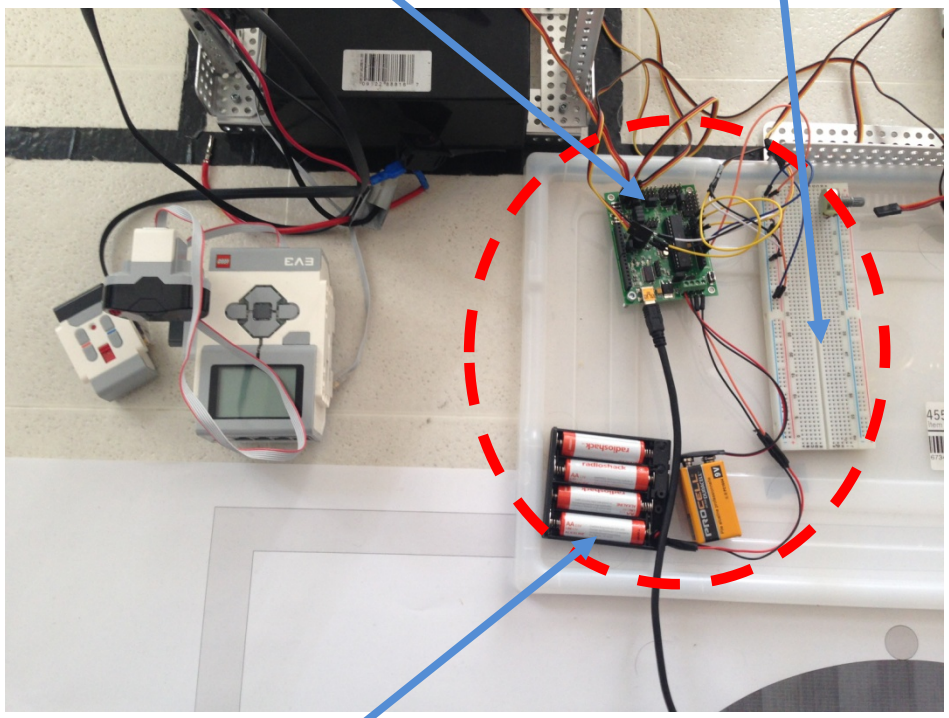


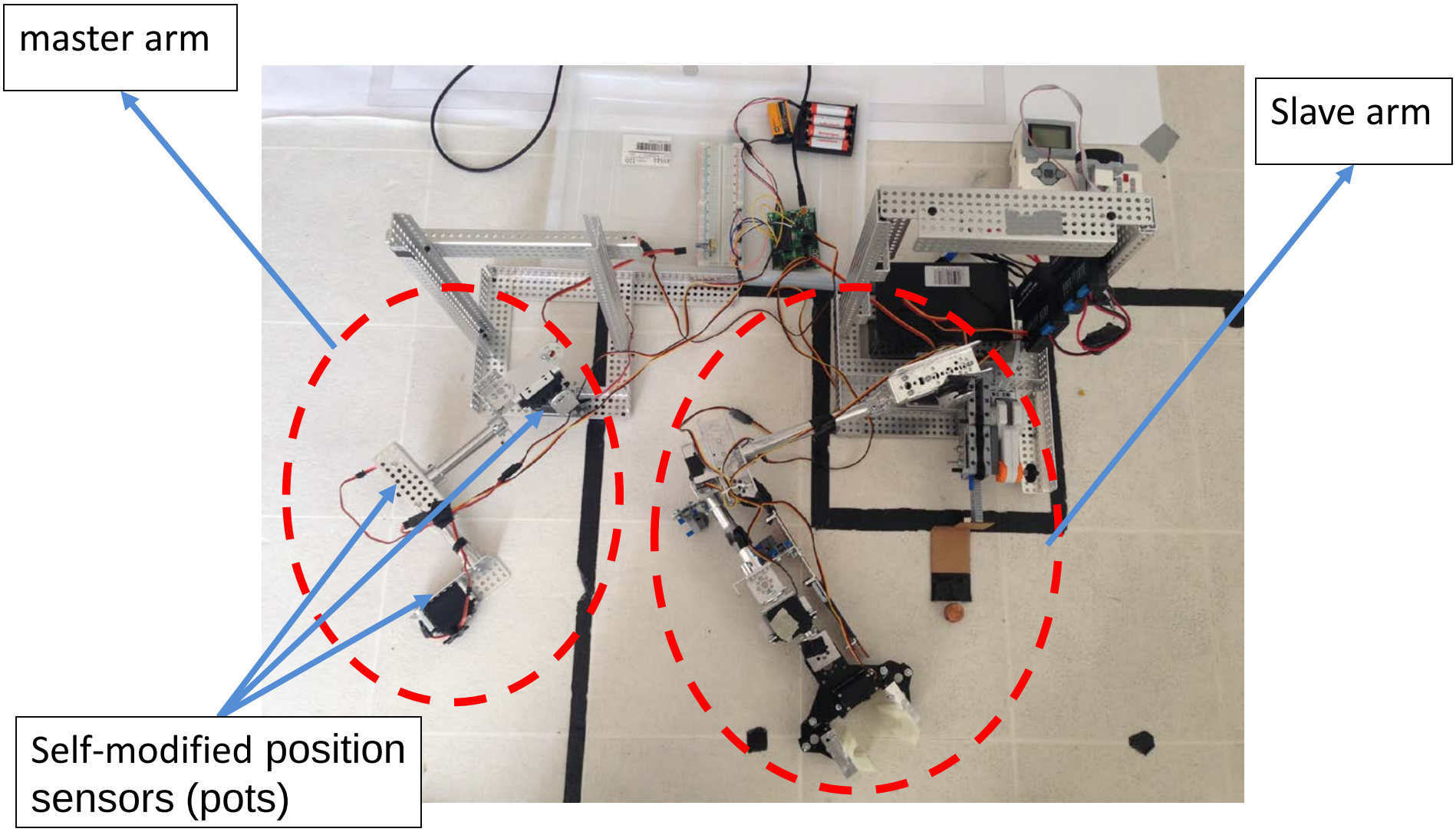
Partial Program Used in Remote Controlled Arm Control



(2) Master and slave control system

- Arduino based micro-controller
- 5 servos (2 x MG 995, 3 x HS-485HB)
- master control system, using modified servo motors
- 6V USB or wall adapter for modified servo (pots), and 9V for logic circuit
- C programming through Arduino IDE (integrated development environment)




master arm
Slave arm
Self-modified position sensors (pots)

Partial Program Used in Master/Slave Controlled Arm Control

masterslave_test_BU

```
Servo hand;  // create servo object to control base servo
Servo griper;
```

Servo and pot pin definitions

```
int potpin5 = 5; // analog pin used to connect the base potentiometer
int potpin4 = 4; // analog pin used to connect the base potentiometer
int potpin3 = 3; // analog pin used to connect the base potentiometer
int potpin2 = 2; // analog pin used to connect the shoulder potentiometer
int potpin = 0; // analog pin used to connect the base potentiometer


int val1; //variable to read the value from the base analog pin
int val2;//variable to read the value from the shoulder analog pin
int val3;//variable to read the value from the shoulder analog pin
int val4;//variable to read the value from the shoulder analog pin
int val5;//variable to read the value from the shoulder analog pin

void setup()
{
```

Servo connections

```
    base.attach(13);      // attaches the servo on pin 3 to the servo object
    shoulder.attach(10); // attaches the servo on pin 5 to the servo object
    hand.attach(3); // attaches the servo on pin 5 to the servo object
    elbow.attach(5); // attaches the servo on pin 5 to the servo object
    griper.attach(2); // attaches the servo on pin 5 to the servo object

 }
```

Servo movement control

```
void loop()
{
    val1 = analogRead(potpin); // reads the value of the base potentiometer (value between 0 and 1023)
    val1 = map(val1, 0, 1023, 0, 179); // scale it to use it with the base servo (value between 0 and 180)
    base.write(val1); // sets the base servo position according to the scaled value
    delay(15); // waits for the base servo to get there
```

Robot Arm Demo Videos

Remote Controlled Robot Arm Video
(Click to play)

Master/Slave Controlled Robot Arm Video
(Click to play)

4. Project Summary

Things we have done:

- Fully functional self-built robot arm built from scratch
- Lego based mini-arm
- Well designed plastic end effecter
- RC control system and programming
- Master and slave control system and programming
- DIY position sensors (pots) for master/slave control

Things we can improve:

- Use more powerful servo motor for arm shoulder for arm lift-up
- Modify the arm to form 3D movement for better access to pennies
- Refinement of the Master/Slave system