LONDON SOUTH BANK UNIVERSITY

Design Engineering 2

Arduino Project: Robot Arm

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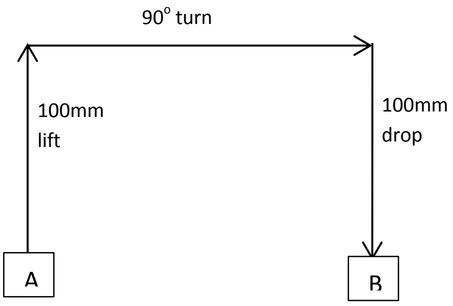
1.0 Abstract

To design and build a pick and place system which will use an electromagnet to pick up a steel paperclip from a point A, raise it by a height of 100 mm, move it around in an arc by 90º and place it at a point B.

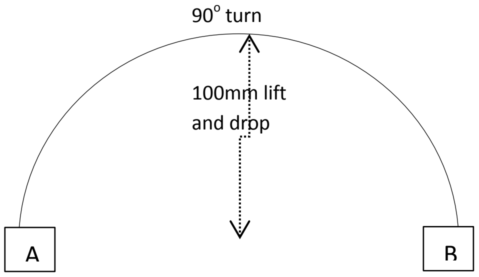
2.0 Manufacturing

The objective of this project was to form a robotic arm using a servo motor and a dc motor, to be able to perform a lift and drop of 100mm, with a 90° turn; this was to achieve a movement up and across from points A to B to pick and place 20 paper clips in a reliable and swift manner. Firstly, ways of shortening the typical procedure of this task were explored; it was decided to achieve the fastest time possible, so performing the tasks of the lift and turn at the same time were considered.

Regular System

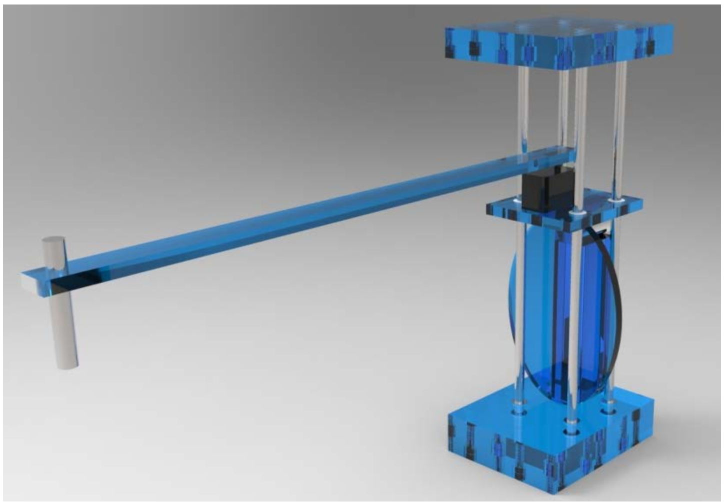


Our Reinvented System



Using the new system would shorten the time of lifting and dropping by completing the task in the centre of the 90° turn. The brief would be satisfied, but performing it in one smooth action in comparison to three, cutting the transaction time too for each action.

The first proposal of creating the lift in a continuous motion was to create an eccentric cam powered by the dc motor in order to lift the servo with the arm and magnet attached. This cam would give the correct lift every time in a continuous flow, while the servo's 90° turn would be timed to operate according to this. In order for the platform to lift and drop accurately on the cam, in needed to be guided. To solve this, silver steel runner rods were inbuilt for the platform to run off with nylon bushes to create a smooth lift with minimum friction acting against the motor.



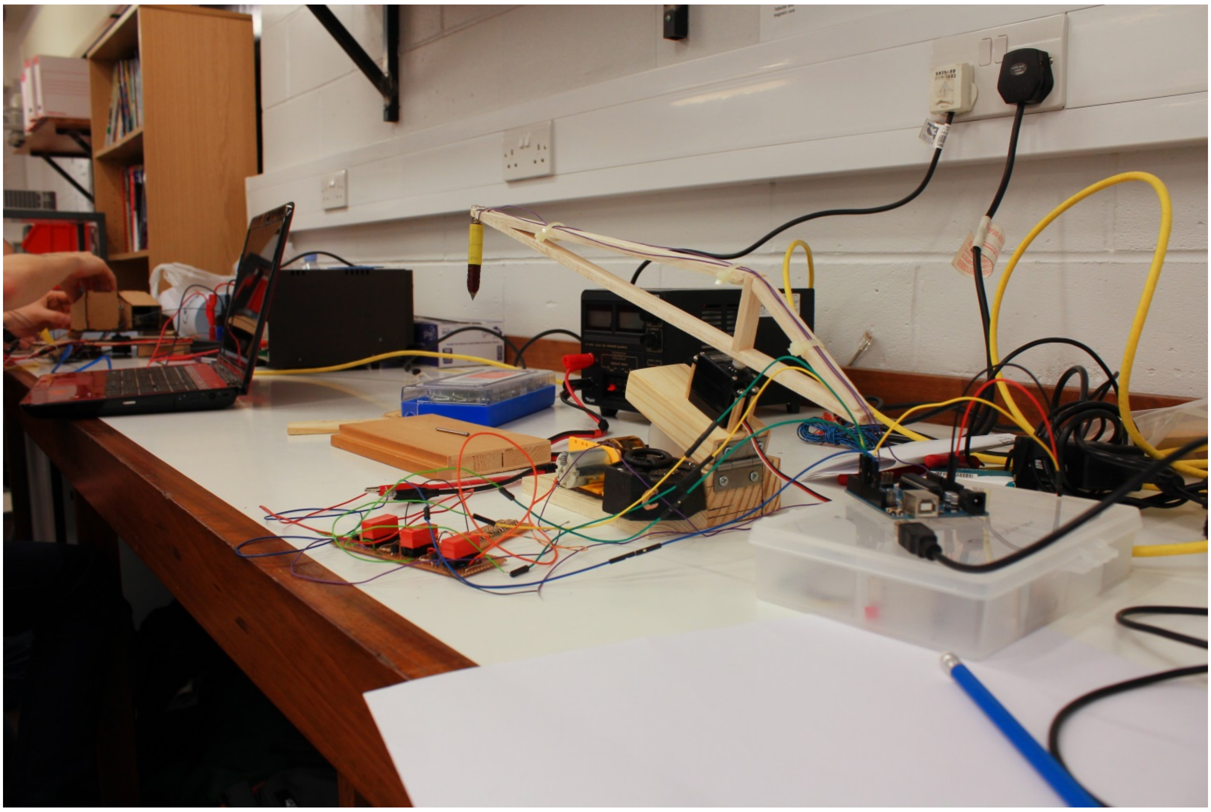
After producing and testing the design, numerous problems were encountered once wired up. These problems included:

- The motor did not provide enough torque for the cam to be turned at a relative speed and lift the servo, arm and magnet. It struggled and stalled with the weight.
- As the cam was lifting the platform from one side, the platform encountered friction on the rods from operating at a slight angle thus making the motion unsmooth and unreliable.

After two weeks of mechanical tweaking to the model in an attempt to overcome these issues, there seemed to be no solution for this design. Thus it was decided to re-design the model, taking into consideration the problems we had already faced.

The second proposed design was to incorporate the same arm movement of a smooth arc, by using an eccentric cam. The key difference being that instead of lifting a flat surface along parallel rods, the new design would lift a hinged platform thus angling the arm to give the final required height. It was also decided to keep the cam as near to the pivot point as possible so the size of the cam could be relatively small. A new arm was also designed and built to give further stability to the magnet at the end.

The new design gave slight issues such as to the accurate placement of the motor, cam and hinge to produce the desired lift. These issues were resolved within a fairly short time-frame and the model ended up working well. However, once the model was connected with the circuitry, a few issues arose. The amount of force the servo expended when rotating proved a little too much for the joint connecting it to the arm, which failed a few times. The overall look of the new design, having been built in a very limited time frame, was also not up to the standards of the group and did not reflect the same sort of aesthetics as the initial design.



Taking these issues into consideration a few mechanical changes would be made, had the group the chance to make them. The overall aesthetic of the design would be improved by using laser cut acrylic as with the first design, and taking such measure as to hide operational elements of the model such as the hinge, motor, gearbox etc. Also a more firm fixture would be used to join the arm to the servo, possibly a bolt through the servo's drive shaft. These changes would offer a better operating and more aesthetically pleasing robot.

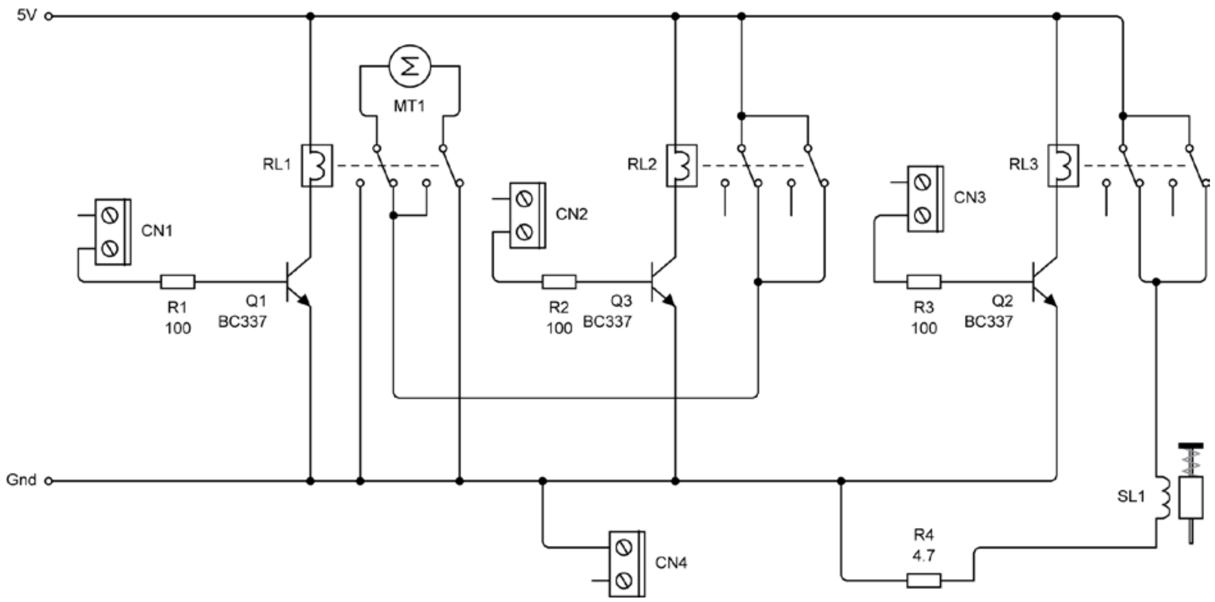
3.0 Electronics

An electronic circuit was built and paired with an Arduino Uno microcontroller to control the robotic mechanisms. A program was also written to efficiently repeat the cycle of picking up paper clips and transporting them as specified.

The circuit was constructed following the diagram below. Relays were used to switch specific functions on/ off and timings of each function were programmed using the Arduino software. Appropriate timings were chosen by trial and error.

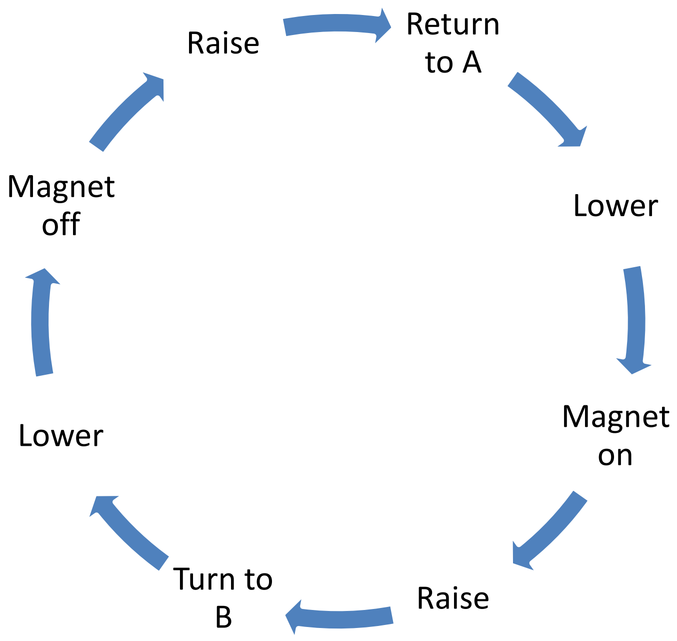
Terminal blocks CN1, CN2 and CN3 represent Arduino input terminals. CN4 grounds the Arduino.

The circuit was constructed onto copper strip board. Calculations were made as to what appropriate resistor value would protect the electromagnet from overheating. An array of resistors was used in parallel as substitute for a resistor with a higher Watt rating.



4.0 Programming

Initially the logical order of actions was drafted, to simplify the programming process. Then each action was written out in code, in the order in which they needed to happen.



Raise

Return to A

Lower

Magnet on

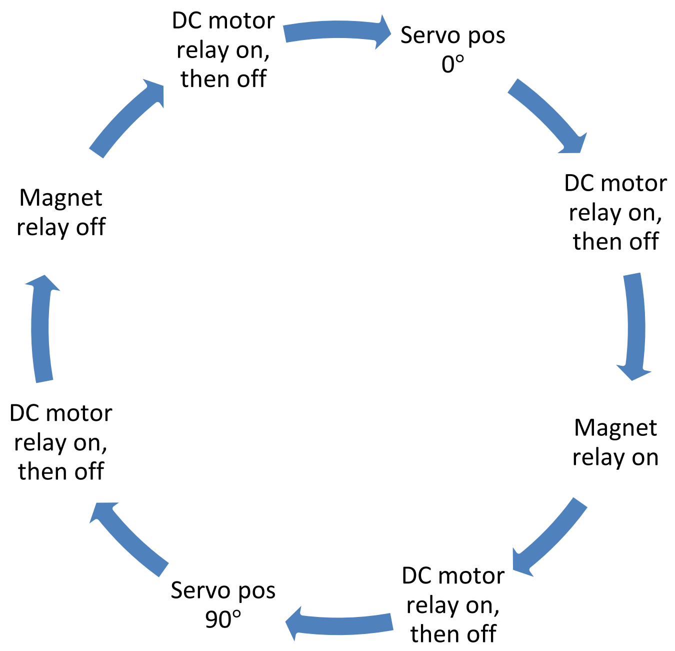
Raise

Turn to B

Lower

Magnet off

The components required to perform each action is illustrated in the diagram below.


DC motor relay on, then off
Servo pos 0°
DC motor relay on, then off
Magnet relay on
DC motor relay on, then off
Servo pos 90°
DC motor relay on, then off
Magnet relay off

The reverse relay was not employed since the cam mechanism made it redundant. However the electronics were kept in case of design changes required their use. The problem of using a cam was that without means to control the position of the cam, the mechanical operation becomes difficult to reproduce. This also made it difficult to compensate for when the cam is moving to it's high position and low position. As the cam slows down faster as it rotates to its high position, since it's working against gravity. Likewise for when the cam is rotating to it's lower position, when it's working with gravity.

5.0 Conclusion

The issues with the mechanics was not resolved, therefor efficient motion could not be achieved. Mechanical components need to move with low friction in the correct range of motion.

6.0 Appendix

```
/*  Code designed by Daniel Alexander and Sabiha Kelesoglu. */

#include <Servo.h>

 Servo myservo;  // create servo object to control a servo

            // a maximum of eight servo objects can be created

 int pos = 0;    // variable to store the servo position

 void setup() {

  // initialize the digital pin as an output.

pinMode(6, OUTPUT);  //magnet

pinMode(8, OUTPUT);   // switch relay

pinMode(7, OUTPUT); // reverse relay
```

```
 myservo.attach(9);  // attaches the servo on pin 9 to the servo object
}
void loop() {


 digitalWrite(8, HIGH);   // switch relay on
  delay(700);           //  rise
 digitalWrite(8, LOW);    //switch relay off
 for(pos = 0; pos < 90; pos += 1)  // goes from 0 degrees to 90 degrees
  {                                  // in steps of 1 degree
    myservo.write(pos);              // tell servo to go to position in variable 'pos'
    delay(50);                       // waits 15ms for the servo to reach the position
  }
digitalWrite(8, HIGH);   // switch relay on
  delay(500);           //  lower
 digitalWrite(8, LOW);   //  switch relay off
 digitalWrite(6, LOW);    //magnet relay off
delay(1000);
digitalWrite(8, HIGH);   // switch relay on
delay(700);           //  rise
digitalWrite(8, LOW);    //switch relay off
  for(pos = 90; pos>=1; pos-=1)     // goes from -90 degrees to 0 degrees
  {
    myservo.write(pos);              // tell servo to go to position in variable 'pos'
    delay(50);                       // waits 15ms for the servo to reach the position
  }
digitalWrite(8, HIGH);   // switch relay on
 delay(500);           //  lower
digitalWrite(8, LOW);   //  switch relay off
digitalWrite(6, HIGH);    //magnet relay on
delay(1000);
}
```