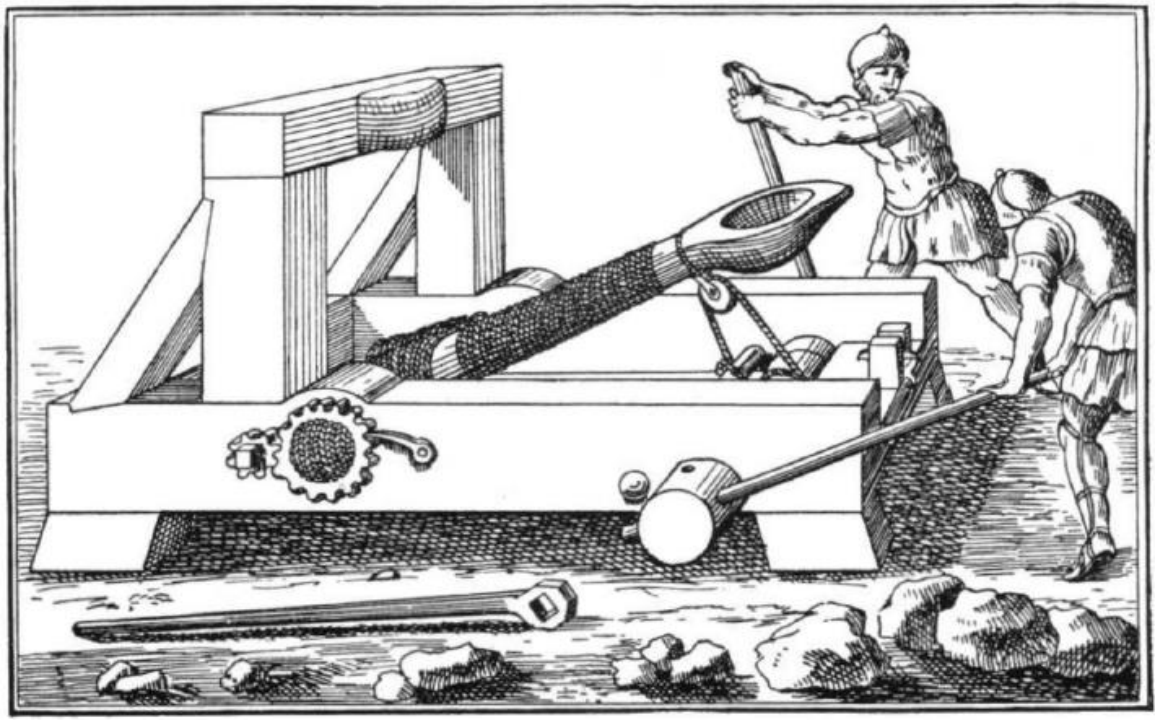
Engineering Design Project I
UTA013

Dr. Poonam Verma
Assistant Professor
ECED, TIET, Patiala

Engineering Design Project-I: Mangonel

- In Engineering Design Project-I, Mangonel (Roman catapult) is to be designed and implemented.



Mangonel: Electronics Part

The Electronic Part is divided into 4 sections:

- Programming of Arduino Digital I/O pins for various applications.
- Sensing any activity through Arduino and instructing accordingly. Also, data capturing through sensors.
- Interfacing of hardware and software to do a specific task (using 7-segment display)
- Develop a micro-electronic circuit to determine and display the angular velocity of the throwing arm.

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Objective

1. To compute the time taken by Mangonel arm to cross two IR sensor pairs using Arduino.

2. To display the computed time on 7-segment display.

3. To compute the angular velocity of the throwing arm.

Objective-1: Computation of time

Following steps are executed to compute the time of throwing arming

1. Capture two IR sensor signals from the Mangonel.
2. Combine these two signals into a single signal using AND gate.
3. Convert the resulting signal into a long pulse using JK flip-flop.
4. Compute the length of the pulse with the help of pulseIn function in Arduino.

Objective-1: (Cont…)

Following steps are executed to compute the time of throwing arming

1. **Capture the IR sensor signals from the Mangonel.**
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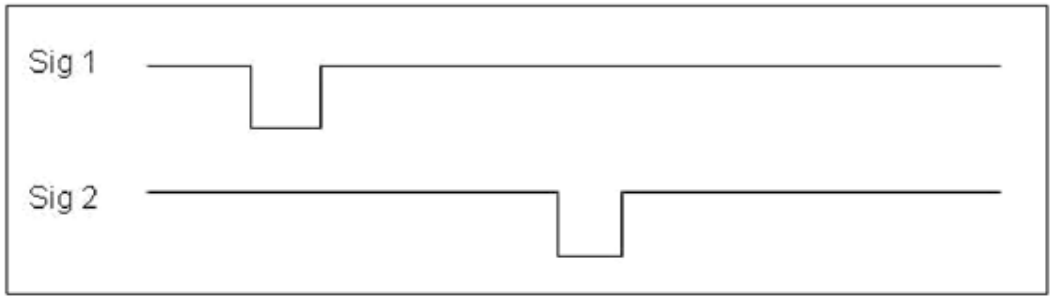
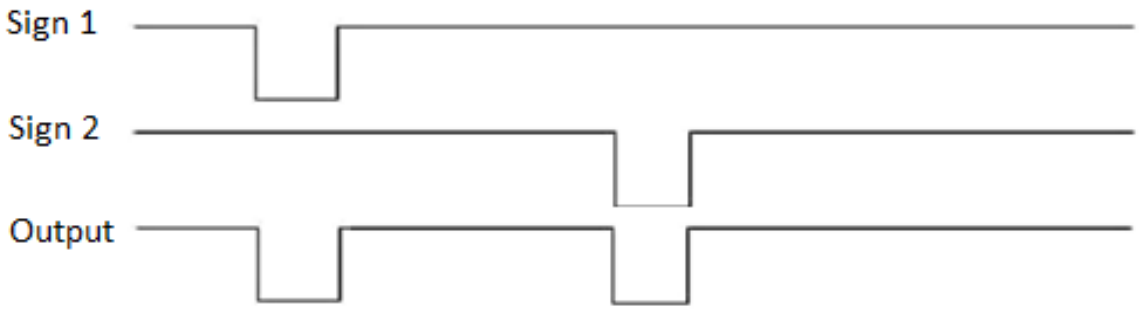


Objective-1: (Cont…)

Following steps are executed to compute the time of throwing arming

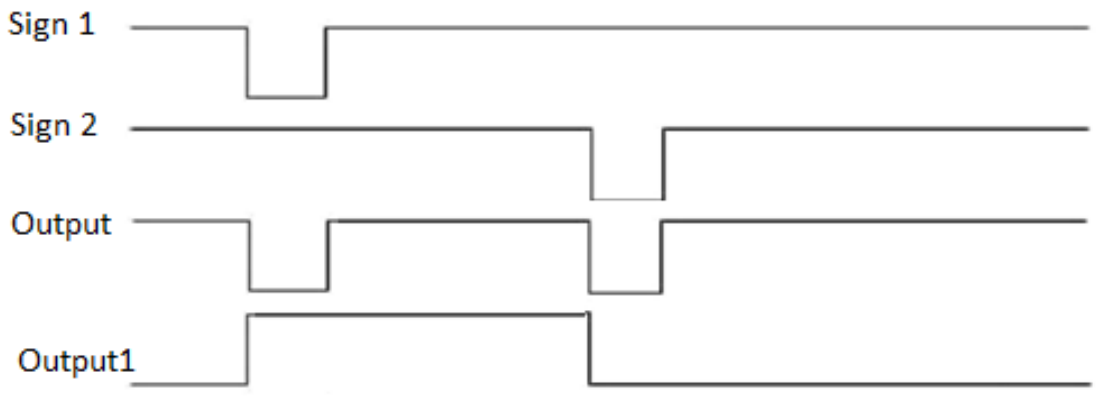
1. Capture two IR sensor signals from the Mangonel.
2. **Combine these two signals into a single signal using AND gate (IC CD4081).**
3. Convert the resulting signal into a long pulse using JK flip-flop.
4. Compute the length of the pulse with the help of pulsein function in Arduino.



Objective-1: (Cont…)

Following steps are executed to compute the time of throwing arming

1. Capture two IR sensor signals from the Mangonel.
2. Combine these two signal into a single signal using AND gate.
3. **Convert the resulting signal into a long pulse using JK flip-flop (IC CD4027).**
4. Compute the length of the pulse with the help of pulsein function in Arduino.



Objective-1: (Cont…)

Following steps are executed to compute the time of throwing arm

1. Capture two IR sensor signals from the Mangonel.
2. Combine these two signal into a single signal using AND gate.
3. Convert the resulting signal into a long pulse using JK flip-flop.
4. **Compute the length of the pulse with the help of *pulseIn* function in Arduino.**

PulseIn function

- Reads a pulse (either HIGH or LOW) on a pin.
- If value is HIGH, pulseIn() waits for the pin to go from LOW to HIGH, starts timing, then waits for the pin to go LOW and stops timing.
- It returns the length of the pulse in μs or gives up and returns 0 if no complete pulse was received within the timeout.
- Works on pulses from 10 μs to 3 minutes in length.

PulseIn(): Syntax

- pulseIn(pin, value)
- pulseIn(pin, value, timeout)

PulseIn(): Parameters

- pin: the number of the pin on which you want to read the pulse. (int)
- value: type of pulse to read: either HIGH or LOW. (int)
- timeout (optional): the number of μs to wait for the pulse to start; default is one second (unsigned long)
- It returns the length of the pulse (in microseconds) or 0 if no pulse started before the timeout (unsigned long)

PulseIn(): Example code

The example calculate the time duration of a pulse on pin 7.

```
int pin = 7;
unsigned long duration;
void setup()
{
  pinMode(pin, INPUT);
}
void loop()
{
  duration = pulseIn(pin, HIGH);
}
```

Objective-2: Display time on 7-segment

```
void setup()
{
  pinMode(2, OUTPUT);       // D0
  pinMode(3, OUTPUT);       // D1
  pinMode(4, OUTPUT);       // D2
  pinMode(5, OUTPUT);       // D3 (MSB)
  pinMode(6, OUTPUT);       // Latch Disable 0
  pinMode(9, OUTPUT);       // Latch Disable 1
  pinMode(8, OUTPUT);       // Latch Disable 2
  pinMode(10, OUTPUT);      // reset pin
  pinMode(13, INPUT);       // received from JK flip flop
}
```

Objective-2: Display time on 7-segment

- void loop()
- {
  digitalWrite(10, HIGH);
  digitalWrite(10, LOW);
- unsigned int a = pulseIn(13,HIGH,180000000);
- // returns a 5 digit number
  int b=a/100; // returns a 3 digit number
  int c=b%10; // extracts LSB
  int d=a/1000; // returns a 2 digit number
  int e=d/10; // returns MSB
  int f=d%10;

Objective-2: Display time on 7-segment

- int i= c%2;
- int j= (c/2)%2;
- int k= (c/4)%2;
- int l=(c/8)%2; // Converts the BCD equivalent of decimal number.

- digitalWrite(2, i);
- digitalWrite(3, j);
- digitalWrite(4, k);
- digitalWrite(5, l);
- digitalWrite(6, HIGH);
- digitalWrite(6, LOW);

Objective-2: Display time on 7-segment

- int m=f%2;
- int n=(f/2)%2;
- int o=(f/4)%2;
- int p=(f/8)%2;

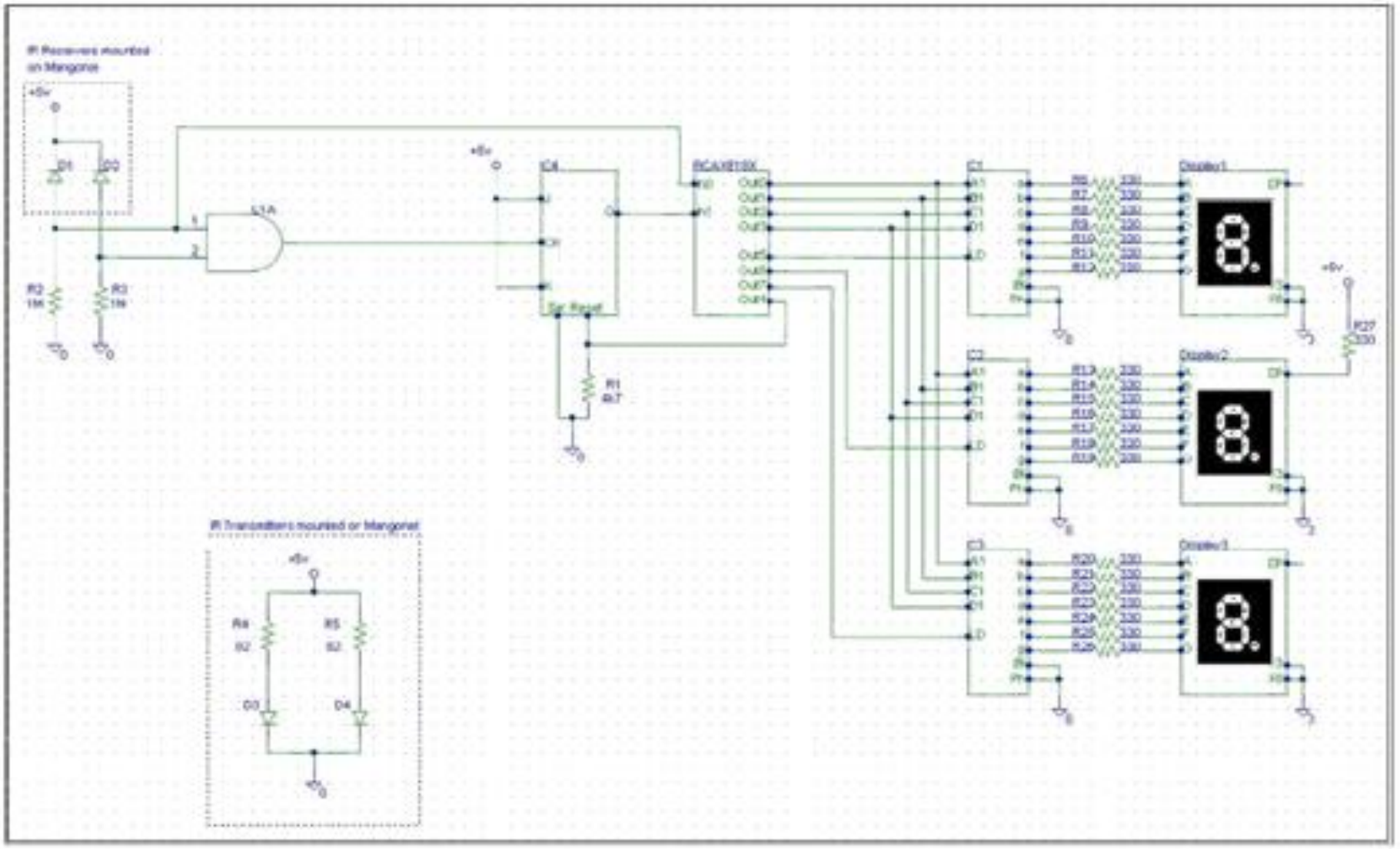
- digitalWrite(2, m);
- digitalWrite(3, n);
- digitalWrite(4, o);
- digitalWrite(5, p);
- digitalWrite(8, HIGH);
- digitalWrite(8, LOW);

Objective-2: Display time on 7-segment

- int q=e%2;
- int r=(e/2)%2;
- int s=(e/4)%2;
- int t=(e/8)%2;

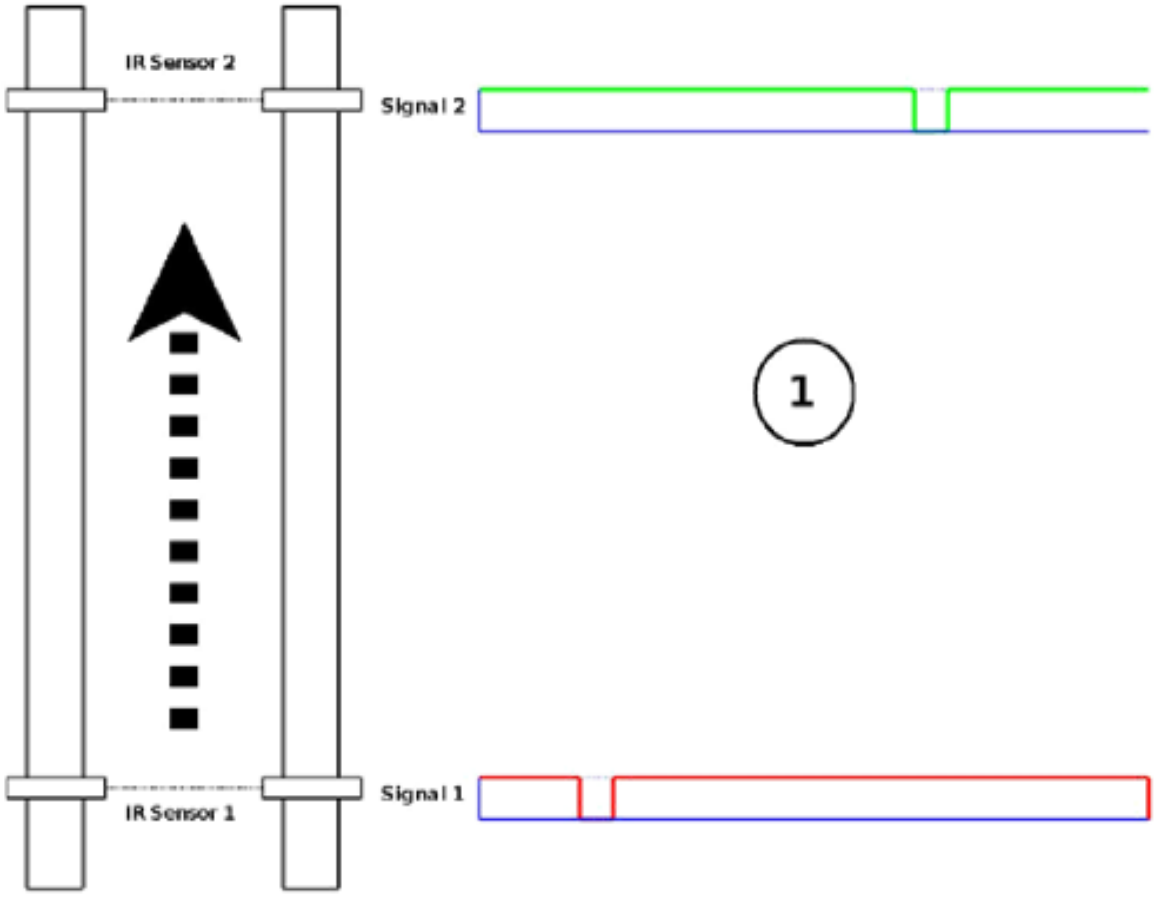
- digitalWrite(2, q);
- digitalWrite(3, r);
- digitalWrite(4, s);
- digitalWrite(5, t);
- digitalWrite(9, HIGH);
- digitalWrite(9, LOW);

Schematic Diagram



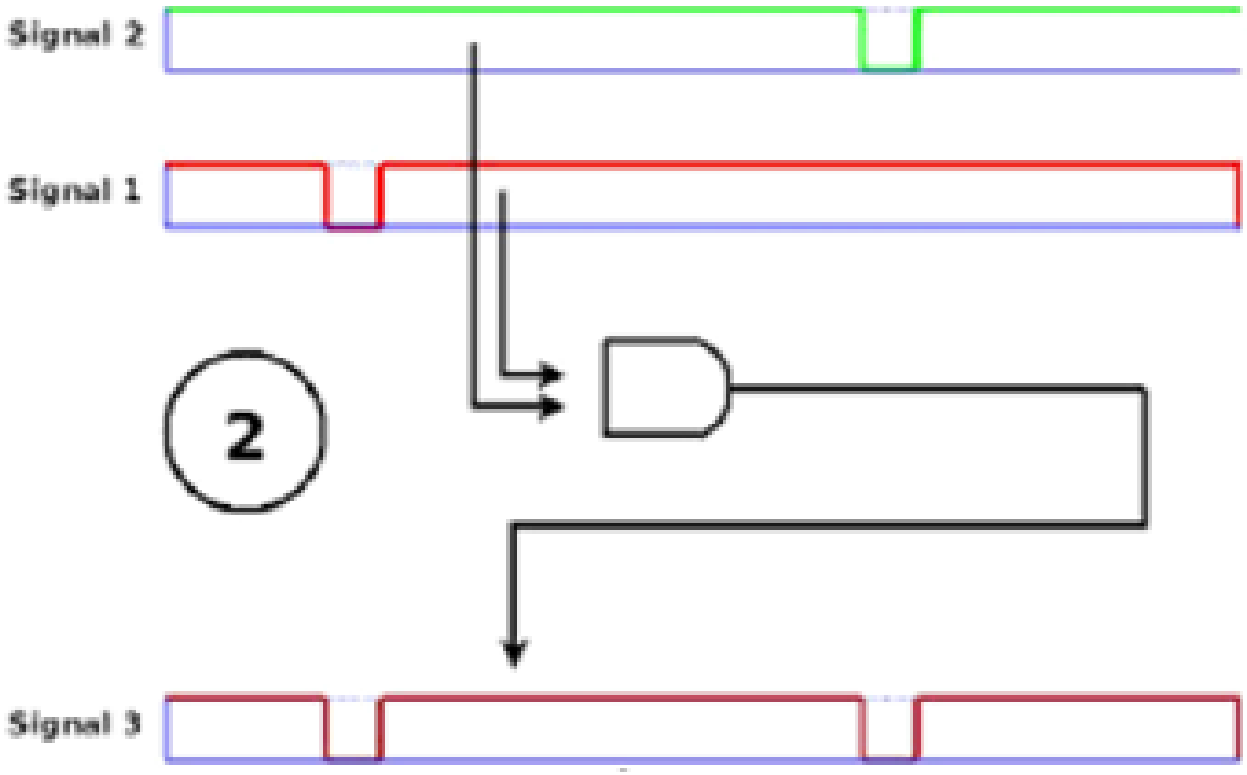
Flow diagram for the Task

- Step 1: Extraction of signals from sensors.



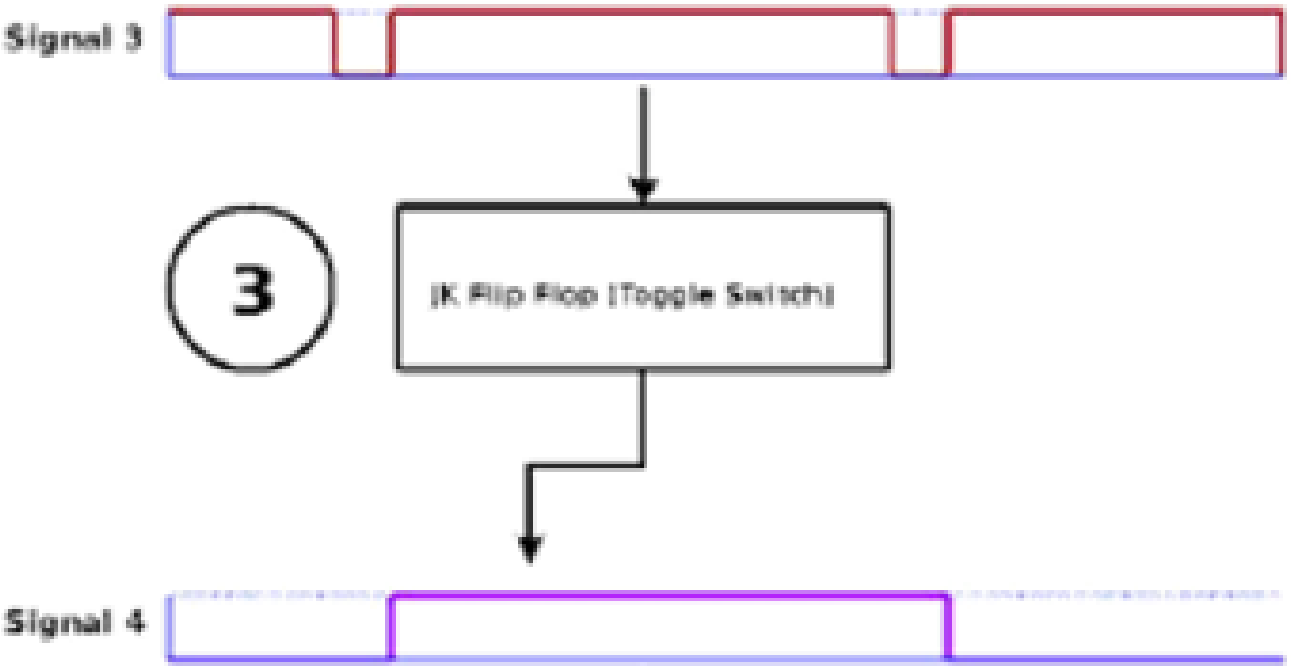
Flow diagram for the Task

- Step 2: Combining two sensed signals into one.



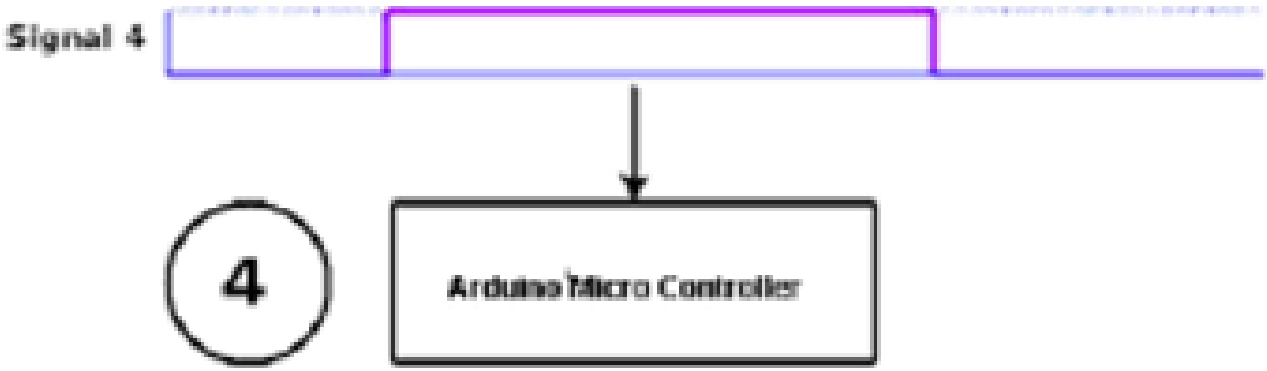
Flow diagram for the Task

- Step 3: Generate long pulse using JK flip-flop.



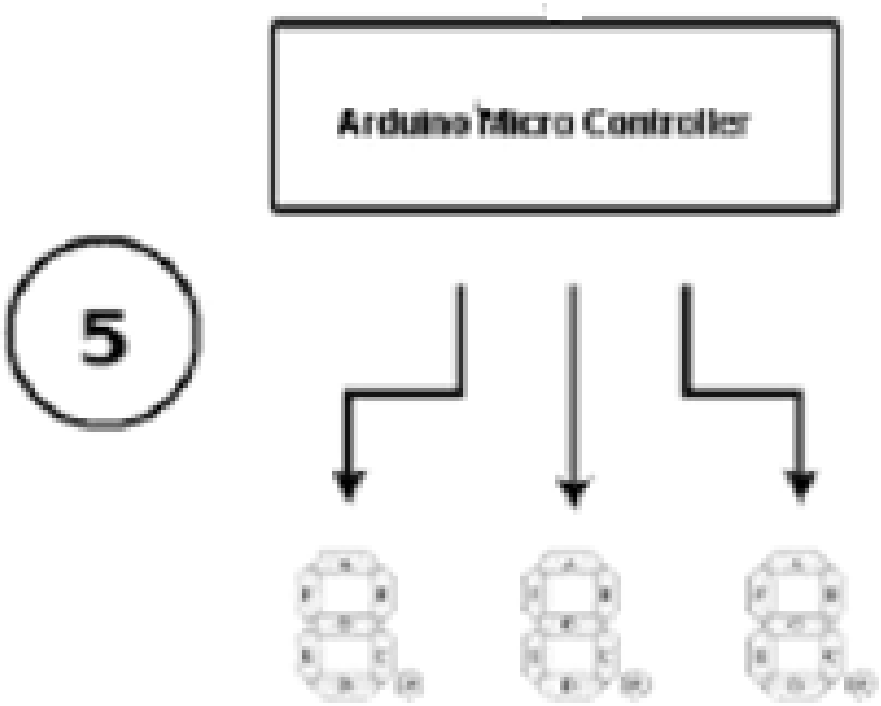
Flow diagram for the Task

- Step 4: Measure the pulse width using Arduino.



Flow diagram for the Task

- Step 5: Display the measured pulse width on 7-segment display.



Objective3: Computation of Angular Velocity

- Angular velocity (w) = θ/t
  where θ is angle in radian

- The value of $\theta = (\pi/180)x45 = 0.785$

- The angle 45^0 is the angle between two sensors with respect to the centroid.

- The display procedure will be same as that of time.

Cont…

- Two subroutine will be created.

- One subroutine for displaying the time and other for the angular velocity.

Conclusion

- View the Mangonel project

Thanks