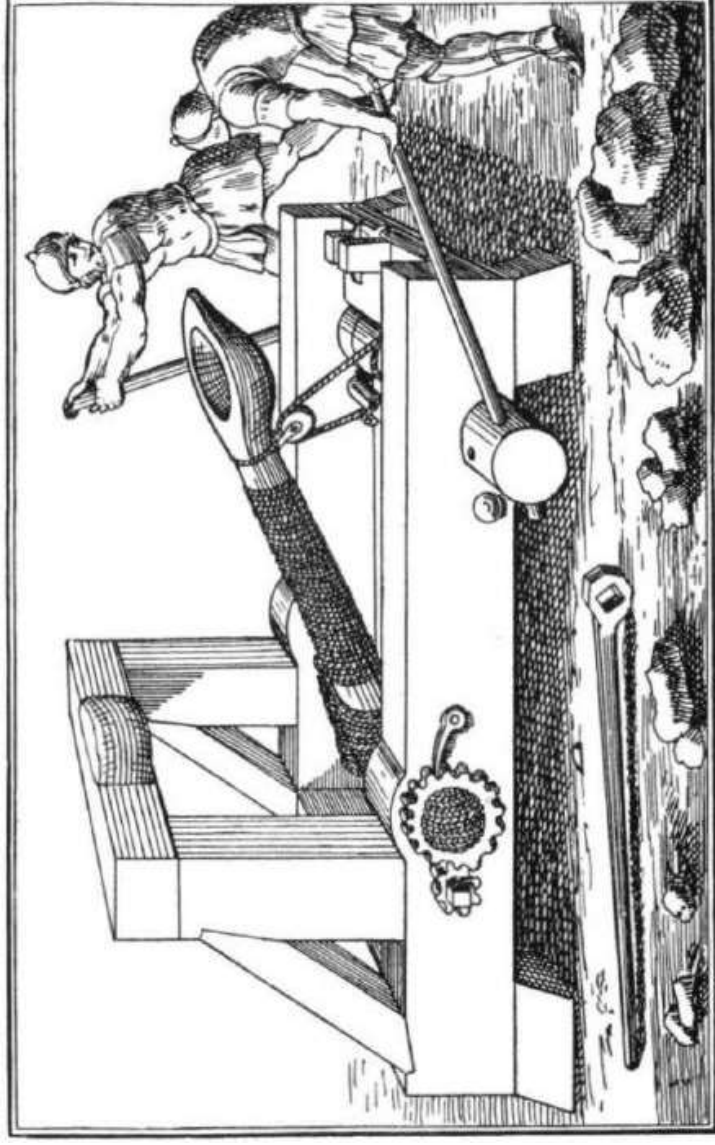


Engineering Design Project-I: Mangonel

- 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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- Programming of Arduino Digital I/O pins for various applications.
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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

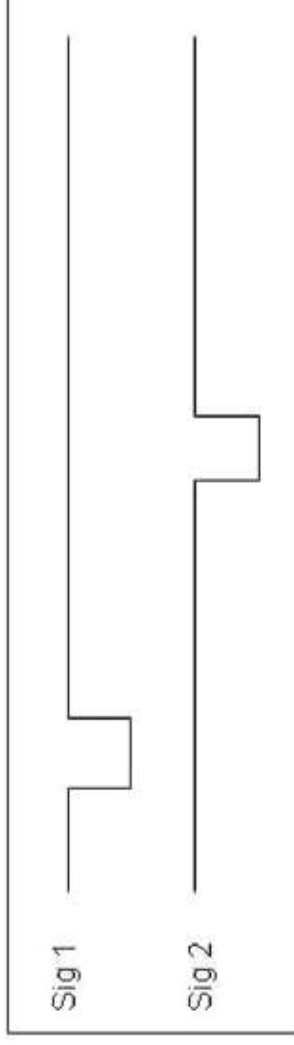
1. Capture two IR sensor signals from the Mangonel.
2. Combine these two signals into a single signal using AND gate.
3. Convert the resulting signal into a long pulse using JK flip-flop.
4. Compute the length of the pulse with the help of pulseIn function in Arduino.



Objective-1: (Cont...)

Following steps are executed to compute the time of throwing arming

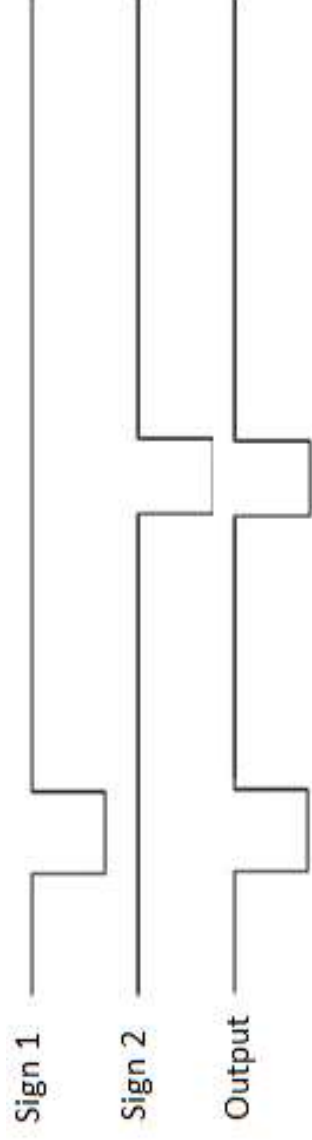
1. **Capture the IR sensor signals from the Mangonel.**
2. Combine these two signals into a single signal using AND gate.
3. Convert the resulting signal into a long pulse using JK flip-flop.
4. Compute the length of the pulse with the help of pulsein function in Arduino



Objective-1: (Cont...)

Following steps are executed to compute the time of throwing arming

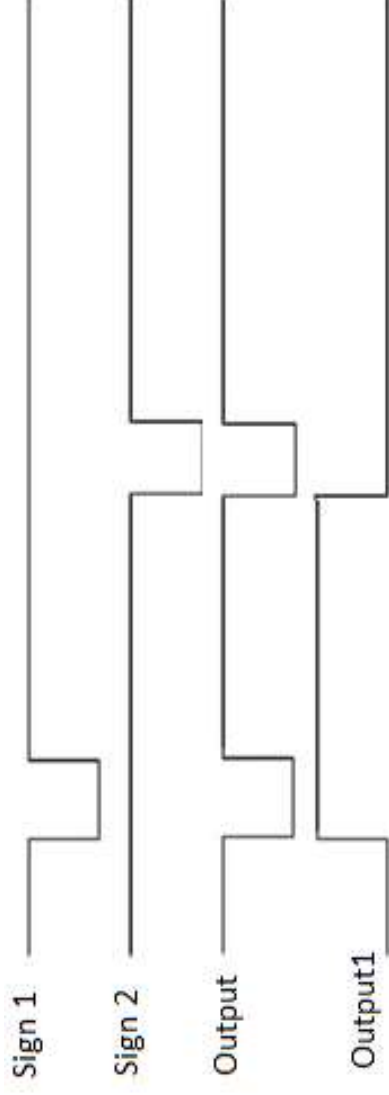
1. Capture two IR sensor signals from the Mangonel.
2. **Combine these two signals into a single signal using AND gate (IC CD4081).**
3. Convert the resulting signal into a long pulse using JK flip-flop.
4. Compute the length of the pulse with the help of pulsein function in Arduino.



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,18000000);
- // 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;`

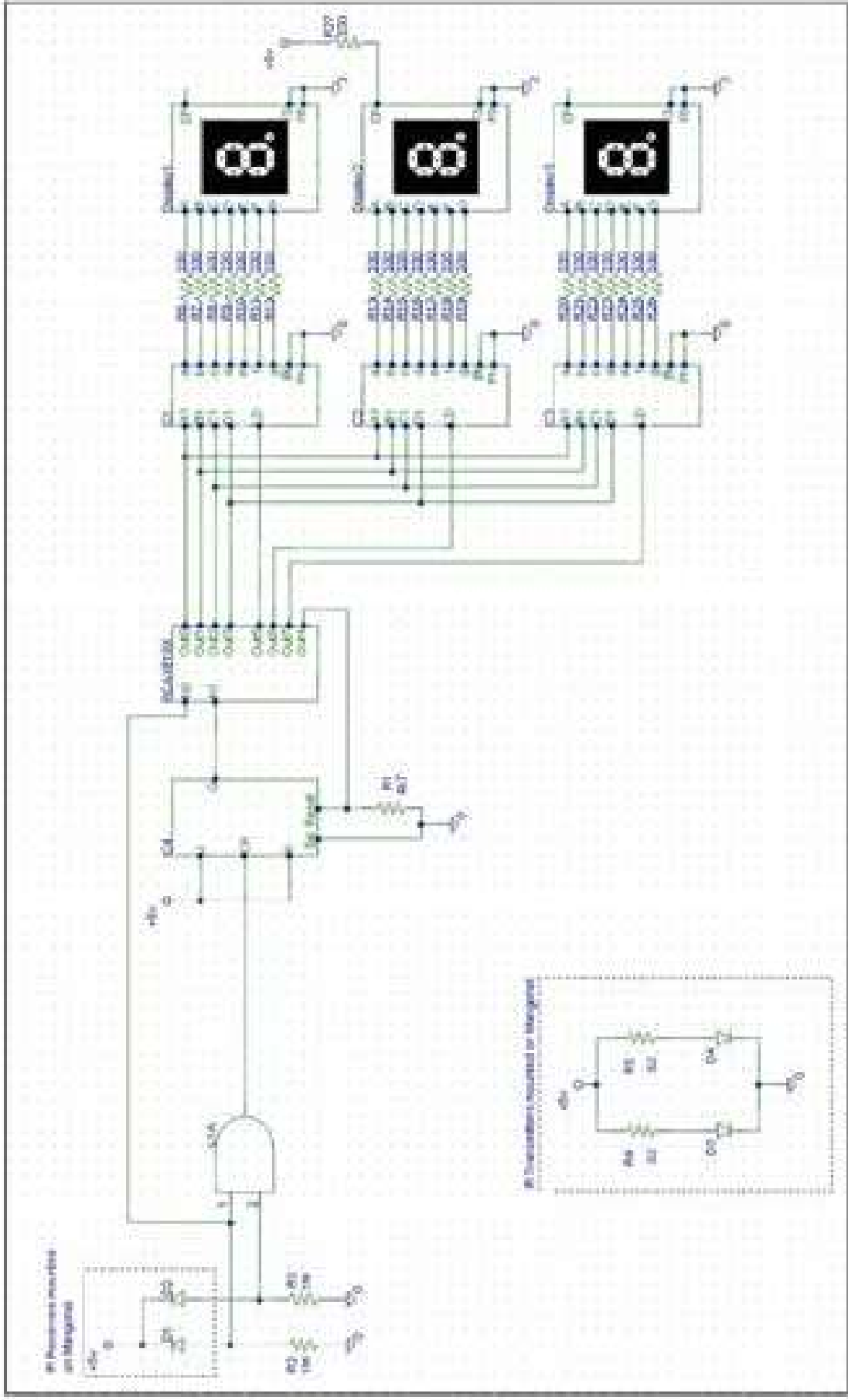
- `digitalWrite(2, m);`
- `digitalWrite(3, n);`
- `digitalWrite(4, o);`
- `digitalWrite(5, p);`
- `digitalWrite(8, HIGH);`
- `digitalWrite(8, LOW);`

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;`

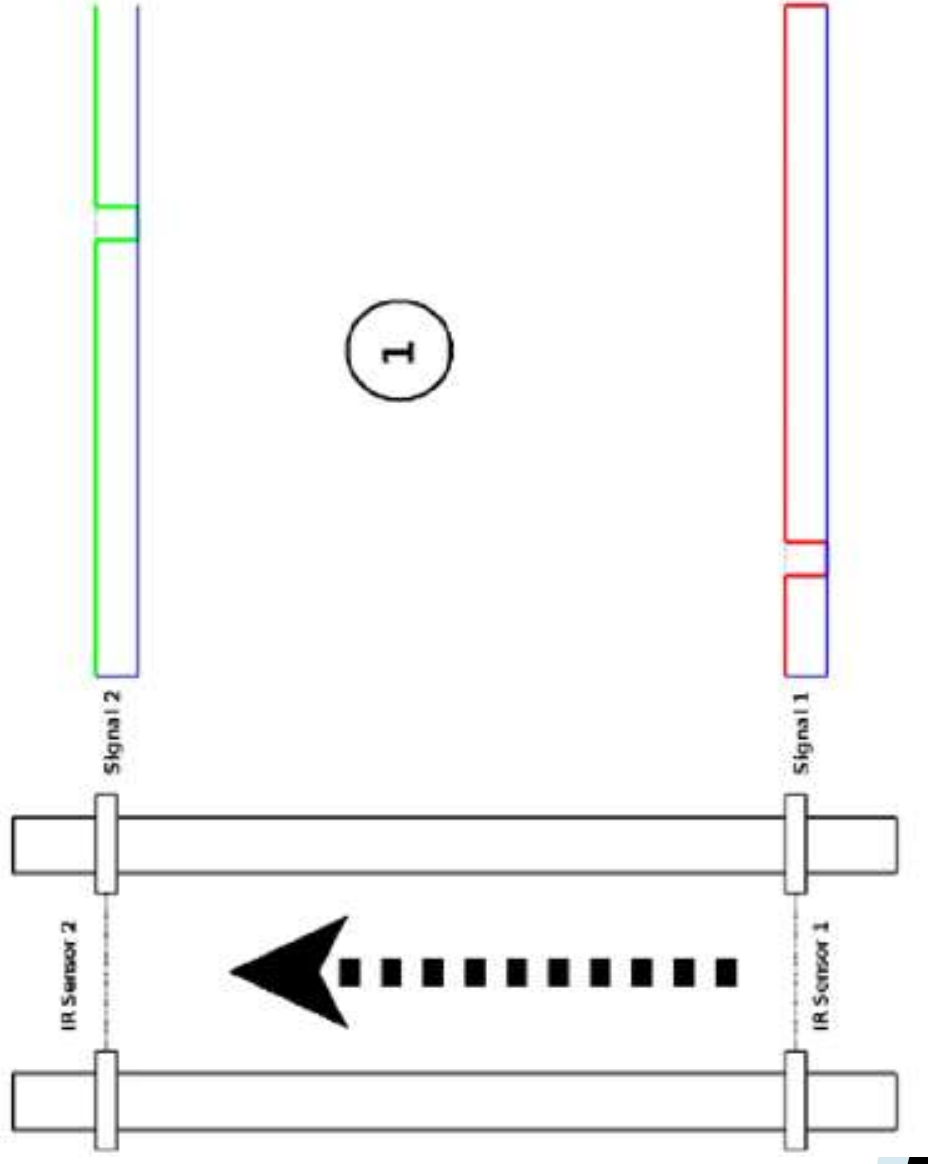
- `digitalWrite(2, q);`
- `digitalWrite(3, r);`
- `digitalWrite(4, s);`
- `digitalWrite(5, t);`
- `digitalWrite(9, HIGH);`
- `digitalWrite(9, LOW);`

Schematic Diagram



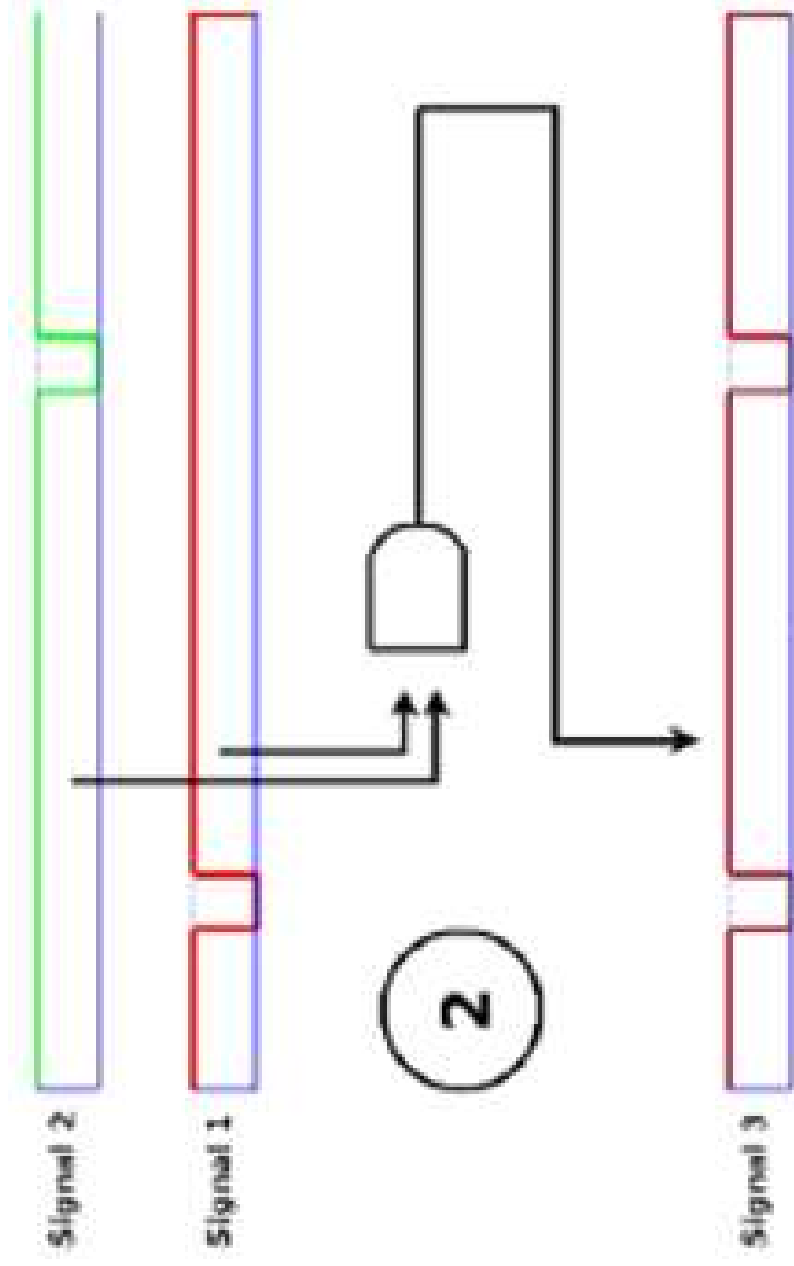
Flow diagram for the Task

- Step 1: Extraction of signals from sensors.



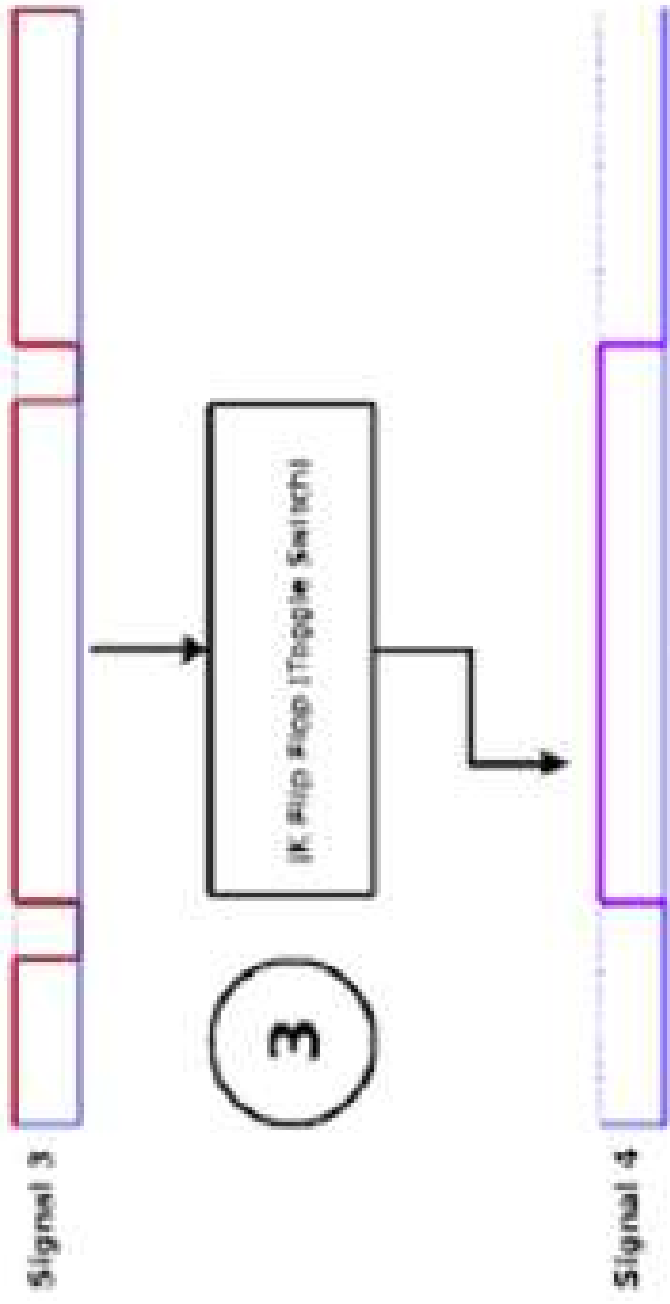
Flow diagram for the Task

- Step 2: Combining two sensed signals into one.



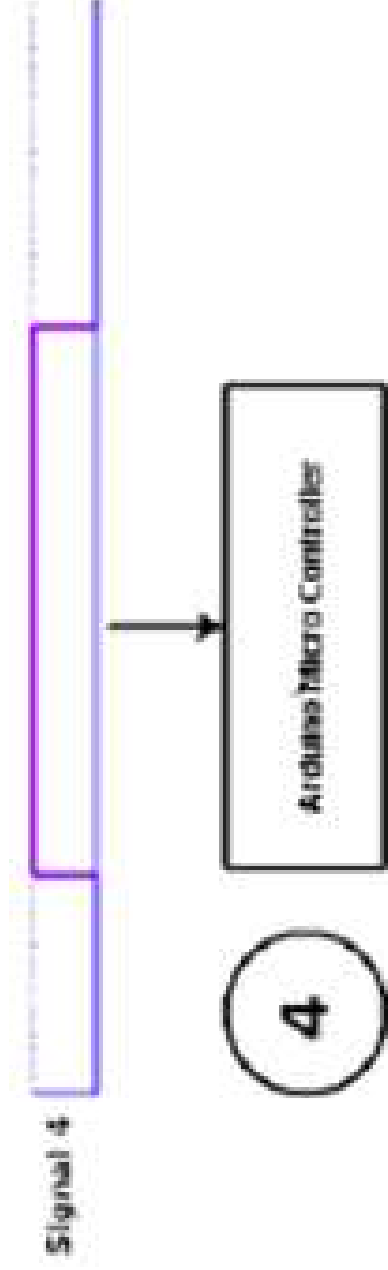
Flow diagram for the Task

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



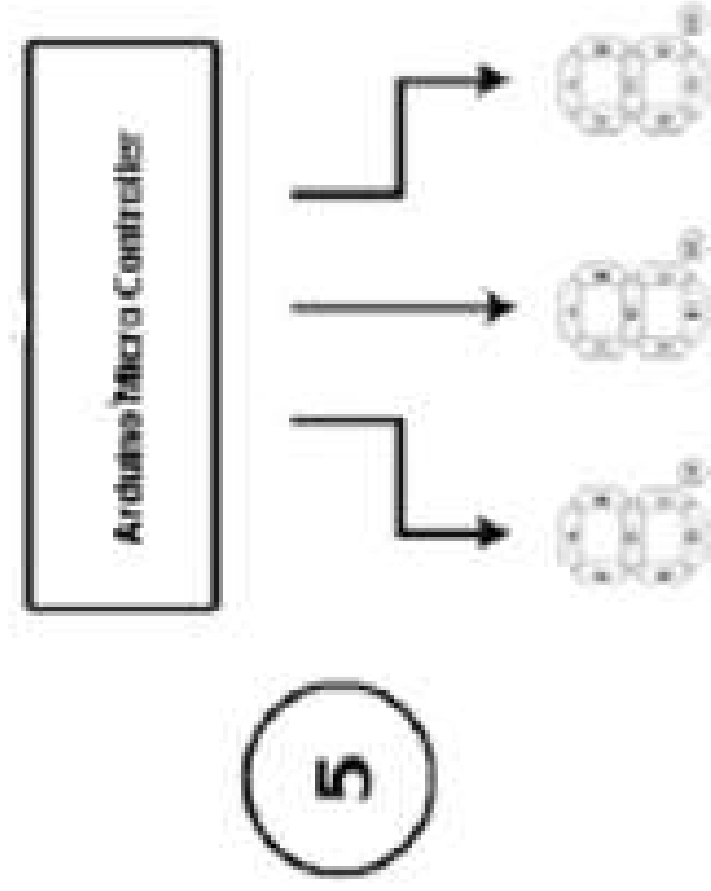
Flow diagram for the Task

- 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 $\theta = (\pi/180) \times 45 = 0.785$
- The angle 45° 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

