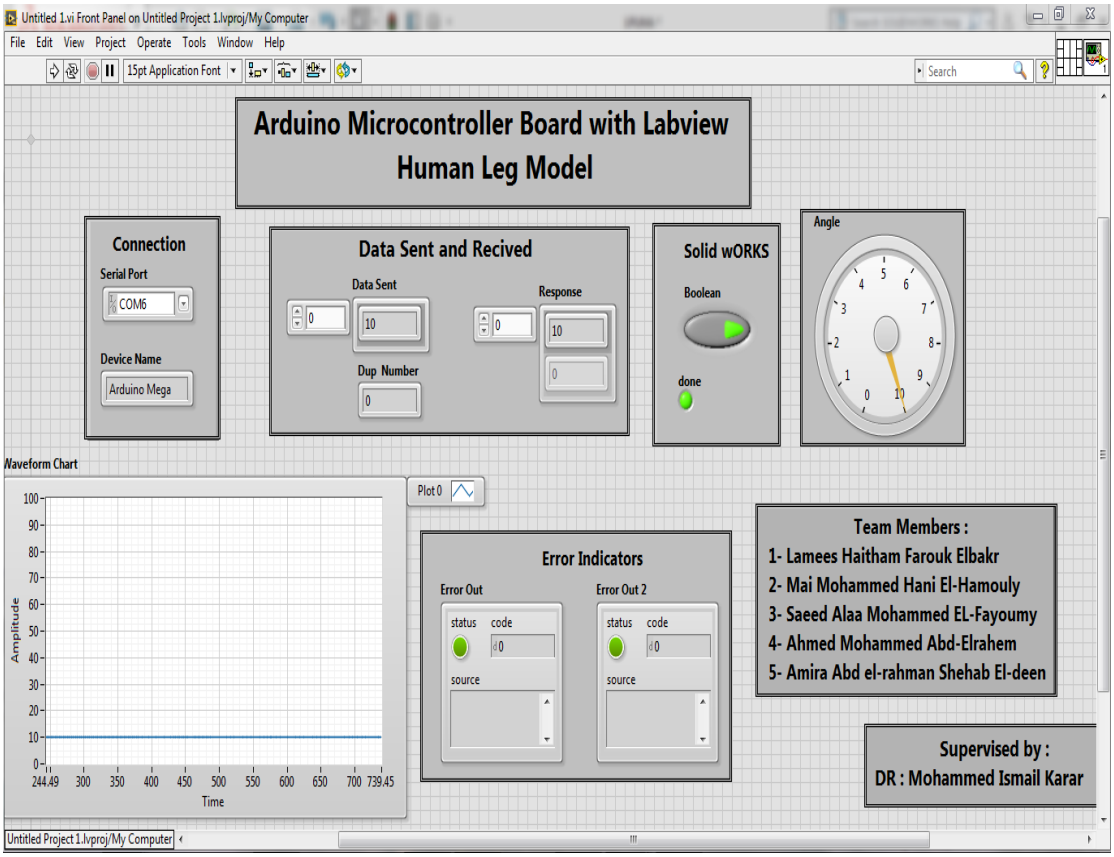
Arduino Microcontroller Board with Labview

Human Leg Model



Supervised by :

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Objective :

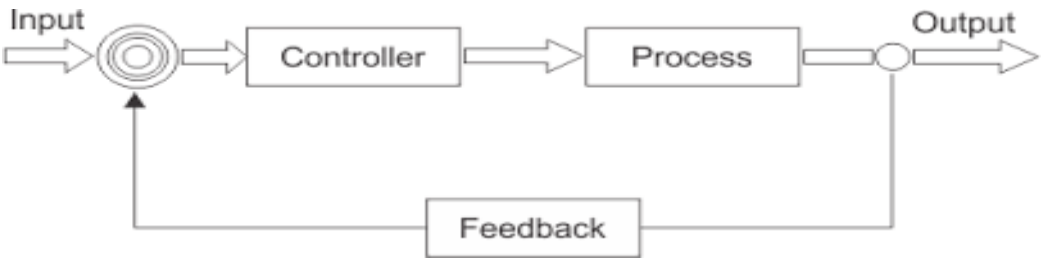
Designing a **simulation** system **for robotics** system for rehabilitation.

Rehabilitation robotics includes development of robotics devices for assisting patient.

Our **system** will aid the **patient** with **flexion deformity of knee** where they have inability to fully straighten their knee.

System Description :

The Block Diagram for any closed loop system is :



For our system :

Input : desired torque (Equivalent voltage)

Controller : PID controller based on Arduino

Process : Human Leg Mechanical Joint

Output : leg angle

The system is divided into 5 parts :

1- Modeling : implementation of mathematical model for human leg (simulated in labview)

2- controller : designing pid controller based on Arduino.

3-Simulation : system simulation with controller on solidworks

4- communication & GUI : connection between labview and Arduino and simulation GUI

5- Hardware : LCD interface to display output

Let's start to introduce our system in details :

For Modeling

System parameters :

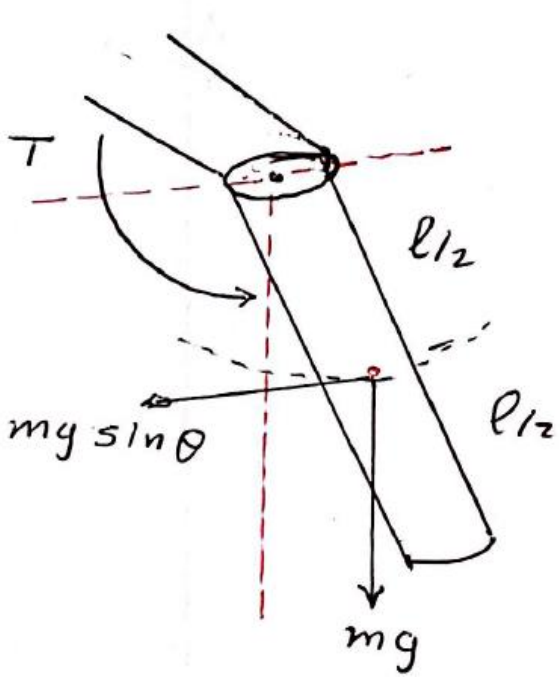
T : Applied Torque by muscles

D : Viscus Friction of the junction

L : Length

m : mass

J : inertia $\mathbf{J = m * g * \frac{L}{2}}$



Model transfer function :

$$\mathbf{J}\,\ddot{\theta} + \mathbf{D}\dot{\theta} + \frac{\mathbf{L}}{\mathbf{2}}\,\mathbf{mg}\sin(\theta) = \mathbf{T}$$

Linearizing Sin(θ) around $\theta = 0$

$$\mathbf{J}\,\ddot{\theta} + \mathbf{D}\dot{\theta} + \frac{\mathbf{L}}{\mathbf{2}}\,\mathbf{mg}\theta = \mathbf{T}$$

Applying Laplace transform

$$\mathbf{J}\,s^2\theta + \mathbf{D}s\theta + \frac{\mathbf{L}}{\mathbf{2}}\,\mathbf{mg}\theta = \mathbf{T}$$

$$\theta\left(\mathbf{J}\,s^2 + \mathbf{D}s + \frac{\mathbf{L}}{\mathbf{2}}\,\mathbf{mg}\right) = \mathbf{T}$$

$$\frac{\theta}{T} = \frac{1}{J s^2 + Ds + \frac{L}{2} mg}$$

let : j=1 , D = 0.6

$$\frac{\theta}{T} = \frac{1}{s^2 + 0.6s + 1}$$

For controller :

Implementation of pid using Arduino

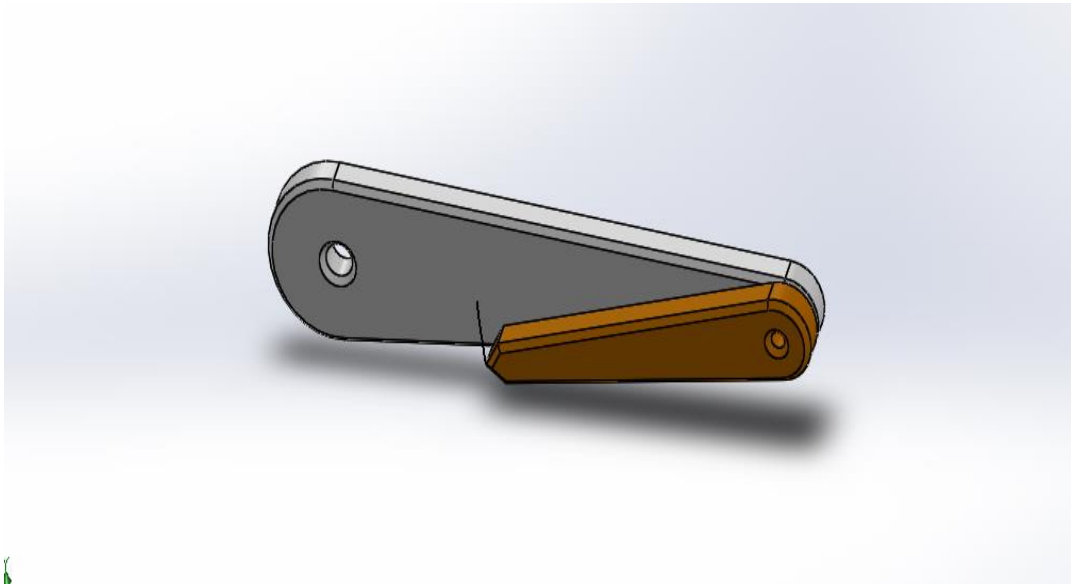
```
int myCustomCommand(unsigned char numInputBytes, unsigned char* input, unsigned char* numResponseBytes, unsigned char* response)

  data = input[0];      // feedback from labview
  //data=data/2;         //sensor conversion factor
  error= desired-data;
  s=s+error;
  sig=kp*error+ki*s+kd*(error-eold);
  response[0]=sig;
  lcd.setCursor(1,1);
  lcd.print("Angle : ");
  lcd.setCursor(10,2);
  lcd.print(sig);
  eold=error;
 *numResponseBytes = numInputBytes;

 return 0;
```

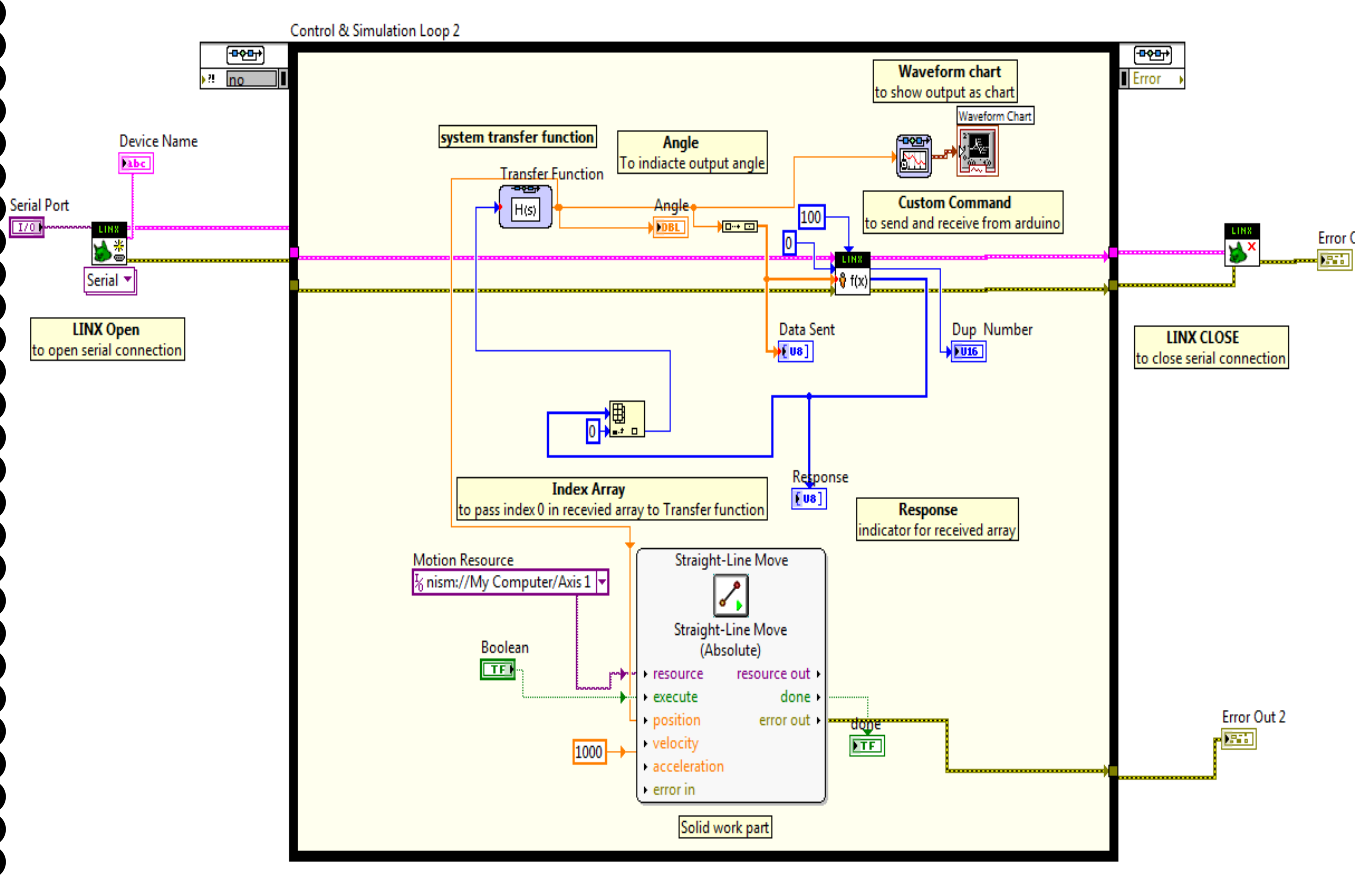
For Simulation

System model on solidworks

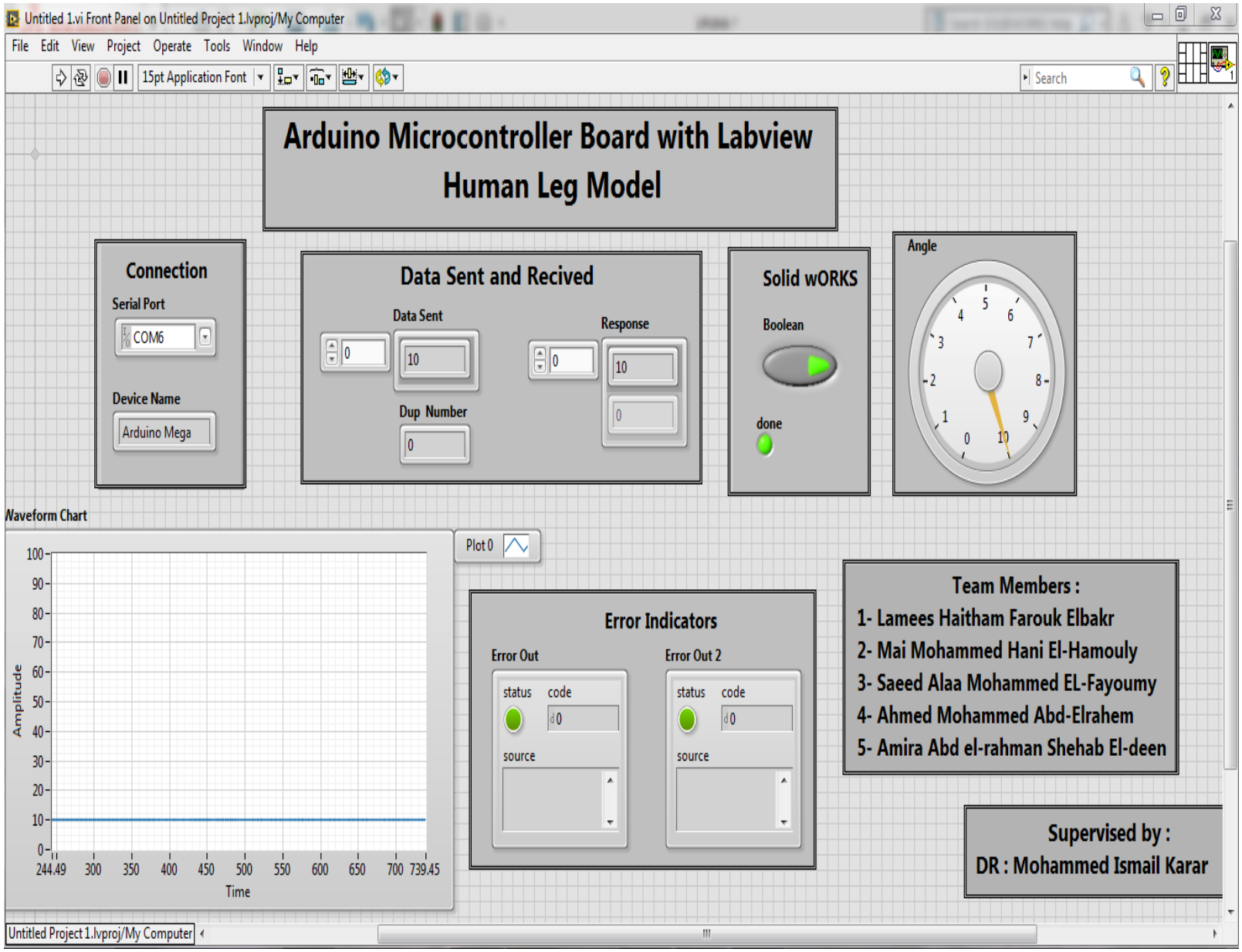


For communication & GUI

We use MakerHub LINX for communication between labview



Labview GUI


Untitled 1.vi Front Panel on Untitled Project 1.lvproj/My Computer
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Solid wORKS
Boolean
done
Angle
Waveform Chart
Plot 0
Amplitude
Time
Error Indicators
Error Out
Error Out 2
status
code
source
Team Members :
1- Lamees Haitham Farouk Elbakr
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4- Ahmed Mohammed Abd-Elrahem
5- Amira Abd el-rahman Shehab El-deen
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Untitled Project 1.lvproj/My Computer

Hardware implementation :

we add LCD part as Hardware to display the output :

References :

1- Programming Arduino with Labview

2- labview makerHub community "https://www.labviewmakerhub.com/doku.php?id=learn:tutorials:libraries:linx:misc:adding_custom_command"

3- Design of robotics knee "graduation project 2016"