Report 04 – (b)

Ideal & Real Block Diagram for actuator Kinetics

MCT 621

Motion Control and Servo Systems

Fall 2021

Submitted By/

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Introduction

In this Report, Ideal and Real block diagrams are purposed for controlling a robot arm regarding the RP robot ARM studied in the lectures for MCT621-Fall 2021, the Four blocks are:

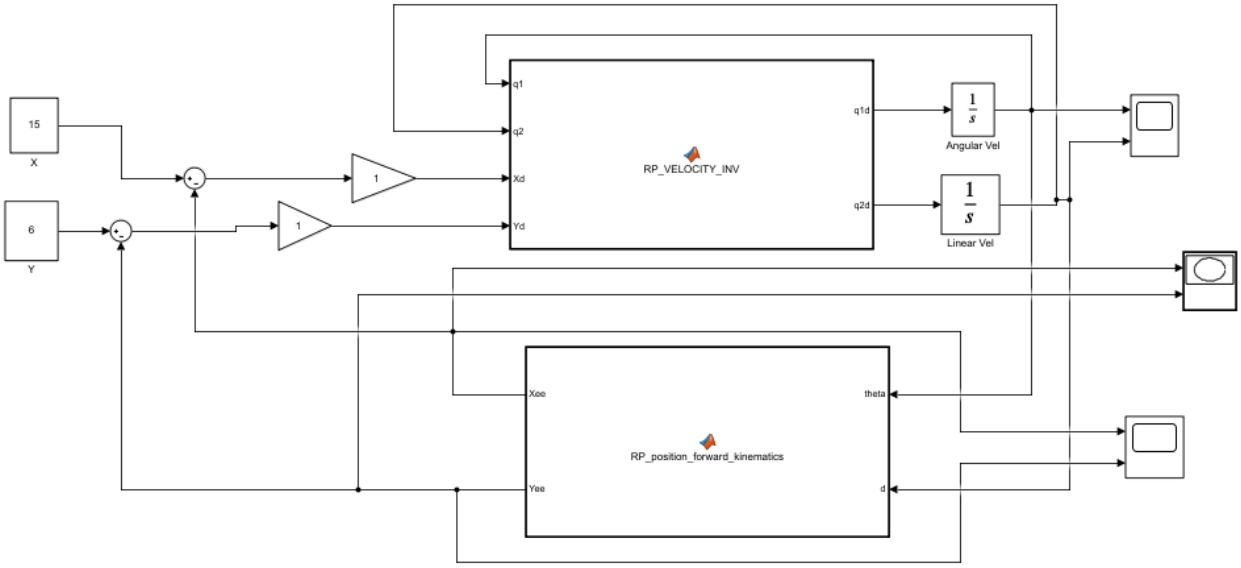
1. Ideal Block Diagram for Kinetics
2. Real Block Diagram for Kinetics using the motor purposed befor

These Blocks are described in detail. Then simulation is done on each of them and so having comments on the change of gain.

All simulations are done using MATLAB/Simulink, and the blocks are written as a MATLAB functions.

1. Ideal Block Diagram

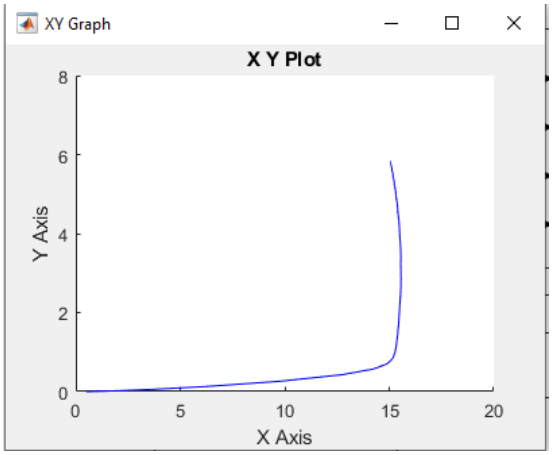
The following block diagram is an IDEAL Block diagram for controlling the robot arm. The motor is just set to be an integrator to have ideal kinetics model. The controller used is Proportional controller. The desired position of the end effector is to have X = 15 and Y = 6.



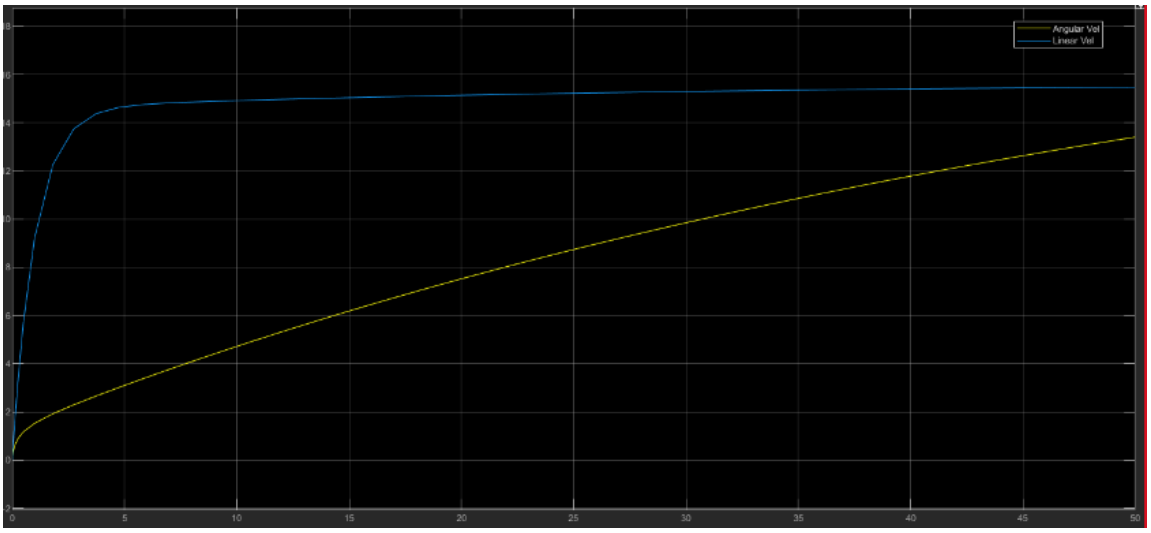
For the controller gains for X & Y = 1, 1 respectively the following results are shown

- 2D path of the RP robot's END-EFFECTOR

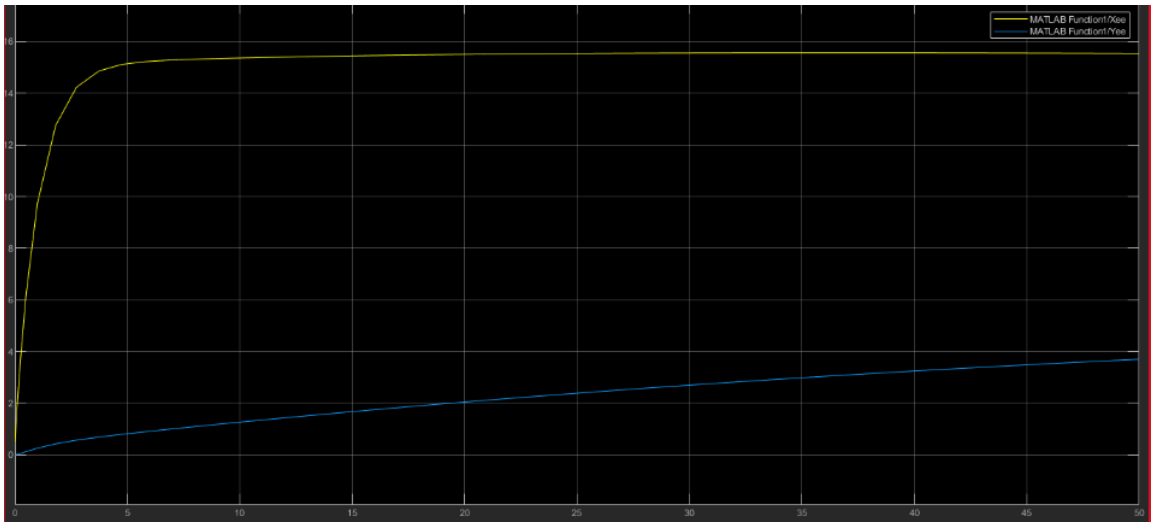
  It shows that the robot started from 0.5 where the prismatic actuator is has zero displacement and the 0.5 is the length of the robot's link. Then the robot crossed the 15m in X which was desired then it came back again to it while reaching 6m in Y.



- The following Graph shows the Displacement of each actuator, in blue the linear displacement of the prismatic joint, and in yellow the angle travelled by the revolute joint.



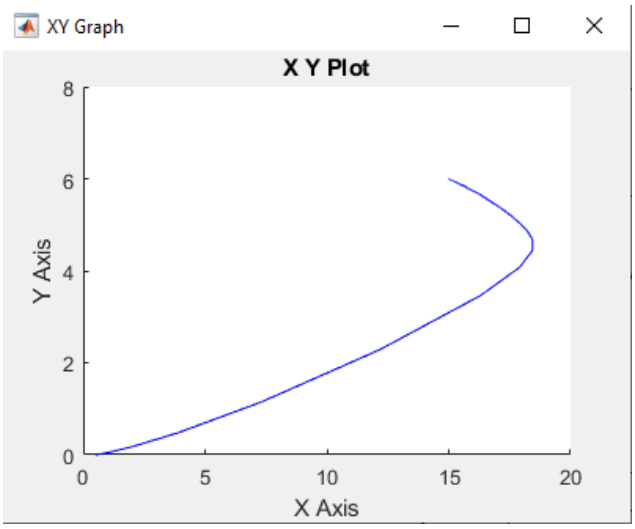
- The following Graph shows the Position of the End-Effector, in Yellow the Position of the EE in the X direction, and in blue the position of the EE in the Y direction.



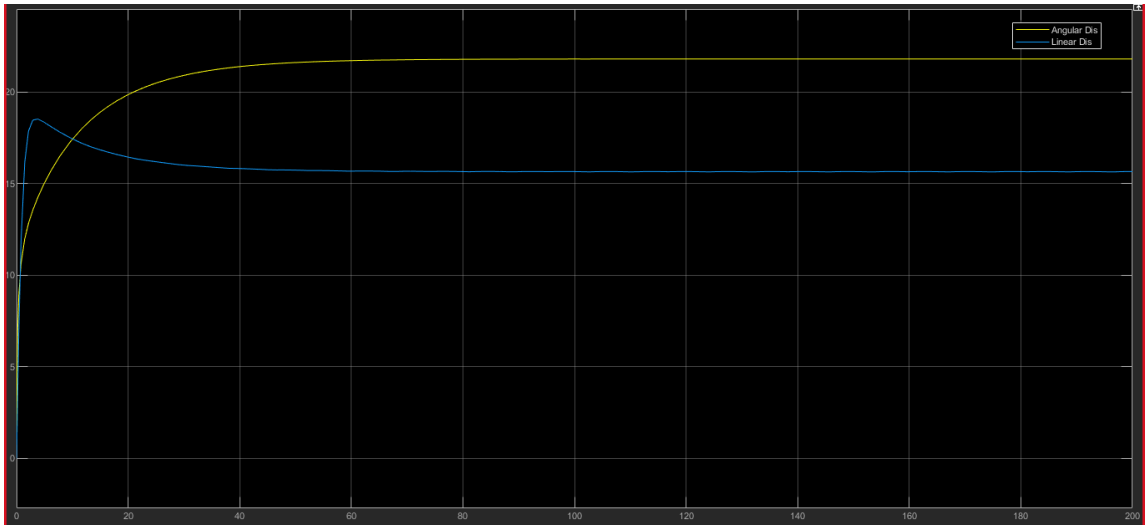
For the controller gains for X & Y = 1, 10 respectively the following results are shown

- 2D path of the RP robot's END-EFFECTOR

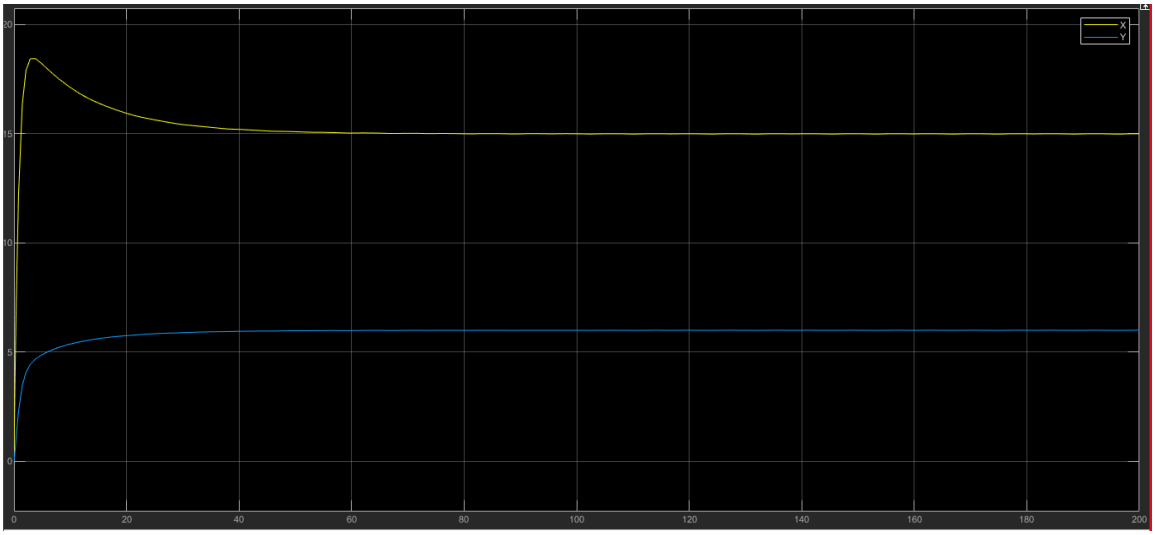
  It shows that the robot started from 0.5 where the prismatic actuator is has zero displacement and the 0.5 is the length of the robot's link. Then the robot crossed the 15m up to 19 approximately in X then it came back again to 15 while reaching 6m in Y.



- The following Graph shows the Displacement of each actuator, in blue the linear displacement of the prismatic joint, and in yellow the angle travelled by the revolute joint.



- The following Graph shows the Position of the End-Effector, in Yellow the Position of the EE in the X direction, and in blue the position of the EE in the Y direction.

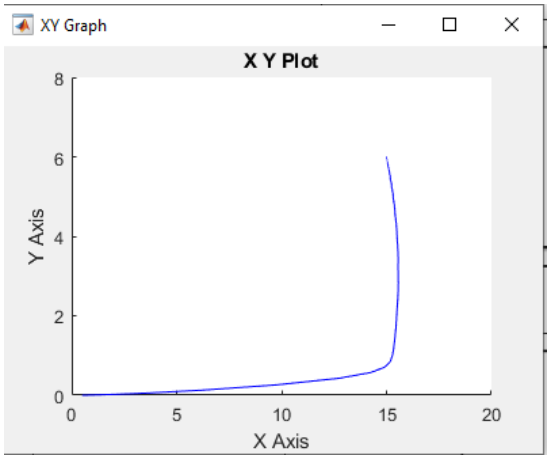


Position in X direction had an overshoot, this was caused because the controllers gain in Y maximized the error 10 times greater than the controller in Y, so that the motors moved faster to get to its desired position so that it overshoots in Y.
The effect of the controller appeared clearly in the XY graph as the slope of the rising curve increased which means the controller gave more action help both joint deliver the End Effector faster to the Desired position in Y.

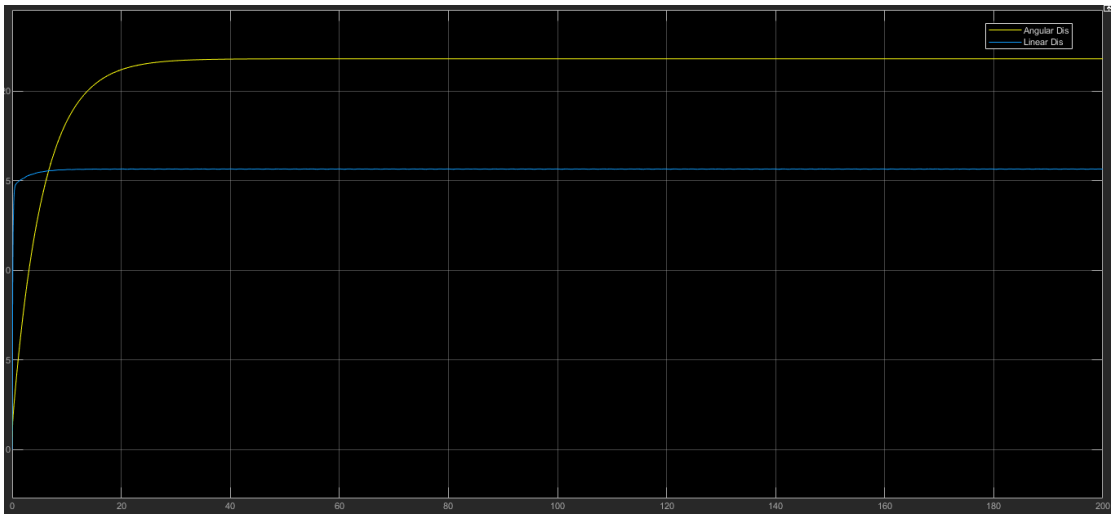
For the controller gains for X & Y = 10, 10 respectively the following results are shown

- 2D path of the RP robot's END-EFFECTOR

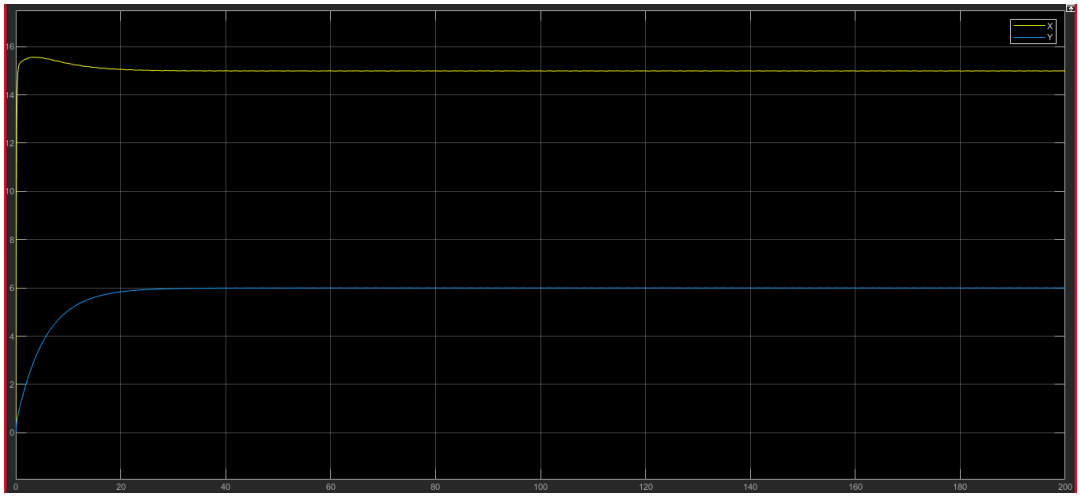
  It shows that the robot started from 0.5 where the prismatic actuator is has zero displacement and the 0.5 is the length of the robot's link. Then the came to 15m approximately in X then it came back again to before 15 while reaching 6m in Y.



- The following Graph shows the Displacement of each actuator, in blue the linear displacement of the prismatic joint, and in yellow the angle travelled by the revolute joint.



- The following Graph shows the Position of the End-Effector, in Yellow the Position of the EE in the X direction, and in blue the position of the EE in the Y direction.

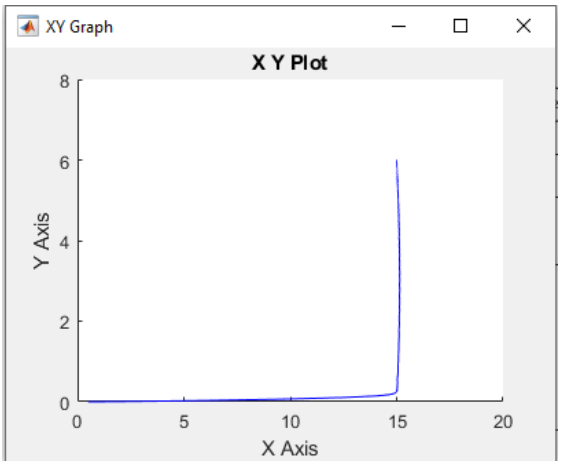


Position in X direction a smaller overshoot than last time, this was caused as the two controllers has the same gain, so the robot behaves like the first experiment in some manner but faster as the high gains makes the motors move with higher speeds.

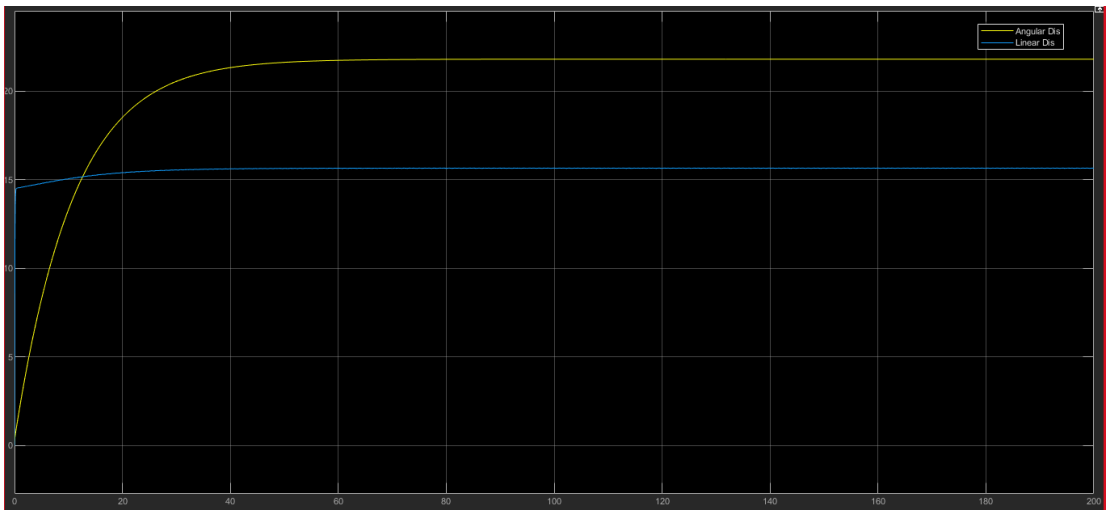
For the controller gains for X & Y = 20, 5 respectively the following results are shown

- 2D path of the RP robot's END-EFFECTOR

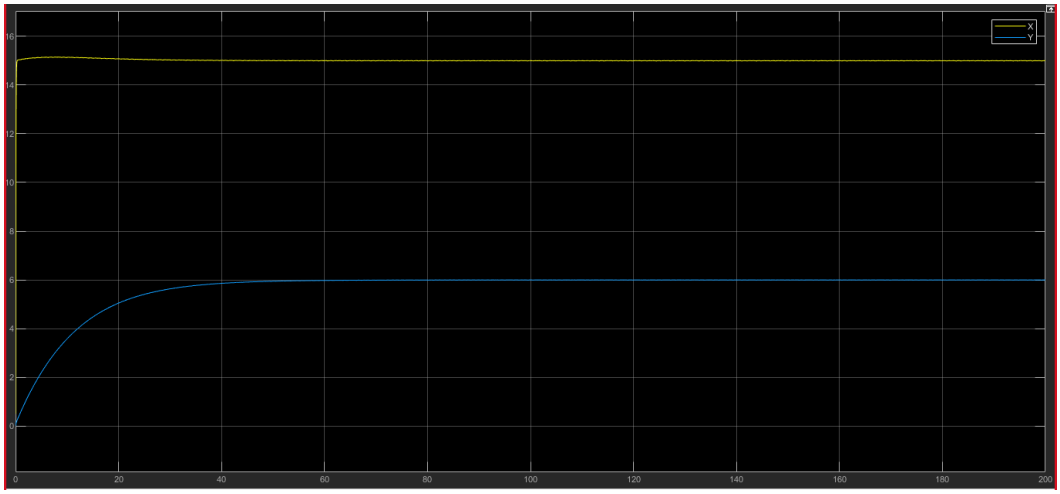
  It shows that the robot started from 0.5 where the prismatic actuator is has zero displacement and the 0.5 is the length of the robot's link. Then they came to 15m approximately in X and nearly settled while reaching 6m in Y.



- The following Graph shows the Displacement of each actuator, in blue the linear displacement of the prismatic joint, and in yellow the angle travelled by the revolute joint.



- The following Graph shows the Position of the End-Effector, in Yellow the Position of the EE in the X direction, and in blue the position of the EE in the Y direction.



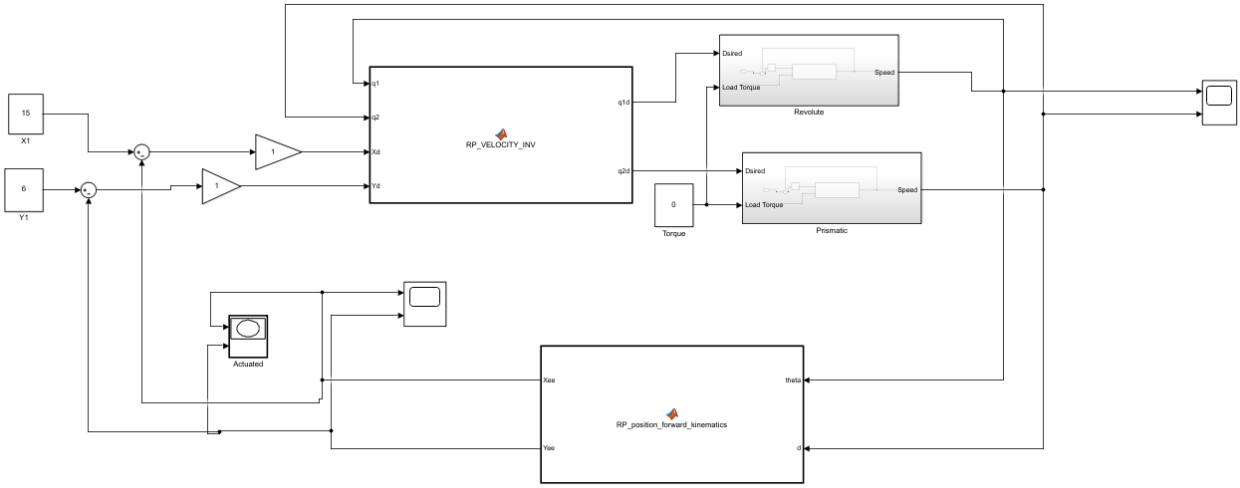
Position in X direction reached very fast with no overshoot and a smooth transition

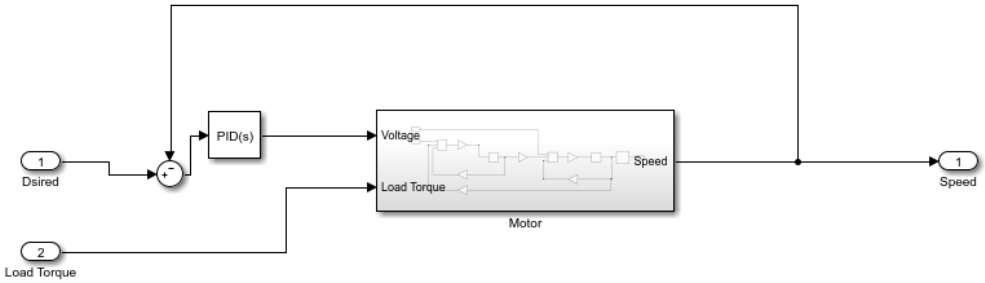
In conclusion

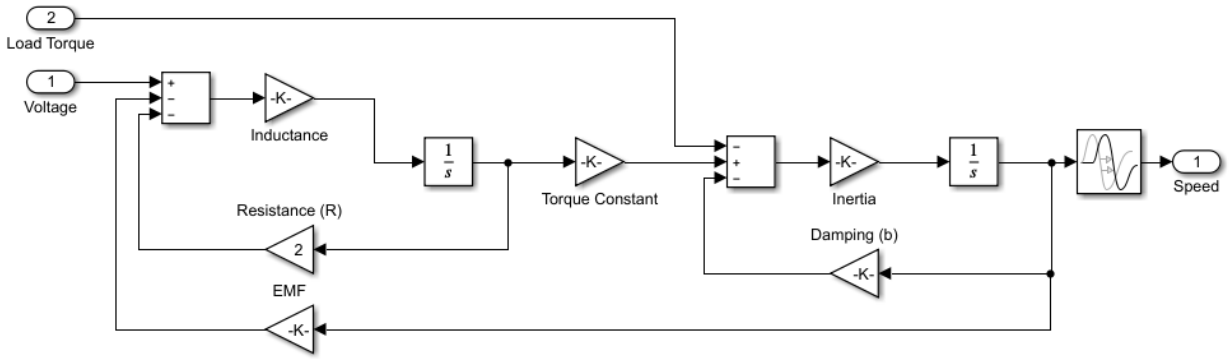
When the gain increases the error is read higher, so the speed of the motors increases so the system is faster. But when there is higher gain in the not needed branch, overshoot happens.

2. Real Block Diagram

The following block diagram is actuated Block diagram for controlling the robot arm using the motors purposed before including Lag = 0.01s and PID controller for each motor tuned to saturate the LAG. The controller used is Proportional controller. The desired position of the end effector is to have X = 15m and Y = 6m.



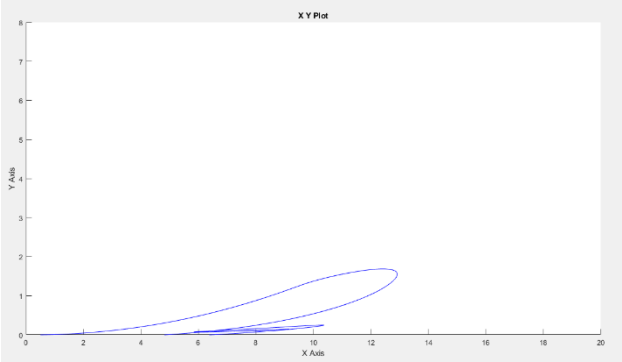




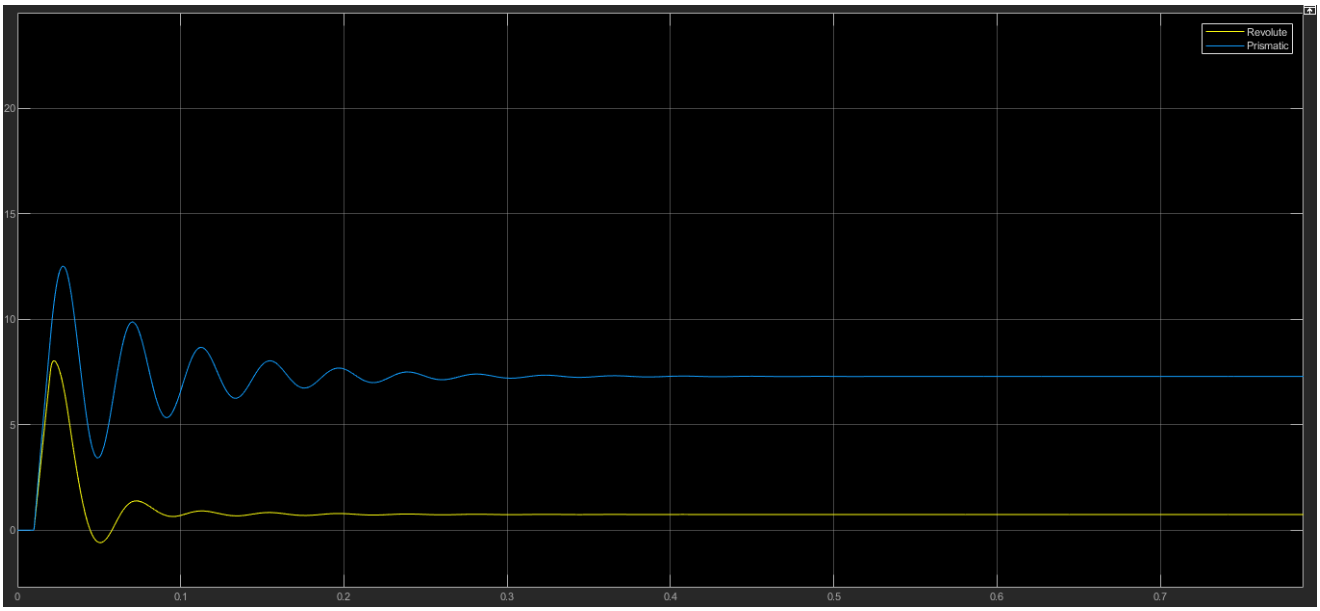
For the controller gains for X & Y = 1, 1 respectively the following results are shown

- 2D path of the RP robot's END-EFFECTOR

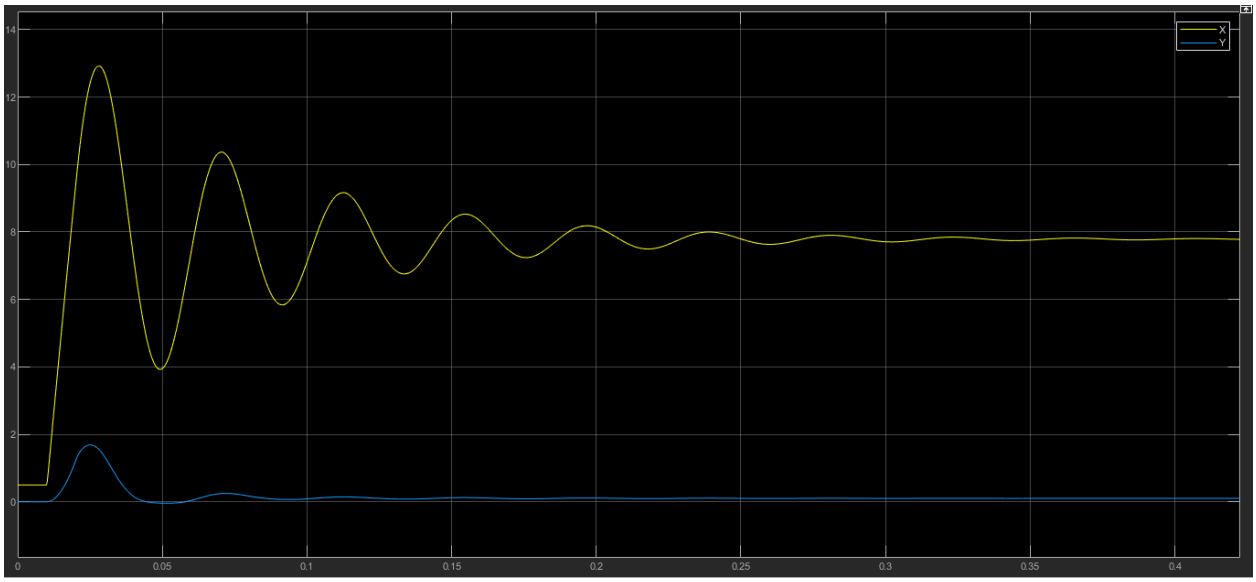
  It shows that the robot started from 0.5 where the prismatic actuator is has zero displacement and the 0.5 is the length of the robot's link. Then the robot moved in non accurate path due to lag issues.



- The following Graph shows the Displacement of each actuator, in blue the linear displacement of the prismatic joint, and in yellow the angle travelled by the revolute joint.



- The following Graph shows the Position of the End-Effector, in Yellow the Position of the EE in the X direction, and in blue the position of the EE in the Y direction.

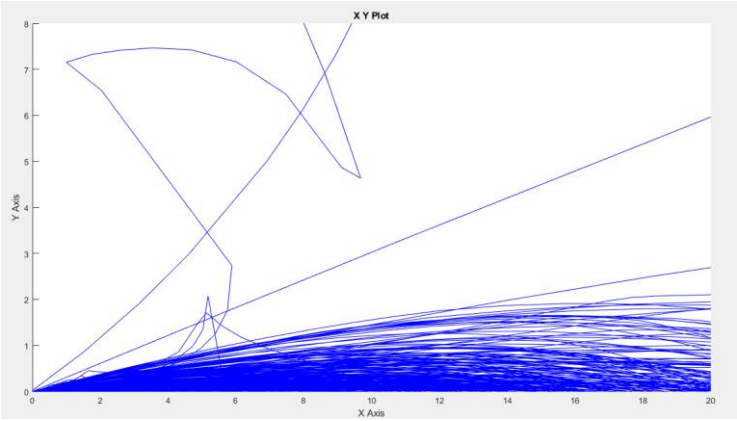


The previous graphs has much ripples which can make the system unstable, these ripples happened due to the lag term inside the motor

For the controller gains for X & Y = 1, 10 respectively the following results are shown

- 2D path of the RP robot's END-EFFECTOR

  It shows that the robot is moving in very bad way very far away from its desired position, so the system is unstable



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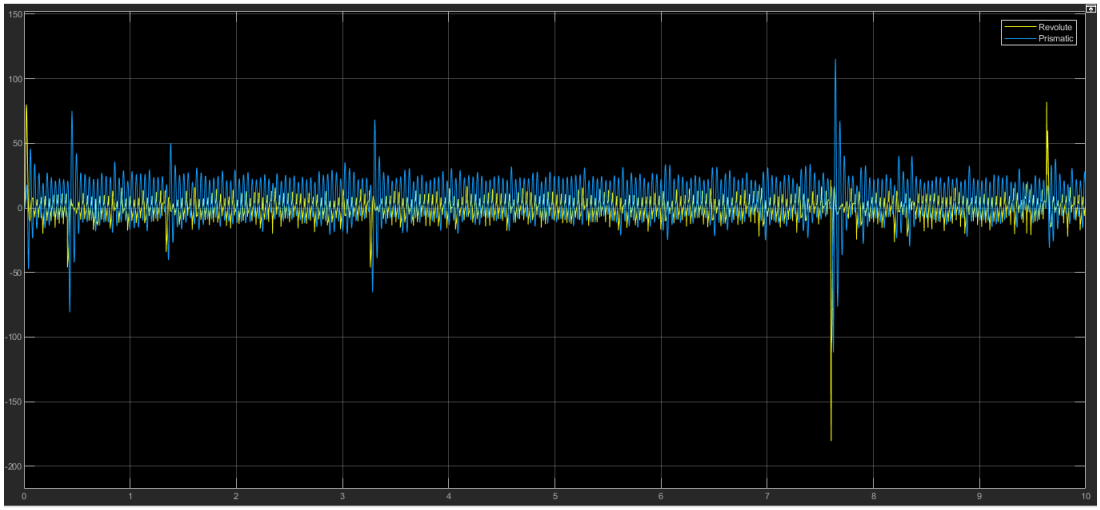

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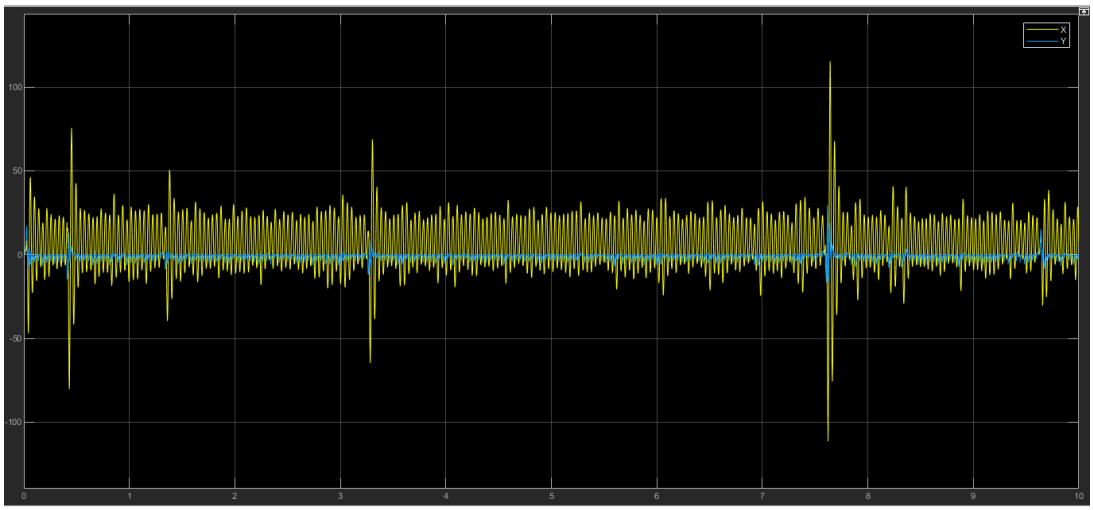
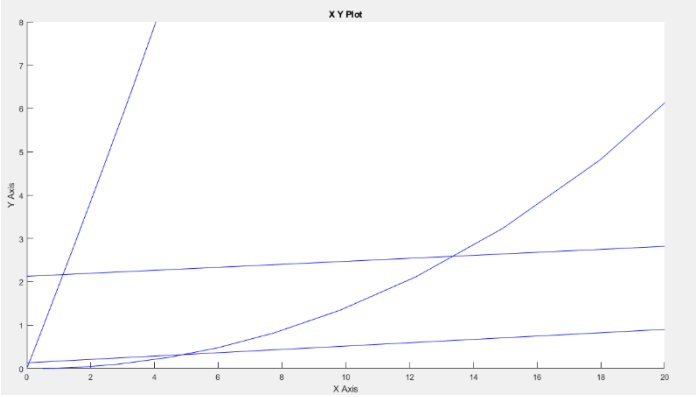


The previous graphs shown the instability of the system. The system failed.

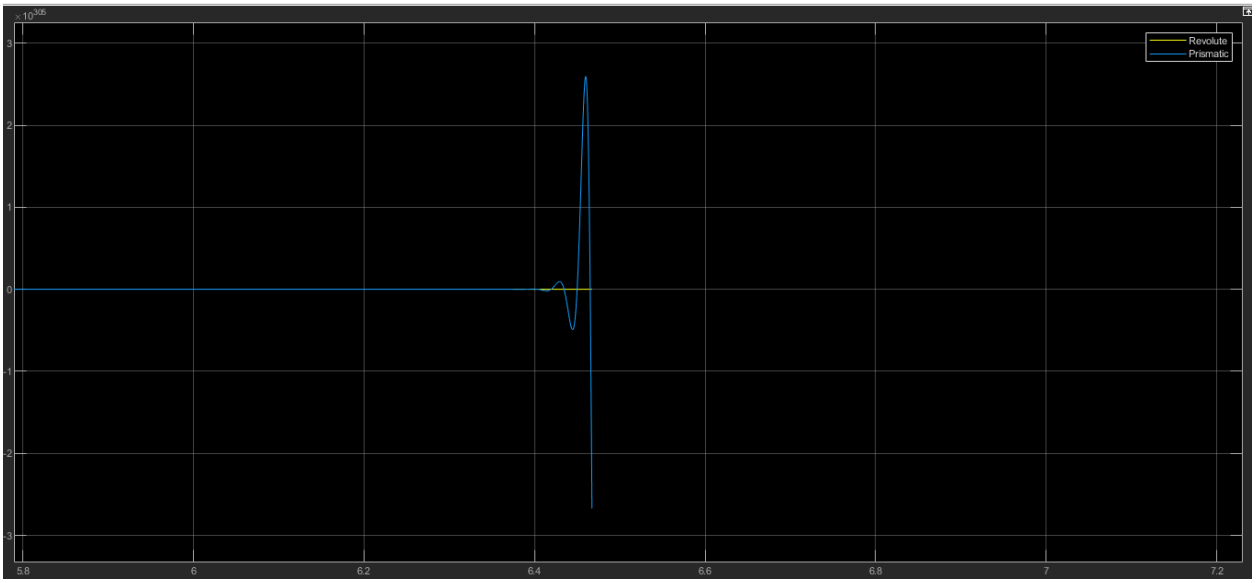
For the controller gains for X & Y = 10, 10 respectively the following results are shown

- 2D path of the RP robot's END-EFFECTOR

  It shows that the robot is moving in very bad way very far away from its desired position, so the system is unstable

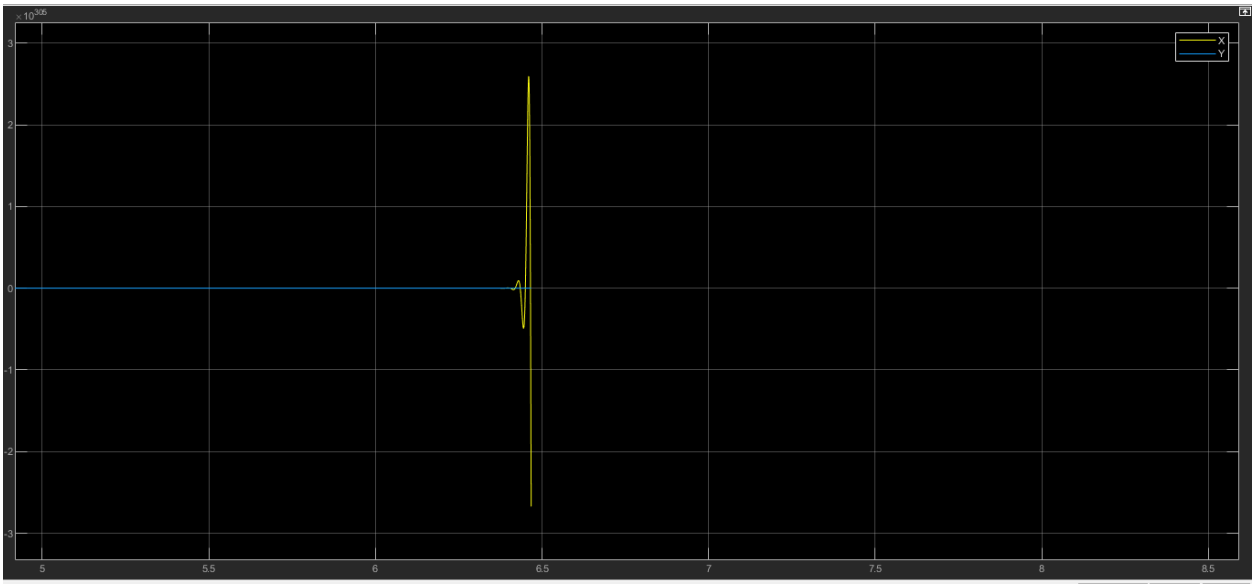


- The following Graph shows the Displacement of each actuator, in blue the linear displacement of the prismatic joint, and in yellow the angle travelled by the revolute joint. Infinite Prismatic derivative



- The following Graph shows the Position of the End-Effector, in Yellow the Position of the EE in the X direction, and in blue the position of the EE in the Y direction.

infinite X

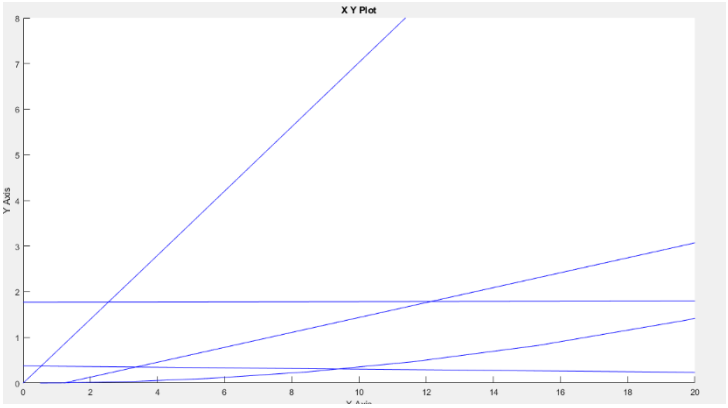


The previous graphs show infinite rate of change in positions, so the motor consumed very high current, and it is down.

For the controller gains for X & Y = 20, 5 respectively the following results are shown

- 2D path of the RP robot's END-EFFECTOR

  It shows that the robot is moving in very bad way very far away from it's desired position, so the system is unstable



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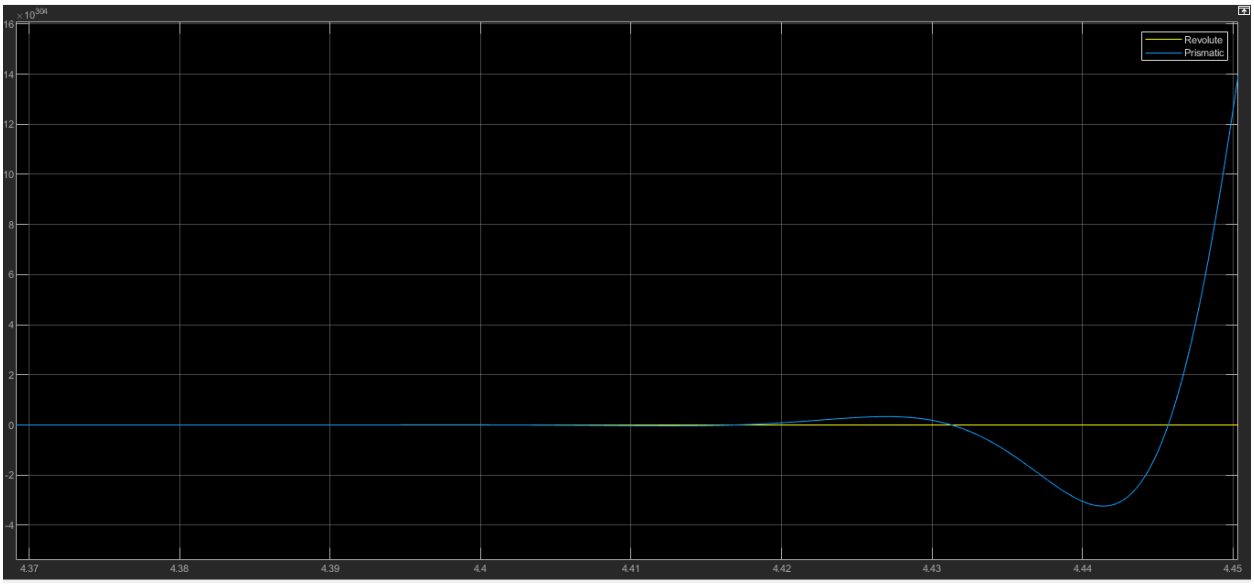

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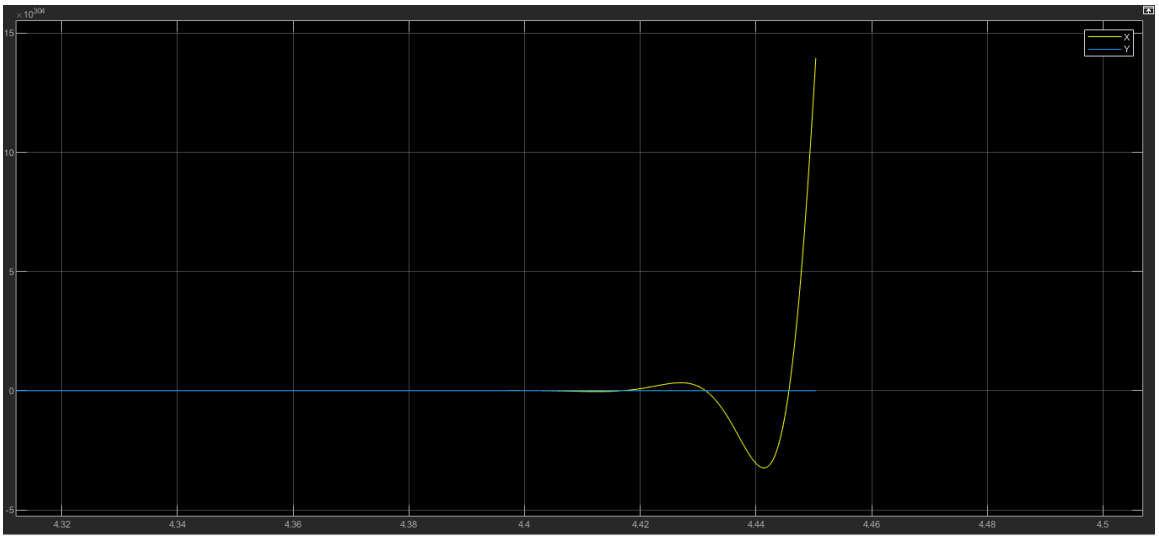

The previous graphs show infinite rate of change in positions, so the motor consumed very high current, and it is down.

In conclusion

When the gain increases the error is read higher, so the speed of the motors increases so the system is faster. But when there is higher gain in the not needed branch, overshoot happens.