PID Control Using MATLAB

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***Abstract*—A PID controller is a tool that can be used to control different variables in a system. It is used in MATLAB to control the process and regulate the feedback in a control system. A transfer function on the other hand is an equation that is modeled around the input process and output of a system. It is able to represent higher-order equations through algebraic manipulations. In the experiment, the researchers were tasked to create a program with specifications regarding PID Controllers and transfer functions. It was done mainly through the use and manipulation of MATLAB codes. MATLAB is an important tool to people because it can provide an analysis structure for people in the field of control systems. It is able to show different variables and graphs to further understand what a topic is about. It also encourages the researchers to be more creative with their solutions in doing so.**

***Keywords*—PID Controllers, Transfer Functions, MATLAB, Feedback, Control**

I. INTRODUCTION

PID Controller or proportional integral derivative controller is a very useful tool to control different variables like temperature, pressure, airflow, and velocity. This controller is widely used in MATLAB to regulate the feedback and control process of the variables.

A transfer function is an equation modeled on a system's input and output. It can represent higher-order equations and can be obtained through algebraic manipulations which mostly concern integrals and differential equations.

II. MATLAB PROGRAM

```
disp("LBYCPC3 - PID Control")
disp("CHUA, Kendrick Dayle J." + ...
   "MANALANSAN, Sean Patrick T." + ...
   "MAYUGA, Zachary Brent L.")
disp("Transfer Function: numerator =
[C], denominator[A B C]")
```

```
%Question 1
A = input("What is the value of the
A:");
B = input("What is the value of the
B:");
C = input("What is the value of the
C:");
sys = tf([C],[A B C]);
sys1 = feedback(sys,-1);
figure;
subplot(2,2,1)
impulse(sys1)
subplot(2,2,2)
step(sys1)
subplot(2,2,3)
t = 0:0.01:1;
rampTime = t;
ramp = lsim(sys1,rampTime,t);
plot(t,ramp)
title('Ramp Response');
subplot(2,2,4)
parabolicTime = t.^2/2;
parabolic = lsim(sys1,parabolicTime,t);
plot(t,parabolicTime)
title('Parabolic Response');
figure;
pzmap(sys1)
%Question 2
Kp = input("What is the value of the
Kp:");
Kd = input("What is the value of the
Kd:");
Ki = input("What is the value of the
Ki:");
sys2 = pid(Kp,Ki,Kd);
sys3 = feedback(sys1*sys2,1);
figure;
subplot(2,2,1)
impulse(sys3)
subplot(2,2,2)
```

```
step(sys3)
subplot(2,2,3)
t = 0:0.01:1;
rampTime = t;
ramp = lsim(sys3,rampTime,t);
plot(t,ramp)
title('Ramp Response');
subplot(2,2,4)
parabolicTime = t.^2/2;
parabolic = lsim(sys3,parabolicTime,t);
plot(t,parabolicTime)
title('Parabolic Response');
figure;
pzmap(sys3)
```

III. DISCUSSION AND ANALYSIS

MATLAB is a great tool used for control system representation. In the project, there were multiple tasks that needed to be performed. Each of these tasks is required to show the step response, impulse response, ramp response, parabolic response, and the PZ map. To achieve the output, there were already commands that were ready to be used and others that still needed additional work to reach the outcome. The programmers were able to use their skills to produce the outcome and achieve the right results.

In the first given problem, the program will ask for the input 2nd order transfer function and will produce an output of the step response, impulse response, ramp response, parabolic response, and the PZ map of the input transfer function. The program will convert the input transfer function to negative unity feedback. The subplot will be used to show multiple outputs. To find the impulse and step response, the command impulse() and step() will be used respectively. The command lsim() will be utilized for the ramp response and the parabolic response. The parameters of the lsim() command are the transfer function, the input signal, and the time samples. The time will be 0 to 1 second with an increment of 0.1. The input signal ramping time will be equal to the time samples, while the parabolic time will be squared divided by 2 of the time samples. They will then be plotted accordingly. Lastly, for the PZ map, the command pzmap() will be used with the transfer function as its parameter.

For the second given problem, the program will also generate the step response, impulse response, ramp response, parabolic response, and the PZ map, however, the input will be different from the first problem. The program will ask the user for the coefficients of the PID controller: Kp, Kd, and Ki. Afterward, the program will generate the equivalent system transfer function that will depend and cascade on the original transfer function given in the previous problem.

Sample input on MATLAB:

```
>> LBYCPC3_Project
LBYCPC3 - PID Control
CHUA, Kendrick Dayle J.MANALANSAN, Sean Patrick T.MAYUGA, Zachary Brent L.
Transfer Function: numerator = [C], denominator[A B C]
What is the value of the A:2
What is the value of the B:2
What is the value of the C:8
What is the value of the Kp:4
What is the value of the Kd:6
What is the value of the Ki:3
```

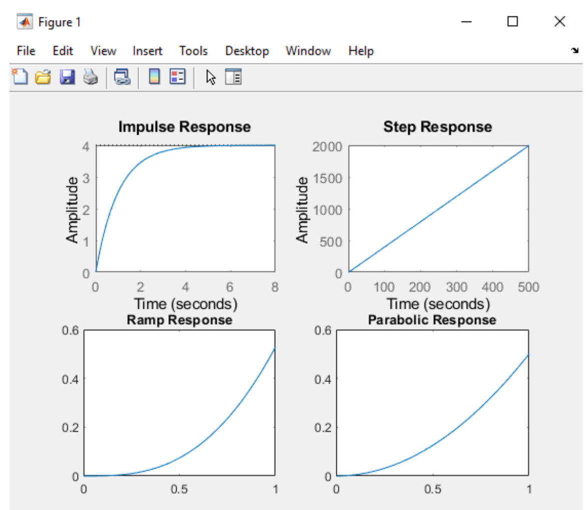

Figure 1. Sample Subplot Output of the First Problem

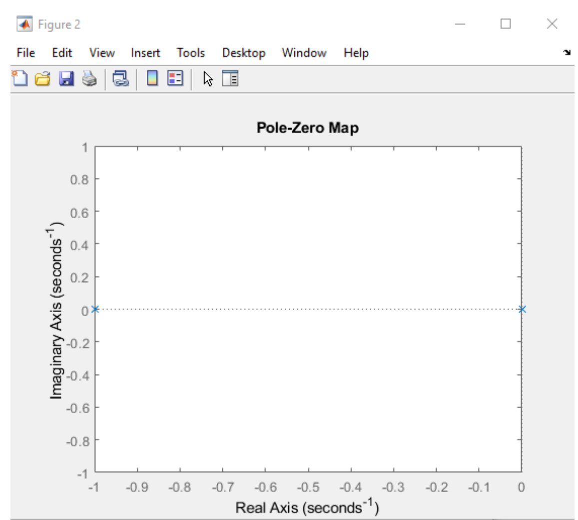

Figure 2. Sample Pole-Zero Map of the First Problem

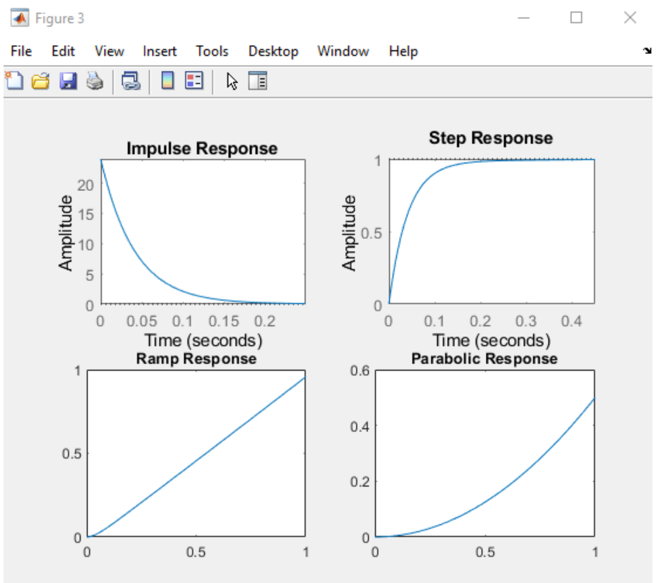

Figure 3. Sample Subplot Output of the Second Problem

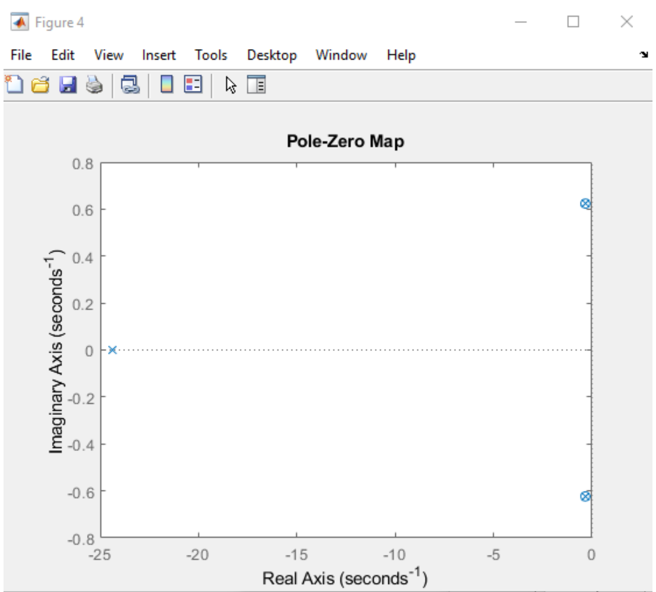

Figure 4. Sample Pole-Zero Map of the Second Problem

The outcomes of this research have provided the programmers an avenue to use all of their skills together in MATLAB. The programmers were able to achieve the desired results and the outputs that were presented were correct. The reason for each of the codes that were selected was explained and made sense for the application of the project.

IV. CONCLUSION

Using MATLAB's functionalities in the engineering world is vast. Nevertheless, this paper focuses on creating powerful controllers to manipulate real-life variables like temperature, pressure, and the like, specifically PID or proportional integral derivative controllers. This paper has discussed a way to attain such important variables utilizing the PID controller using MATLAB. As its code is stated in the previous parts of the study. When people are knowledgeable about MATLAB, they will be able to compute boundless engineering problems that need simple to complex computations.

In this study, students created a PID controller in MATLAB and they effectively constructed it with the use of different functionalities that they have learned in class combined together.

REFERENCES

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