Design your Control Systems with Python, Why Not?

Brilian Putra Amiruddin
Electrical Engineering Department, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

EuroPython 2020

Essential Python Library

There are four main library for designing control systems using Python
- Python Control Systems Library
- NumPy
- SciPy
- MagPy

Python as an Alternative Language

The reason why we can use Python as an alternative language for control systems design
- It is free and open-source, so we legally can use that without paying for software license
- Possessing all of the basics function for control systems design
- Support MATLAB like control systems design function
- Python is a powerful and agile programming language
- Having large communities

Control Systems Field

A Control System is an interconnection of components forming a system configuration that will provide a desired system response. There are five main elements of control system, these elements are
- Sensor
- Actuator
- Plant
- Reference Signal
- Controller

System Parameters

The DC Motor parameters values are shown in Table 1

<table>
<thead>
<tr>
<th>Parameters Name</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moment of Inertia (J)</td>
<td>0.08 kg·m²</td>
</tr>
<tr>
<td>Motor Voltage (V)</td>
<td>120 V</td>
</tr>
<tr>
<td>Electromotive Force Constant (Kc)</td>
<td>0.51 N/m</td>
</tr>
<tr>
<td>Motor Torque Constant (Kt)</td>
<td>0.01 N.m/Ampere</td>
</tr>
<tr>
<td>Electric Resistance (R)</td>
<td>0.5 Ohm</td>
</tr>
<tr>
<td>Electric Inductance (L)</td>
<td>0.5 H</td>
</tr>
</tbody>
</table>

Controlling The Systems

Before we implement and design the controller to the DC Motor, we ought to know the block diagram of the DC Motor Speed Control System as shown in Figure 5.

After that, the next step is to design the controller in this case, three different types of the commonly used and straightforward controller were applied, they are
- PID (Proportional Integral Derivative) Controller
- State-Feedback Controller
- LQR (Linear Quadratic Regulator) Controller

The gain of the PID controller, poles for the state-feedback controller, and LQR controller weight were chosen arbitrarily (the detail of the gain and the other controller parameters can be seen on the provided notebook). The implemented controllers were simulated using several reference input signal.

Designing the Control Systems

In this poster, the DC Motor system is used to design its speed control system.

The aim of designing the speed control system for a DC Motor system is to control or regulate the DC Motor Speed to go to the desired speed.

Systems Analysis

It is important to know and analyzed well the system before we design the controller or control system, because with knowing more the characteristics of the system, the easier we design the control system is.

First, the poles of the DC motor system are analyzed pole-zero map as shown in Figure 4.

The control input for this system is the voltage applied to DC Motor. Thus, by changing or varying the voltage, the Motor will be rotating clockwise or counterclockwise.

The DC Motor system characteristics used in this poster are continuous, linear, and stable in nature because it is linear and stable so it will be more straightforward to control.

Acknowledgements

Thank you to Almighty God, my parents, auntie, and my friend Wati Azmi Hartono for helping, motivating, and guiding me in completing this work.

Verdict

In conclusion, the Python programming language can be used for designing the control systems with a free and open-source environment.

Additionally, with those advantages, then Python as well can be used as a powerful alternative for every student, lecturer, and researcher across the world in the control systems field.

References

[1] ‘System control on Twitter: ’After a month of addition and modification the Structure chart of control theory was finally completed.” Thank you all for your guidance, and suggestions @CSSIEE @IFAC_Control @SpringerControl @KJMemesControlhttps://twitter.com/TMNAlgRaTMM/Twitter/Twitterhttps://twitter.com/LughLib62007/status/1271641079599644672 (accessed Jul, 2020).

More Full Explanation

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brilianputraa

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