EE 352: Control Systems Lab project report

Project title

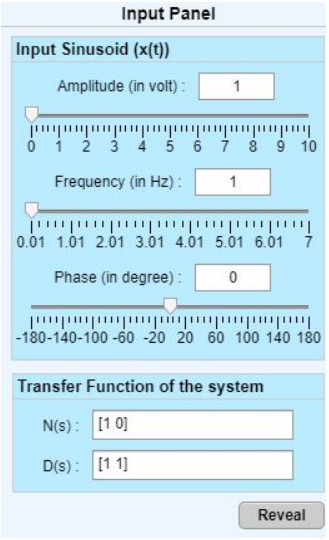
Simulation and visualization of the frequency response of a system using MATLAB GUI.

Summary

Using the MATLAB based GUI, the frequency response of a system (defined by its transfer function) can be obtained. The app provides a panel to enter the transfer function. The input panel controls the three parameters of the input sinusoid, namely amplitude, phase, and frequency. The input sinusoidal signal can also be changed by sliding the knobs of amplitude, frequency, and phase on the slider in the Input Panel box (named as Input Sinusoid (x(t))). Based on the input signal and the transfer function, the GUI plots the input response and output response of the system in both the phasor (Z -plane) and the time domain, and it also calculates the different properties of the output signal in the Output Panel. It also plots the bode diagrams (magnitude response and the phase response with respect to the frequency). The animation panel can be used to animate all the plots with changing frequency of input signal. The main feature of the app is the frequency sweep, which happens during the animation.

Working

There are several panels in the app, namely Input Panel, Output Panel, Graph Panel, and the Animation Panel. They are explained below in detail.



1. Input Panel

This panel controls the amplitude, phase, and frequency of the input sinusoidal signal. There are sliders dedicated to each of these parameters, which also controls the input signal parameters. It also has a dedicated sub-panel for the transfer function (TF) of the system. The numerator of the TF is denoted by N(s), and it should be entered as a vector containing coefficients of the numerator polynomial of the TF. Similarly, the denominator, D(s) also expects the same input form as N(s). The coefficients of the polynomials should be entered in the decreasing order of their associated term. For example, if TF = $\frac{S}{S+1}$, then N(s) = [1 0] and D(s) = [1 1].

2. Graph Panel

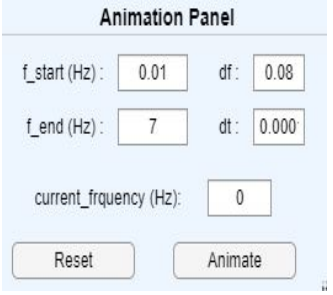
There are four graphs in this panel. The first graph (having title Input and Output Sinusoids) contains two plots, one for input sinusoid and the second for output sinusoid in time-domain. The second graph (having title complex plot) plots the system response in polar form or complex form. The third and fourth graph plots magnitude and phase bode diagrams respectively.

3. Output Panel

It shows the amplitude and phase of the output sinusoid (y(t)). It also shows Gain (in dB) and the phase (in degree) of the system for the current input sinusoid.

4. Animation Panel

This panel can animate all the graphs in Graph Panel. It requires the starting frequency, from which the animation starts, and the ending frequency, at which the animation stops. It has two more parameters df and dt, df is an incremental change in the input sinusoidal frequency for the consecutive plots, and dt is the delay (in seconds) between consecutive plots.

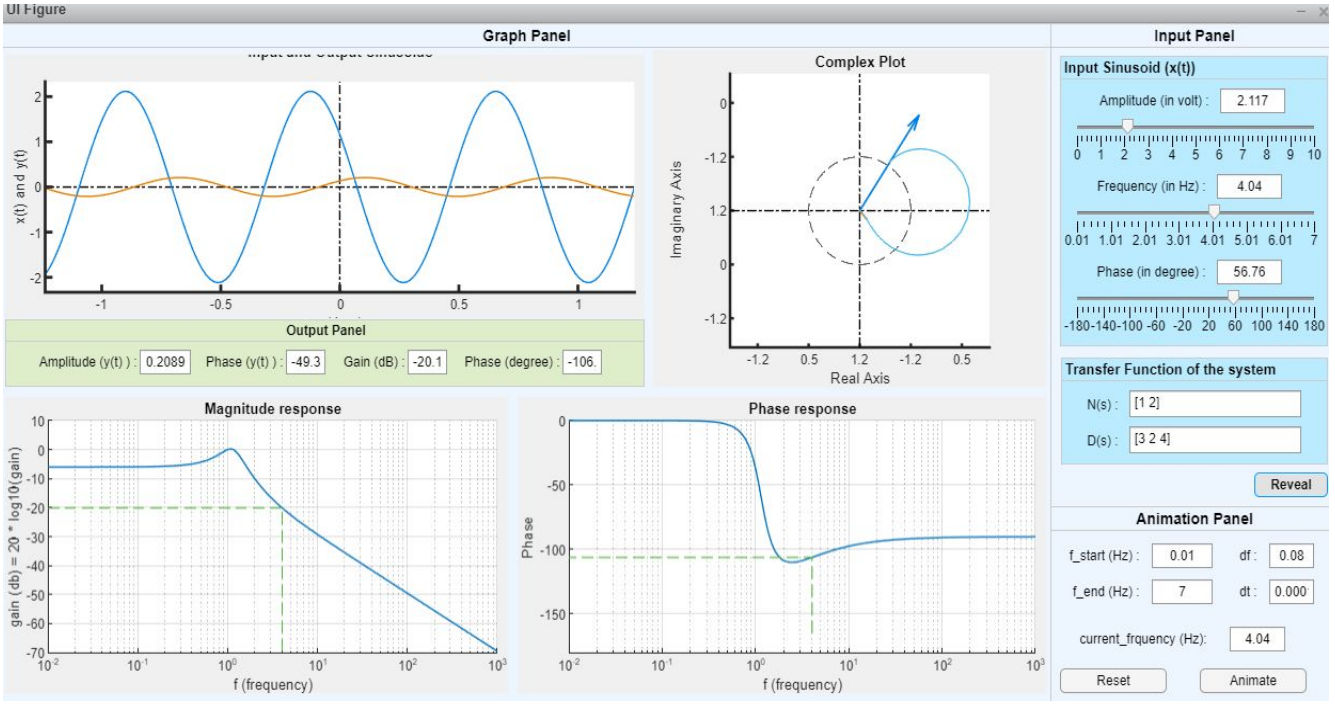


Results

Results are shown in the output panel numerically, and the graph panel shows the results visually. The figure below shows the app output for the transfer function,

$$T(s) = \frac{S+2}{3S^2+2S+4}$$

Click on **this** to watch an animation generated by this app.



Future Scope

- Add a utility to automatically sweep through frequency and generate a video file as output.
- Add a 3D complex plot to make the animation more informative in terms of frequency.
- Improve the animation speed by doing optimization in the calculation and animation algorithm.
- Integrate with hardware like Arduino to make it a real-time response visualizer.
- Add a utility to generate an approximate transfer function of the system from the input and output data.
- Create a standalone and desktop and web app.