

Analysis of Control system Stability using Scilab

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ABSTRACT: This paper present frequency response using bode plot in scilab. Frequency response comments on stability of control system. In this paper we start with transfer function of control system and their pole zero plots to frequency response through scilab. The control system is a combination of elements arranged in planned manner where each element is responsible to produce desired output. This is represented by mathematical relation if this relation is linear then it will be a linear control system. The stability of system can be judged by frequency response analysis. This frequency response analysis is carried out by using bode plot technique in scilab. Scilab is a free open-source mathematical software package for scientific computation. It includes hundreds of general purpose and specialized functions for numerical computation which is organized in libraries called toolboxes that cover such as simulation, optimization, systems and control, and signal processing

KEYWORDS: Transfer function, Open & Closed loop, Frequency response, Scilab.

I. INTRODUCTION

A control system is a system of devices or set of devices, that manages commands, directs or regulates the behavior of other device(s) or system(s) to achieve desire results. In other words the definition of control system can be rewritten as A control system is a system, which controls other system. As the human civilization is being modernized day by day the demand of automation is increasing accordingly. Automation[12] highly requires control of devices. In recent years, control systems plays main role in the development and advancement of modern technology and civilization. Practically every aspects of our day-to-day life is affected less or more by some control system. A bathroom toilet tank, a refrigerator, an air conditioner, a geezer, an automatic iron, an automobile all are control system. These systems are also used in industrial process for more output. We find control system in quality control of products, weapons system, transportation systems, power system, space technology, robotics and many more. The principles of control theory is applicable to engineering and non engineering field both[4].

Open Loop Control System

A control system in which the control action is totally independent of output of the system then it is called open loop control system. Manual control system is also an open loop control system. Fig - 1 shows the block diagram of open loop control system in which process output is totally independent of controller action.

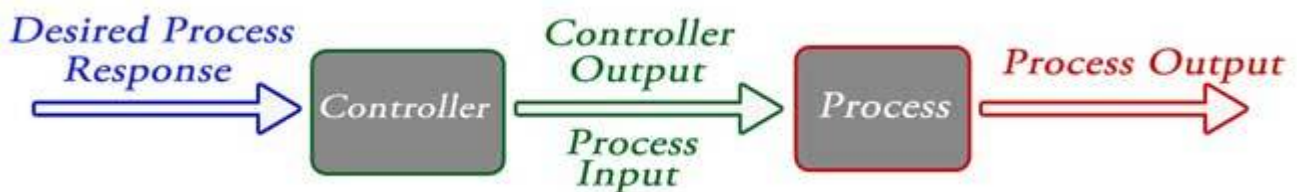


Fig - 1 shows the block diagram of open loop control system

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Closed loop control system

A feedback is a common and powerful tool when designing a control system. Feedback loop is the tool which take the system output into consideration and enables the system to adjust its performance to meet a desired result of system. In any control system, output is affected due to change in environmental condition or any kind of disturbance. So one signal is taken from output and is fed back to the input. This signal is compared with reference input and then error signal is generated. This error signal is applied to controller and output is corrected. Such a system is called feedback system. Figure below shows the block diagram of feedback system.

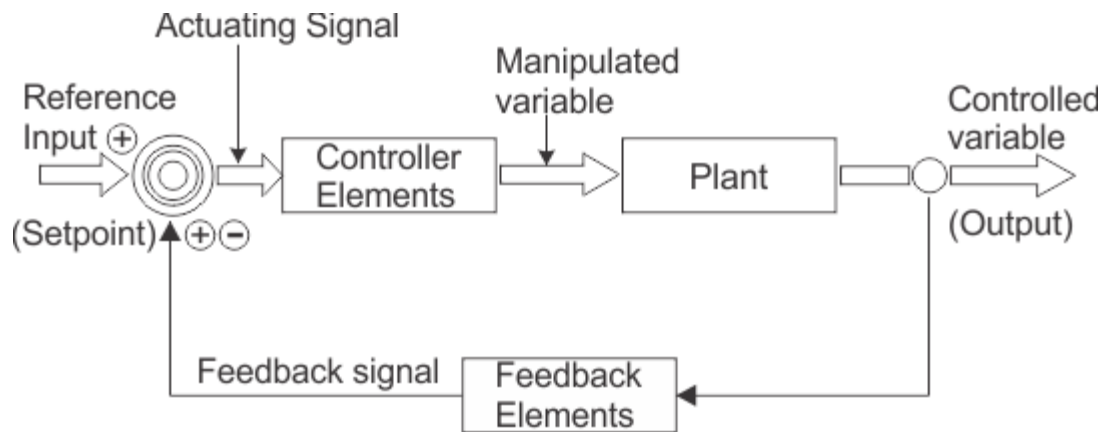


Fig - 2 shows the block diagram of close loop control system

When feedback signal is positive then system called positive feedback system. For positive feedback system, the error signal is the addition of reference input signal and feedback signal. When feedback signal is negative then system is called negative feedback system. For negative feedback system, the error signal is given by difference of reference input signal and feedback signal.

II. RELATED WORK

Study of frequency response, stability & scilab are as follows

I. Frequency response

In LTI systems, if the input to the system is sinusoidal, then the steady-state output will also be sinusoidal at the same frequency but in general with different magnitude and phase. These magnitude and phase differences as a function of frequency comprise the frequency response of the system. The frequency response of a system can be found from the transfer function in the following way: create a vector of frequencies (varying between zero or "DC" to infinity) and compute the value of the plant transfer function at those frequencies[2]

II. Stability

An adequate definition of stability with reference to linear control system is given as "if any oscillation set up in a system in consequence to application of an input damped out with respective time, the system is said to be stable"[4]. In other words if poles and zeros of transfer function lie on left hand of S-plane, the system is said to be stable[11]. Bounded Input Bounded Output (BIBO) definition of stability[10] which states that a system is stable if the output remains bounded for all bounded (finite) inputs. We use transfer function representation to analyse stability. If all poles of the transfer function (values of s at which the denominator equals zero) have negative real parts, then the system is

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stable. If any pole has a positive real part, then the system is unstable. If we view the poles on the complex s-plane, then all poles must be in the left half plane (LHP) to ensure stability. If any pair of poles is on the imaginary axis, then the system is marginally stable and the system will oscillate[2].

Bode plot is the graphical tool for drawing the frequency response of a system. It is represented by two separate plots, one is the magnitude vs frequency and the other one is phase vs frequency[12]. The magnitude is expressed in dB and the frequency is generally plotted in log scale. One of the advantages of the Bode plot in s-domain is that the magnitude curve can be approximated by straight lines which allows the sketching of the magnitude plot without exact computation[6].

III. Scilab

Scilab is free and open source software for numerical computation providing a powerful computing environment for engineering and scientific applications. It is a programming language/development environment developed for mathematical programming, and in particular working with matrices. It is basically an open source version of Matlab, a commercial product for the same process. For this reason Scilab is a perfect fit for image processing, as most image processing problems reduce to matrix manipulation. Scilab is also relatively easy to use, and its development environment makes it ideal for prototyping[5].

III.EXPERIMENTAL RESULTS

Following are the results obtained from scilab for pole zero plot and bode plot of specified transfer function

POLE ZERO PLOT:

For determining stability of any system, transfer function is required to plot and understand the location of poles and zeros on the plot[9]. Pole zero plot is plotted below for given transfer function

$$T.F. = \frac{2S^2 + 5S + 1}{S^2 + 3S + 5}$$

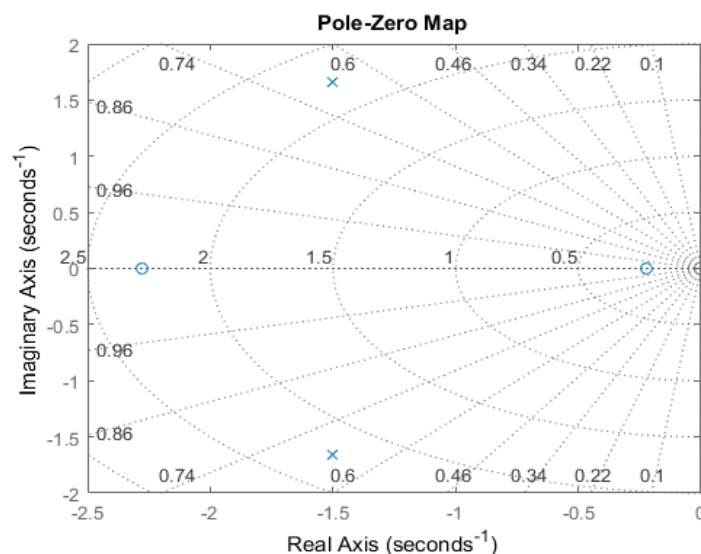


FIG 3:- POLE ZERO PLOT

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BODE PLOT:

Bode plot is a graph of the frequency response of a system. It is usually a combination of a **Bode magnitude plot**, expressing the magnitude (usually in decibels) of the frequency response, and a **Bode phase plot**, expressing the phase shift. Both quantities are plotted against a horizontal axis proportional to the logarithm of frequency. Given that the decibel is itself a logarithmic scale, the Bode amplitude plot is log-log plot, whereas the Bode phase plot is a lin-log plot.

Transfer function for bode plot is given below

$$T.F = \frac{S^2 + 18S + 100}{S^2 + 6S + 102}$$

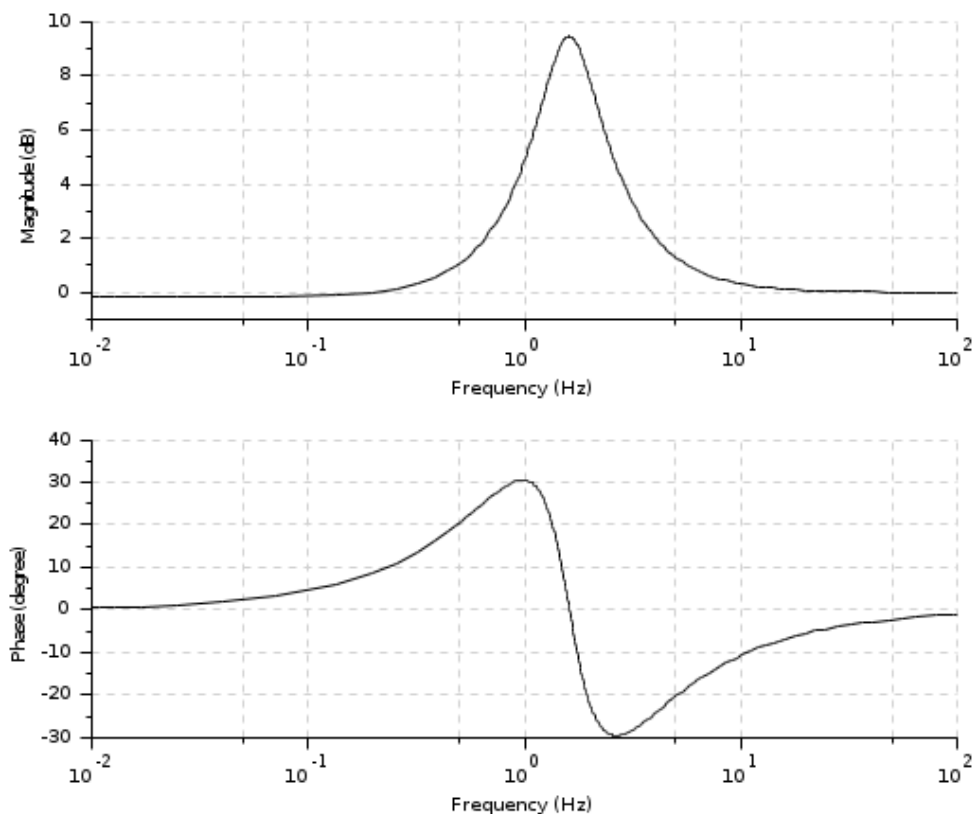


FIG 4: BODE PLOT OF ABOVE TRANSFER FUNCTION

IV. CONCLUSION

This paper deals with stability analysis of system in scilab. It indicates necessity of stability and frequency response of transfer function. This paper helps lots of beginner those who are interested to learn Control system with scilab programming, because it starts with basic control system concept programming and goes to various mathematical operations, frequency domain analysis programming. The scilab programming is user friendly, fast, easy to understand.

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(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

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REFERENCES

- [1] Scilab's package manual, email location: Scilab@inria.fr, web site: www.scilab.com
- [2] Sonam Parihar, "Analyzing the Response of an RLC Circuit" International Journal of Scientific and Research Publications, Volume 5, Issue 7, July 2015, Bipin Tripathi Kumaon Institute of Technology, Dwarahat, Almora, Uttarakhand
- [3] Arti Utikar, Vinita Yerande, "Relative Study of Image Processing Filters with MATLAB, SCILAB and Raspberry Pi" International Journal of Innovative Research in Computer and Communication Engineering (An ISO 3297: 2007 Certified Organization) Vol. 4, Issue 11, November 2016
- [4] B. S. Manke "Linear control system", ISBN 978-817409-310-3, Khanna Publishers
- [5] B. S. Manke, "Scilab Textbook Companion for Linear Control Systems" ISBN 81-7409-107- Khanna Publishers
- [6] L. Ekonomou, "Stability Analysis and Control Design of Fuzzy Systems using Scilab Package", Proceedings of the 6th WSEAS International Conference on Simulation, Modelling and Optimization, Lisbon, Portugal, September 22-24, 2006
- [7] Claude S. Lindquist, "Bode plot construction for real-valued rational functions, Journal of the Franklin Institute, volume 330, issue 2, march 1993.
- [8] Robert Morgan "Linearization and Stability Analysis of Nonlinear Problems", Volume 16, No. 2, Fall 2015
- [9] K. Ogata "Modern Control System" ISBN-10: 8120340108, Prentice Hall India Learning Private Limited; 5 edition (2010)
- [10] Warren E. Dixon, Member, IEEE, Darren M. Dawson, Senior Member, IEEE, B. T. Costic, and Marcio S. de Queiroz, Member, IEEE, "A MATLAB-Based Control Systems Laboratory Experience for Undergraduate Students: Toward Standardization and Shared Resources", IEEE TRANSACTIONS ON EDUCATION, VOL. 45, NO. 3, AUGUST 2002
- [11] Nyan Phyo Aung, Zaw Min Naing, Mo Mo Myint Wai, Hla Myo Tun "Simulation Of Wireless Networked Control System Using TRUETIME And MATLAB", International Journal Of Scientific & Technology Research VOLUME 5, Issue 06, June 2016
- [12] Constantine H. Houppis, Styart N. Sheldon "Linear Control System Analysis & Design with MATLAB", Sixth Edition, 2014 by Taylor & Franchise group