IDENTIFICATION OF A CONTINUOUS STATE SPACE MODEL USING LABVIEW

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Abstract

This paper explains how to estimate a partially-known continuous state-space model of a resistor-inductor-capacitor (RLC) circuit. This model is used to optimize the unknown model parameters. This work illustrates use of LabVIEW for system identification and design of control systems.

Keywords: RLC, System identification, Lab VIEW

1. Introduction:

System identification is the process of extracting or inferring information about a mathematical model by numerical processing experimental data or data derived from experimentally collected data. This paper presents the identification for control. System identification is fundamental for communication and control engineering, and it also plays important roles in many other areas, such as meteorology and economics. Modeling and identification techniques help develop knowledge about a system.[1] They are prerequisites to many practices in engineering and technology and are especially important in the field of automatic control.

Model based control design involves developing and analyzing model to describe a plant or a system, designing and analyzing, and simulating the dynamic system. LabVIEW provides solution for each of these phases. It has different tools which are built on this platform with different approaches at each phase in a model based control design and identification of a system. There are two types of models in system identification. They are parametric and non parametric models. In parametric model to get the data in the form of parameters we are having AR, ARX, ARMAX, State space, Instrument variable estimator and General Linear etc.[2,6]

2. About the LabVIEW

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) which is a graphical user friendly Language which is totally based upon icons/buttons instead of programming codes and code paragraph. This software has the ability to build user defined interface with set of objects and graphical tools. These programs are labeled as Virtual instruments (VIs,) owing to their operational replica of physical instruments, like oscilloscopes, multi-meters, mathematical tools

etc. A Virtual Instrument is the combination two panels generally known as windows. i. Front panel or window, ii. Block diagram window.

All control and indicator are the part of Front panel window and their Icon and connector pane lies in a Block diagram window.[3]

3. RLC circuit:

The following figure shows an RLC circuit, where u is the input voltage, y is the output voltage, i_L is the current, and u_C is the capacitor voltage. Let us assume y equals the capacitor voltage u_C. [5] Let us assume R= 1.5 ohms.
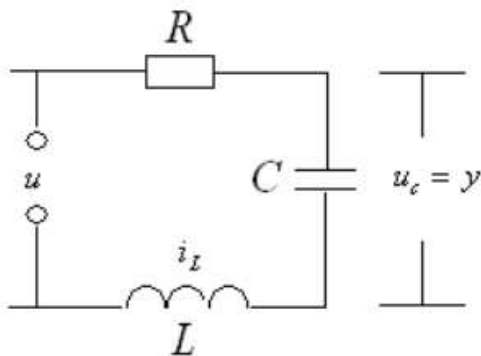

Figure - 1: Series RLC circuit

First-order differential equation relationship between the capacitor voltage and the current of this RLC circuit.

$$\dot{u}_C = \frac{1}{C} i_L \qquad (1)$$

First-order differential equation of the voltage relationship in the circuit.

$$Ri_L + u_C + L\dot{i}_L = u \qquad (2)$$

By using the Laplace transform we can get the following transfer function.

$$\frac{y(s)}{u(s)} = \frac{1}{1 + RCs + LCs^2} \qquad (3)$$

Where s represents the s domain

By manipulating the previous equations, the continuous state-space model for this RLC circuit

$$\begin{bmatrix} \dot{u}_C \\ \dot{i}_L \end{bmatrix} = \begin{bmatrix} 0 & 1/C \\ -1/L & -R/L \end{bmatrix} \begin{bmatrix} u_C \\ i_L \end{bmatrix} + \begin{bmatrix} 0 \\ 1/L \end{bmatrix} u$$

$$y = u_C = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} u_C \\ i_L \end{bmatrix}$$
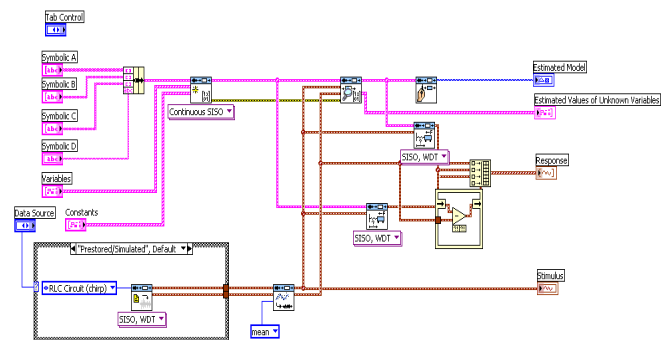
4. Simulated responses:

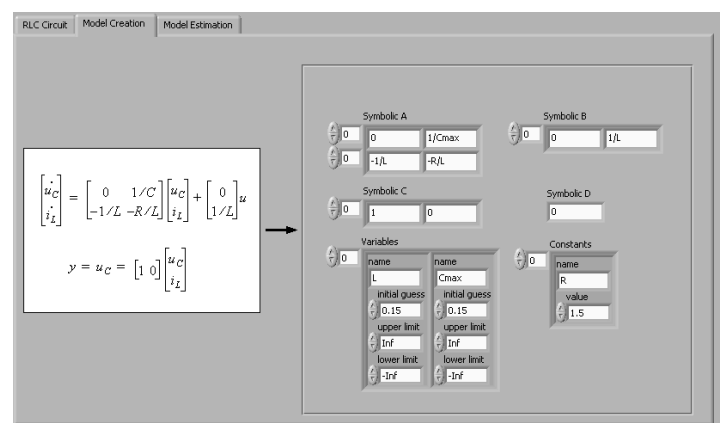**Figure – 2 Block diagram of RLC circuit using LabVIEW**

Figure – 3 Front panel of RLC using LabVIEW

The LabVIEW control design and simulation provides the transfer function and state

space equations. System identification toolkit provides the estimated model, estimated values of the unknown variables and the response of the system. [4, 7]
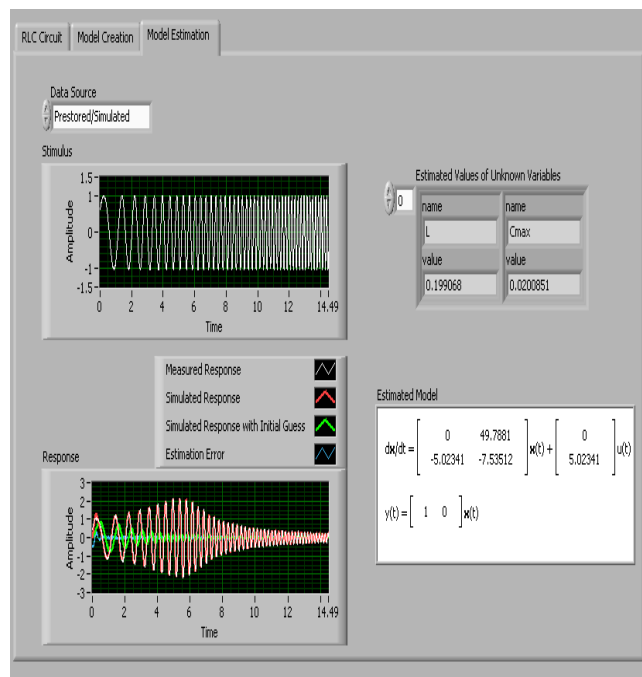
5. Results

Figure – 4 Model Estimation of RLC using LabVIEW

Simulated response matches the measured response. In the model creation we guess the values of L and C are 1.5H, 1.5f.In the model estimation, we are getting the nearest values of that unknown variables. And the estimation error is also very less. By using the AR, ARX, ARMAX

methods also we can get the parameters from the unknown and partially known parameters.

References:

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[6]   Saligrama R. Venkatesh and Munther A. Dahleh" On System Identification of Complex Systems from Finite Data"IEEE transactions on Automatic control, vol. 46, no. 2, February 2001

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