User - Friendly Computer Software in Control and Instrumentation Teaching and Learning

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Abstract - *In this paper we present worked-out laboratory practices for undergraduate electrical engineering courses. They encompass the different parts of control implementation and instrumentation using the software packages Matlab, Simulink and LabVIEW. These software tools can enhance the learning in control and instrumentation and important aspects of system implementation can be promptly considered. Laboratory practices such as interfacing for data acquisition, modulated pulse train generation, control algorithm implementation and parameter estimation are covered here.*

Introduction

The major change occurring at the present is the increasing number of user-friendly softwares that make it possible for students to experience new and fast ways of learning. In minutes, simulation, controllers and real world interfacing can be created. Offering the means to program, interface and control real systems give the students the skills they need to answer to the current industry demands. Therefore, it is imperative that engineering courses give emphasis on design oriented laboratory hands-on experience in their programs.

The software packages LabVIEW [1], Matlab [2] and Simulink [3] can enhance the control and instrumentation learning yielding new insights into the design of more complicated problems. The LabVIEW is a visual software developed in a graphical language for instrumentation and control. With LabVIEW, computer laboratory experiments such as measurements and control tasks are easier performed. The Matlab is a development language offering the best choice of control design tools and the Simulink is a software for modelling, simulation and analysing dynamical systems. Knowledge of these tools will serve the student well throughout their professional career. In this paper worked-out laboratory practices using the softwares Matlab, Simulink and LabVIEW are described.

Sensing, Signal Conditioning and Interfacing

In this section an example of the use of LabVIEW programming language for data acquisition is given. Figure 1 illustrates this application. The interface configuration, test inputs, sampling period, display and recording are easily set through available functions.
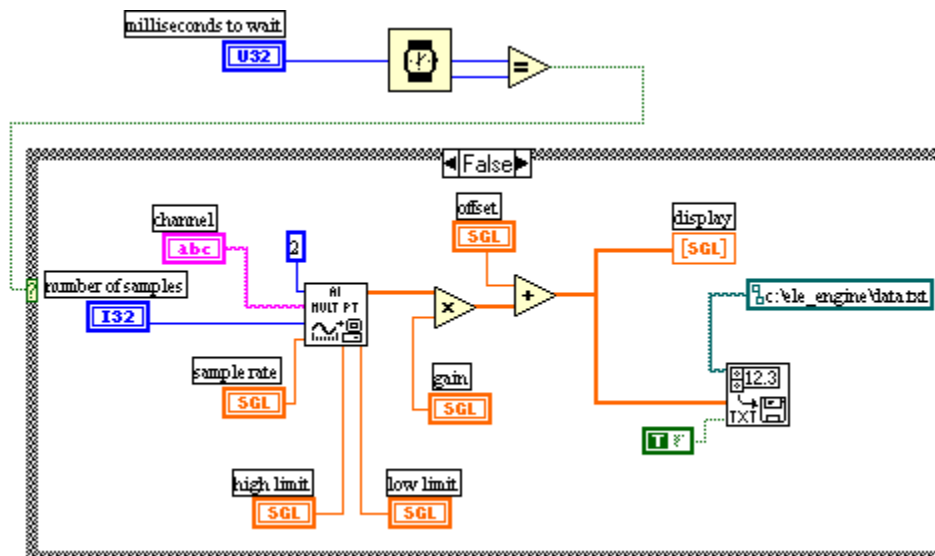

Figure 1: Computer interface for data acquisition.

Control Application

In control application an important issue is the digital implementation of the developed algorithms. Important aspects of filtering, signal scaling and sampling can be studied via simulation and a good software environment is thus desirable. A control application using a magnetic suspension system is illustrated in Figures 2 and 3. The control objective is to keep the ball in a dynamic balance around its equilibrium point. The output variables are the coil current and the ball position. A position detector consisting of a 5V infrared emissor as a light source and a phototransistor MRD-300 as a photoreceiver and a Hall effect sensor NW-SC50 for the current are used. In order to control the coil current, a power amplifier working with an analogue pulse width modulation (PWM) circuit of 5kHz switching frequency and a transistorised DC chopper is used. More details of the control implementation can be found in [4].
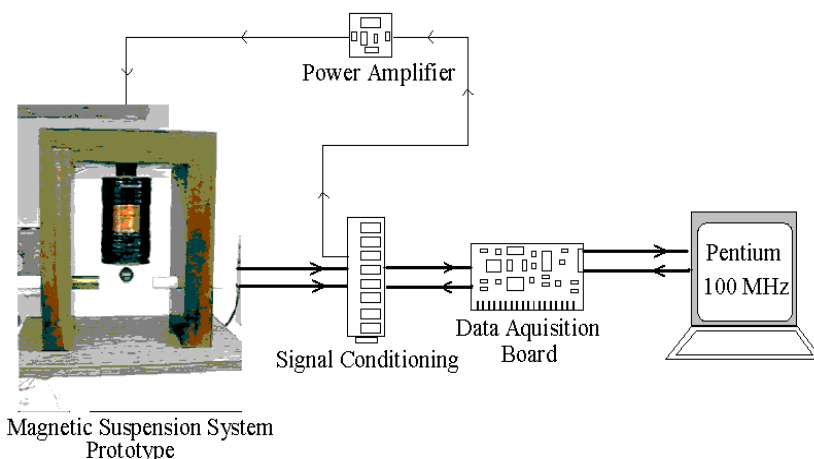

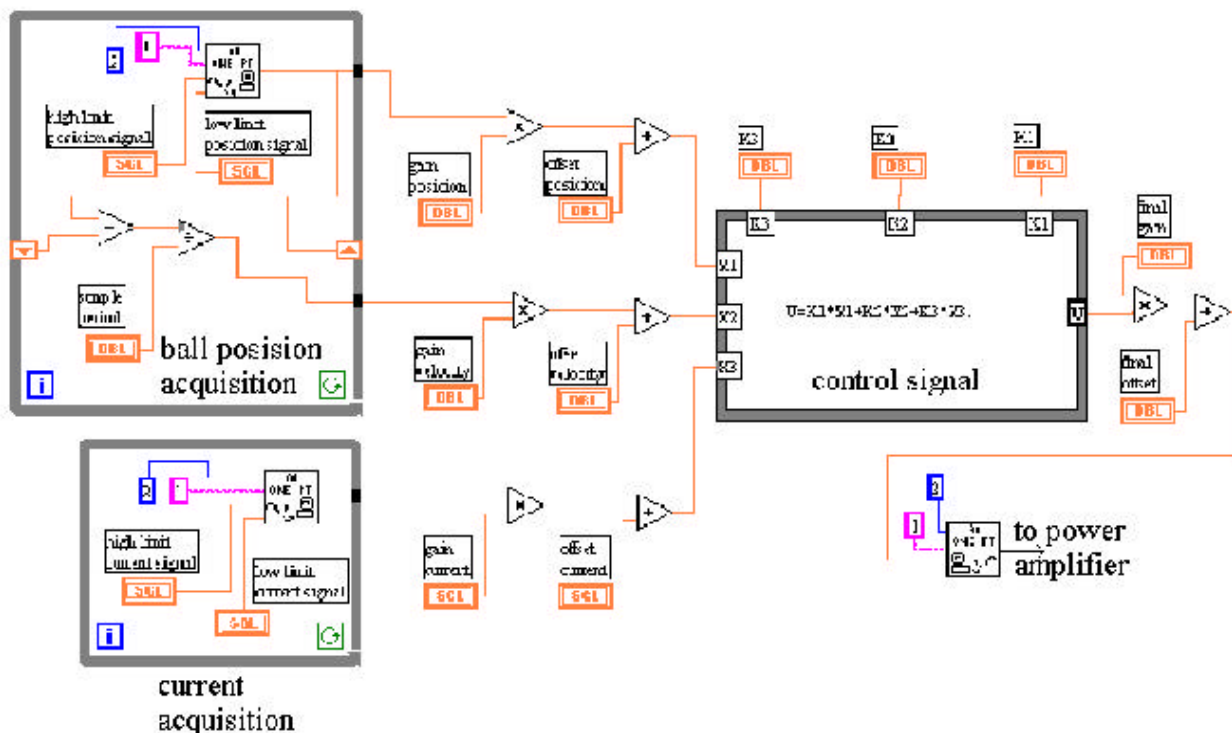Figure 2: Magnetic suspension control system.

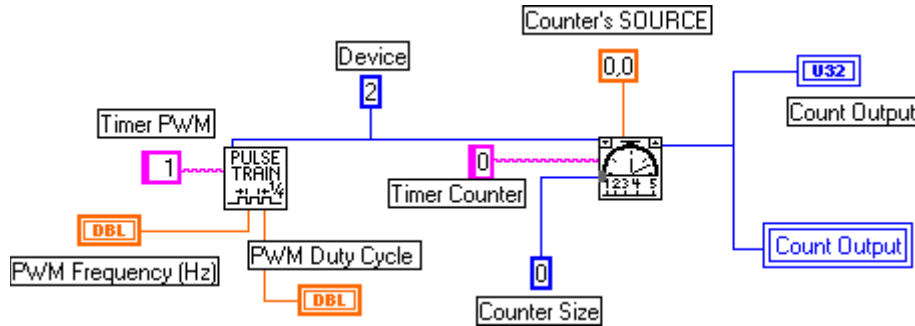*Figure 3: A LabVIEW program for an optimal control algorithm.*

Figure 4: A PWM logic generator LabVIEW program.

A Pulse Width Modulation Logic Program

A power amplifier working with a pulse width modulation (PWM) logic is normally used to drive a servomotor DC. Figure 4 shows a LabVIEW program that generates a PWM logic. Also, a counter for an optical encoder for shaft position measurement is included.

In a PWM logic the control signal modulate the pulse train period in 0 and 1. The pulse train frequency and the pulse polarity can be adjusted in the LabVIEW panel.

A Laboratory Practice on Parameter Estimation

Laboratory experiments using DC servomotors are very popular since a DC servomotor offers the possibility of studying the basic control concepts and is easily encountered in the laboratory. An experiment which contains elements of theory, experimental parametric estimation and computer simulation can enhance the quality of control education. To perform such an experiment in laboratory the Matlab/Simulink environment has proven an efficient and powerful tool. The laboratory practices using servomotors require, in general, the servomotor transfer function, which may be furnished or estimated by several procedures [5] – [8]. The called classic methods used to obtain the servomotor parameters are time consuming and require isolated tests for each parameter. Estimation methods based only on the current response to a step voltage input such as the Pasek method and the method of interpolation have shown to be more effective, faster and simpler to apply. In the latter method the current response of the machine is recorded and processed to yield the machine gain and frequency poles. Therefore, graphic windows associated with algorithms developed in Matlab can be of significant value in performing modelling studies.

Figure 5 shows a laboratory set up for data acquisition and Figures 6 – 8 illustrate a parameter estimation laboratory practice using graphic windows generated in Matlab/Simulink. The graphic windows allow for entering data input files and different methods, estimation result outputs and simulated machine response visualisation.
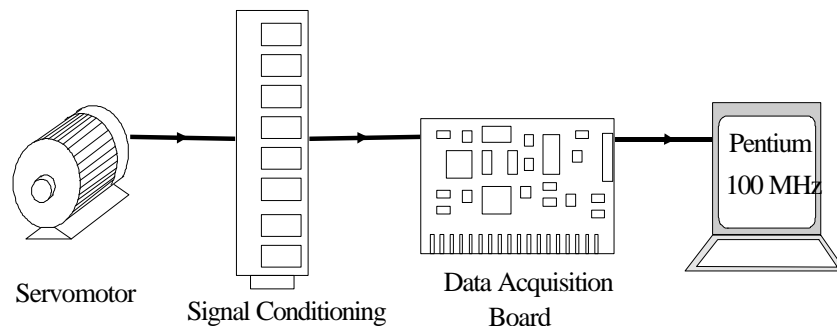
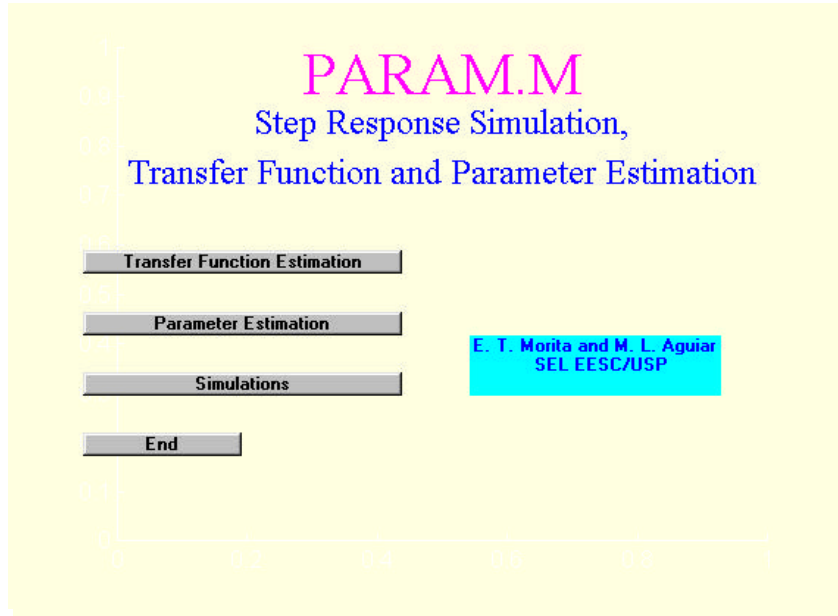*Figure 5: Servomotor data acquisition for parameter estimation.*

*Figure 6: Main menu for parameter estimation
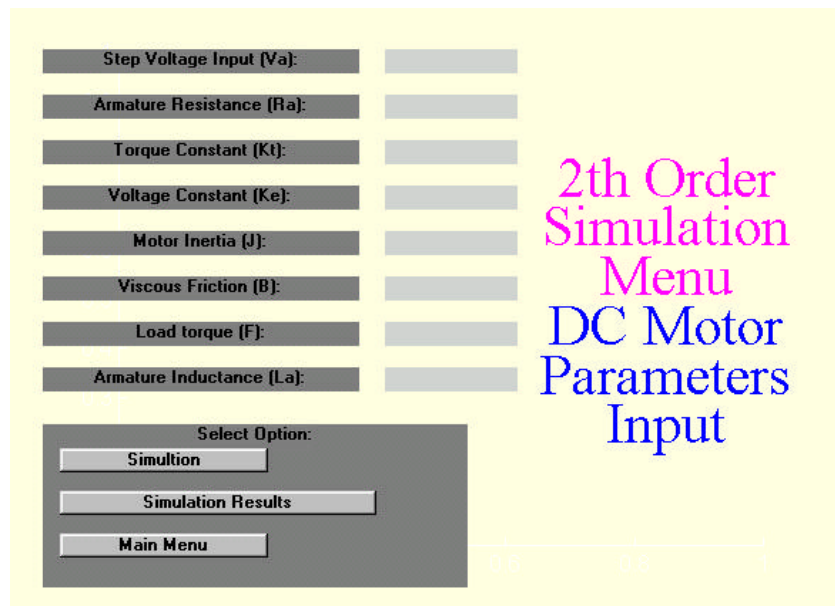and simulation in Matlab environment.*

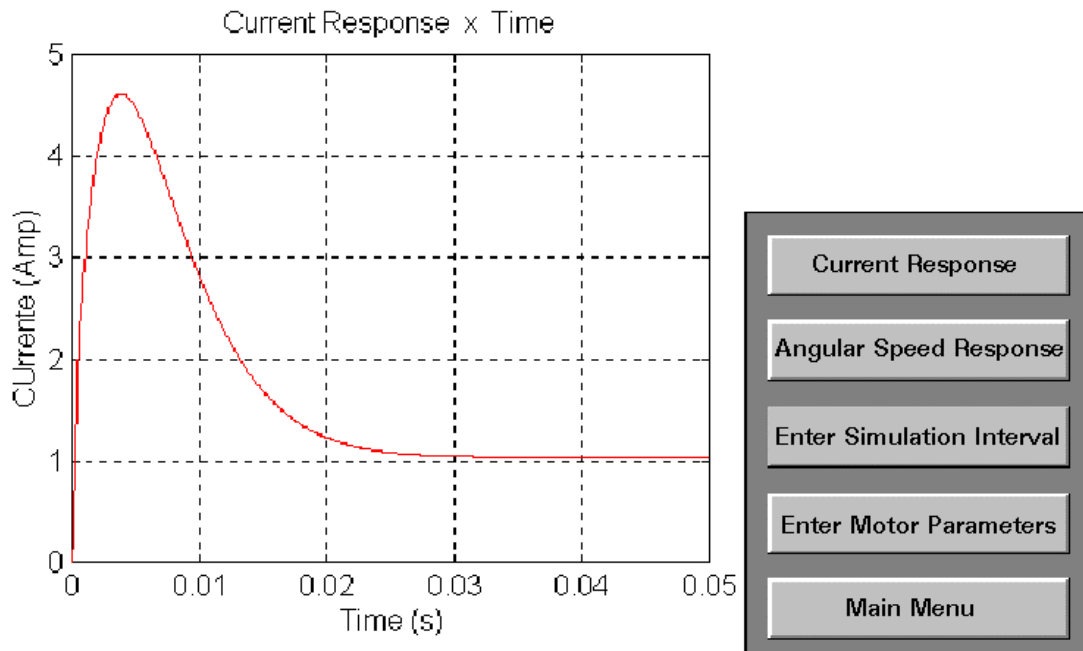*Figure 7: Data input menu for simulation.*

Figure 8: Graphic output for displaying the simulation results.

Conclusions

In this paper we presented laboratory practices to be used at undergraduate electrical engineering courses. They encompass the different parts of control implementation and instrumentation. Simulated and experimental results can be analysed providing interesting comparisons and the validation of the modelling and controller design.

References

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