

# SIMULATION CONTROL SYSTEM DESIGN WITH SCILAB AND XCOS

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## Abstract

### Article Info

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The control system is designed to facilitate the performance of electronic designs for the industrial world. In this research, the design on Scilab is for simulating work on DC Motor objects (DC current, AC and analog and digital signal conversion) and P I D control (control output, system coil). The input data on the Xcos feature for the output of the simulation is adjusted for variables in the thematic mathematical formulations, parameters. The stages of the research method consist of several modeling, analog system modeling, physical modeling, system modeling experimental procedures, modeling through system identification. Scilab design for output simulation on Xcos block diagram results there are several input system parameters, 2, 3 dimensional display sub-systems and function graphs

Keywords : Control System, Scilab, Xcos

## 1. Introduction

A tool to control, govern and regulate the state of a system. This control term can be practiced manually to control the control system. In an automatic system, this tool is widely used in the industrial field in everyday life, it is often used to simplify the production process. The purpose of the control system is to maintain the quality and quantity of a process. the reason an industry needs a control system. First, because this system can reduce the human error generated during system operation, Second, the automatic system of the control system reduces the number of operators so that it will reduce costs. Third, implementing this system will certainly be more efficient because by using control, every change will be responded to more quickly, accurately with manual operators. Types of control systems, one of which is on-off control system and modulating [1].

On-off control systems are known as digital, binary, discrete, and sequential controls. While modulating control, analog, continuous control systems. In addition, there are also several control systems, namely open loop and close loop controls. In designing a control system, several steps are needed, namely, first determining the system to be controlled and the objectives to be achieved from the control mechanism.

The second is modeling the system. System modeling is the process of obtaining a representational approach system. The purpose of system modeling is to find out system behavior (behavior). With the system we can find out what kind of action should be given to run the system desire (system goal). The results of the regulatory system modeling are usually represented by mathematical equations such as transfer function, state-space, and others.[2]

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After modeling, to determine the behavior of the system system analysis. By analyzing the system we can know the stability of the system, the characteristics of the response its limitations. Analysis The system can be divided into response time analysis and response analysis frequency. For time response analysis used unit step test signal, impulses ramps. For frequency analysis, a sinusoidal test signal is used. With this test we can know the characteristics of the response time and frequency response [3].

Scilab is a programming language used for the development of an algorithm. Scilab is available for Windows, Linux and MacOS operating systems. This software provides an environment for computations required in the fields of science and engineering, released as open source under the CeCILL license. has enterprise support for companies that need support. Scilab provides hundreds of mathematical functions [4]. This software has a programming language that can access data structures, 2D plots, 3D plots and graphic functions. How to use the Scilab application is almost the same as Matlab and other applications. However, adjustments in using Scilab must be explained from the beginning.

Xcos is part of the Scilab software that functions to develop dynamic system models. Modeling will use graphics. where Xcos consists of block diagrams with specific functions. This collection of block diagrams is stored in the browser palette menu [5]. This Xcos editor window will later be filled with block diagrams that are in the Palette browser, then build the system to perform the simulation. Palette browser window containing blocks diagrams, the block diagrams above are virtual tools with different functions for simulation system control [6].

Related previous research for motor DC [7], [8], PID Contol [9], The application of Scilab software [10], The purpose of this research is to model the control system on DC Motor and PID Control in the form of 2D, 3D display simulation on Scilab programming applications and Xcos features. Input parameters on the mathematical formula variables and test data values with the suitability of the blog diagram design on the output of the Scilab application with the XCos feature on several modeling trials carried out.

## 2. Methods

### 2.1 Analog System Modeling

How to get a system model can be divided into 2, namely physical modeling or system identification.

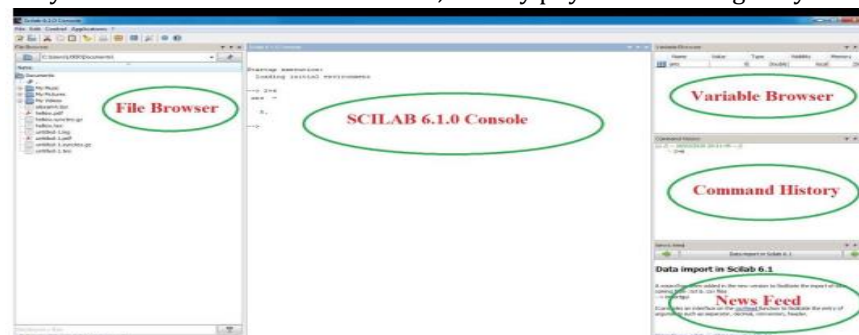


Figure 1. Display Environment in Scilab

Controller Design, After knowing the characteristics of a plant (the device you want to control), a control system is designed. There are many types of controllers such as PID, Pole-placement, Lead-Lag, and others. However, in the industrial world, the controller that is often used is the PID controller [11].

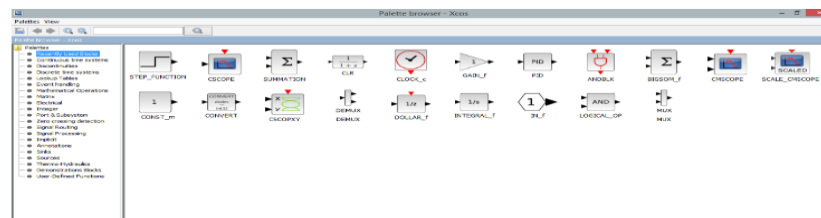


Figure 2. Browser Palette Window

## 2.2 Physical Modeling

Physical modeling can be done if the physical parameters of each plant subsystem are known. To better understand do an experiment. Physical modeling of separate field gain DC motor speed regulation.

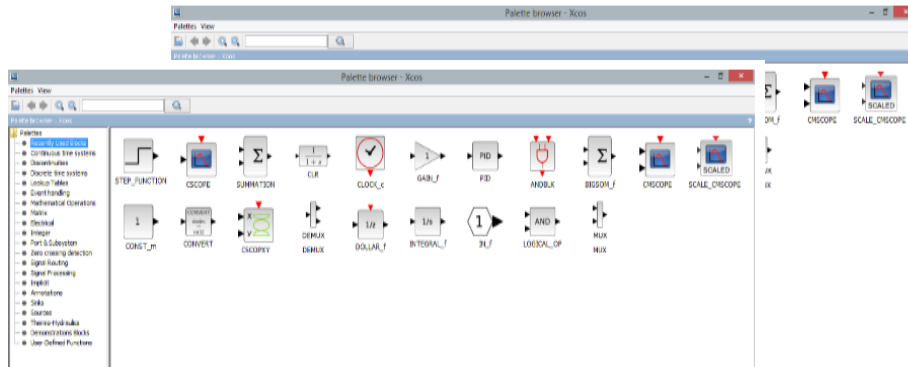


Figure 3. Separate Field Gain DC Motor

With parameter values as follows:

( J ) : Rotor moment of inertia  $0.01 \text{ kg.m}^2/\text{s}^2$ ,

( B ) : Attenuation ratio  $0.1 \text{ Nms}$ , ( Ke): Electromotive force constant  $0.01 \text{ V / rad / sec}$ ,

( Kt ) : Motor torque constant  $0.01 \text{ Nm / Amp}$ , ( R ) : Resistance  $1 \text{ Ohm}$ , ( L ) : Inductance  $0.5 \text{ H}$ .

## 2.3 System Modeling Experiment Procedure

### 1. Open Xcos on Scilab

The way to open it is to open Xicos. Then select Applications on the tool panel. Then select Xcos as shown in Figure 4. After selecting Xcos, the Scicos workspace will appear open as in Figure 4.

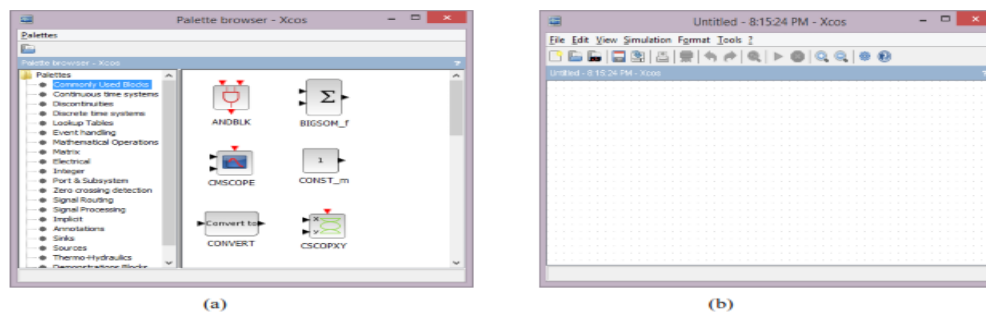


Figure 4. Xcos (a) palette browser, (b) workspace

### 2. Make a block diagram of each sub-system on a DC motor figure 3 on Xcos.

#### a. Anchor Coil Subsystem

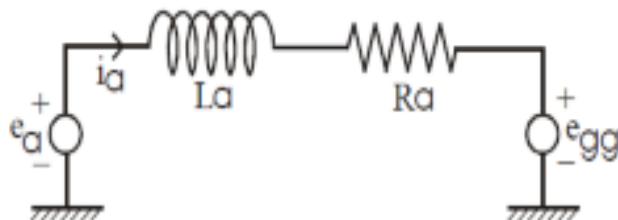


Figure 5. Anchor Coil Subsystem

Based on the above parameters, make a decrease the differential equation and the transfer function of the subsystem then make the block diagram on Xcos Based on the above parameters, make a decrease the differential equation and the transfer function of the subsystem then create a block diagram on Xcos.

Angular Velocity Subsystem-Eggl.This subsystem converts speed into emf voltage constant with the electromotive force constant (Ke). Based on the above parameters, make a decrease the differential equation and the transfer function of the subsystem then create a block diagram on Xcos. Overall model From these subsystems, construct blocks the diagram, calculate the equivalent transfer function the whole thing and make the block diagram on Xcos [12].

## 2.4 Modeling through System Identification

In identification modeling, an approach model will be obtained order-1 of the system according to the equation:

$$G(s) = \frac{K}{\tau s + 1}$$

..... (1)

With K = gain and  $\tau$  = time constant (time constant).

## 3. Results and Discussion

To design a digital control system, we must first obtain a discrete model of the system. The process of converting analog signals to digital is called ADC (Analog to Digital Conversion). Control system design process To design a digital control system, we must first obtain a discrete model of the system [11].

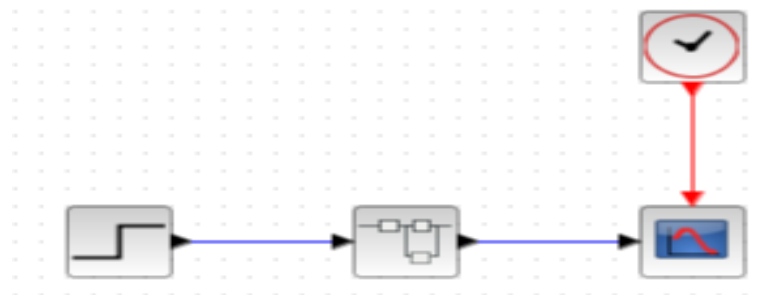


Figure 6. Block Diagram with physical model on XCOS

The process of converting analog signals to digital is called ADC (Analog to Digital Conversion). As for the process of obtaining sampled data from the model. Looking for the value of the sampling time ( $T_s$ ), find the value of the time settling criterion of 0.5% from the plant. Converting continuous system model to discrete model [13].

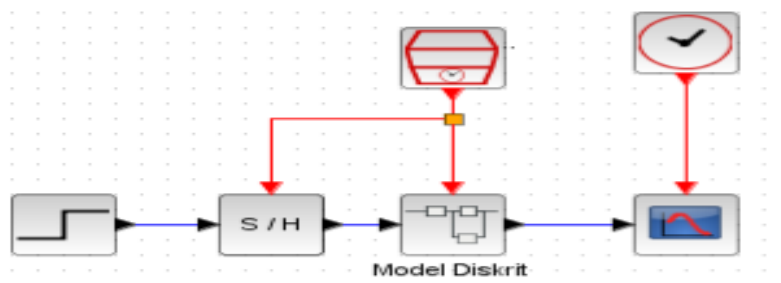


Figure 7. Block Diagram Simulation to Get Stepresponse

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In this control system simulation, what needs to be done is Design block diagrams using Proportional controls, Input constant ( $K_p=1$ ), Running simulation, Displaying output in the form of a graph, Record the resulting responses in tabular form (rise time, overshoot, peak time, and settling time), Repeat the second to fifth simulation for  $K_p=2$ ;  $K_p=3$ ;  $K_p=4$ ;  $K_p=5$ ;  $K_p=6$ ;  $K_p=7$ ;  $K_p=8$ ;  $K_p=9$ ;  $K_p=10$ , Make conclusions [14].

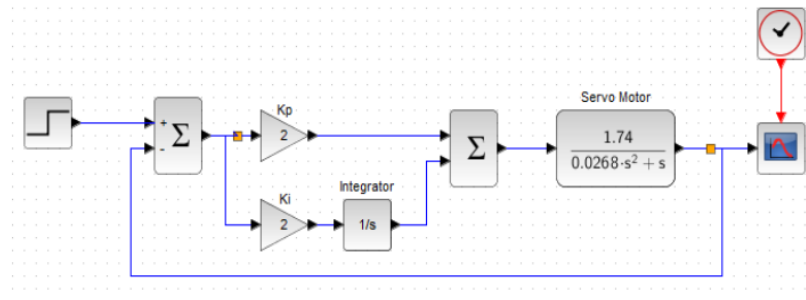


Figure 8. PI Control System Simulation Block Diagram

#### 4. Conclusions

Utilization of the Scilab and Xcos applications in this study, several conclusions were drawn to justify and simulate 2D and 3D on the theory and mathematical formulas of DC Motors and PID Control with several identification stages of modeling on each variable and parameter inputted to the system and subsystem.

The display output is according to the input components, for PID control, analog to digital signal conversion by setting the criteria for time, constants, control system design, making conclusions. In DC motor performance changes Moment of inertia, electromotive force, motor torque constant, resistance, inductance.

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