EE 554 – Final Project

Introduction

In Miniproject2 and Midterm projects we have successfully simulated and implemented a second order system on the DE0/DE0 Nano FPGA. The second order system was accomplished by a 2-stage RC network, as shown in Figure 1.

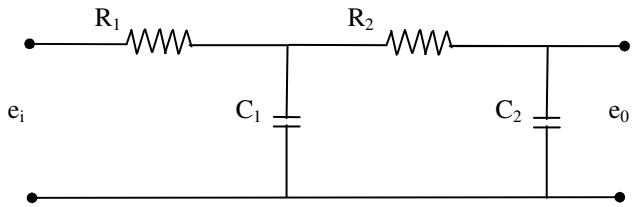

Figure 1. A Second-order Electrical System

Description of the final project

The objective of the Final project is to implement the circuit shown in Figure 1 and use the FPGA to implement a digital controller. The state variable we wish to control is the voltage at the second capacitor, e_0 (shown in Figure 2). A description of a similar system can be found in [1].

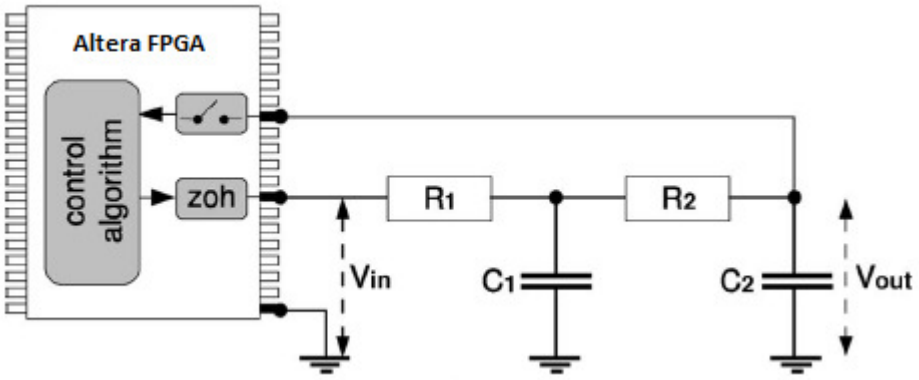

Figure 2. The closed-loop dynamic system

Project requirements

A team of two persons need to demonstrate the embedded control system for inputs like a square wave signal (the system may not be able to track negative voltages but it should output voltages up to 3.3V). The controller required for this project is of the type Proportional-Integral-Derivative (PID). A discrete PID controller can be implemented using the following difference equation:

$$u(k) = u(k-1) + \left(Kp + Ki\,T + \frac{Kd}{T}\right)e(k) - \left(Kp + \frac{2\,Kd}{T}\right)e(k-1) + \frac{Kd}{T}e(k-2)]$$

Your team is required to do a sensitivity analysis on the system described above. The four parameters of interest are:

- T (sampling period).
- Kp (proportional gain).
- Ki (integral gain).
- Kd (derivative gain).

You may use two to three values per parameter for your documentation of the project.

Documentation

You need to deliver a report that may include:

- Front page with standard information: title of project, team members, date.
- Short introduction of the project.
- A section that includes the description of the controller design process.
- A Results section which may include results of the experiments: appropriate, marginal, and inappropriate values for this specific system.
- Future recommendations for the use of the Altera FPGA platform for this project. If you know of a good microcontroller or FPGA platform that you think it could be used for this class, please recommend it.
- MATLAB/C/Verilog code, and plots of system simulations.
- Plots of the outputs of the system as seen on the scope.