Low Cost FPGA Based Replacement for dSPACE Units in the Electric Drives Laboratory

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EE 4701 - Electric Drives
(3.0 cr; Prereq-3015; spring, every year)
AC/DC electric-machine drives for speed/position control. Integrated discussion of electric machines, power electronics, and control systems. Computer simulations. Applications in electric transportation, robotics, process control, and energy conservation.

EE 4703 - Electric Drives Laboratory
(1.0 cr; Prereq-4701 or & 4701; fall, spring, every year)
Laboratory to accompany 4701. Simulink-based simulations of electric machines/drives in applications such as energy conservation and motion control in robotics.
Current Laboratory Hardware Configuration

- dSPACE DSP controller board
- Host Computer Running ControlDesk
How much does it cost?

The Present Laboratory...  

...and what a seat costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor sets</td>
<td>$2,500</td>
</tr>
<tr>
<td>Electric-Drives Board</td>
<td>$1,725</td>
</tr>
<tr>
<td>dSPACE DSP controller</td>
<td>$5,300</td>
</tr>
<tr>
<td>Power Supplies</td>
<td>$316</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>$302</td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
<td><strong>$10,143</strong></td>
</tr>
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So what did we do...

While dSPACE is a wonderful real-time controller it is expensive and more than is really needed.

We needed a digital controller which:

• Inexpensive relative to dSPACE
• Leveraged the existing laboratory hardware
• Flexible with regard to new hardware
• Minimized changes to the student experience
How did we get there?

Mostly through a series of student projects

• 2008: A new FPGA controller for the power electronics lab (Narayan, Castelino)

• 2011: FPGA controller design based on Xilinx System Generator (Dalley)

• 2011: Microcontroller based controller design (Rajavel)
The (NEW) FPGA controller for the Drives Laboratory

• Hardware
  – FPGA board uses Xilinx Spartan 3E FPGA
  – Interfacing hardware, not needed with upgraded Electric Drives board.

• Software
  – Simulink with Xilinx System Generator toolbox
  – GUI on the PC uses the hardware co-simulation capability of Xilinx System Generator in Simulink
NEW Laboratory Hardware Configuration

NEW FPGA Controller Board

Host Computer running Simulink/System Generator
Hardware/Software Co-Simulation

FPGA Controller Board

Simulink model on PC

(JTAG)
How much does it cost?

The Current Laboratory...    ...and what a seat costs

- Motor sets                      $2,500
- Electric-Drives Board      $1,725
- FPGA controller        $530(?)
- Power Supplies       $316
- Miscellaneous        $302

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Total cost                   $5,373
Advantages

• **Inexpensive** relative to dSPACE, approximately by an order of magnitude.

• **Uses existing laboratory hardware**, an upgraded drives board will interface more easily.

• The GUI on a PC can be customized for the **same student experience** (or not) as in the existing lab. It hides unnecessary details.

• The controller and GUI are **very flexible**. You can change controllers and worry about more detail if desirable, possibly in a graduate level class.
The End

Please stop by our poster for more details and a view of the hardware