

University of Agder

Innovation in the classroom: practical training in the Control Theory course for next generation mechatronic engineers in Norway





Professor Michael Ruderman from the Faculty of Engineering and Science at the University of Agder (hereinafter UiA) in Norway is using Speedgoat and MathWorks real-time products in his courses to train Mechatronic master's students all there is to know about control theory.

UiA is a future-oriented higher education institution located in Southern Norway. UiA prides itself for being on the cutting edge of innovation, education and research through co-creating knowledge, not just between their teaching staff and students, but also with regional industries and partners from their extensive network and community.

The Faculty of Engineering and Science offers a master's program in Mechatronics, which merges multiple fields of engineering - such as mechanical, electrical, instrumentation, industrial, computer, and control engineering - and equip students with the right toolkit to strive in life after academia as young engineers.

As part of the Mechatronics curriculum, Professor Michael Ruderman teaches the Control Theory course every fall semester for students at the final stage of their study. He combines theoretical basics of systems and controls with practical hands-on skills training to show how to analyze dynamic systems and design feedback controllers in the frequency domain, state-

space representations and digitalized discrete forms, as well as familiarizing them with common problems and boundary conditions within control engineering and real-world challenges and circumstances of industrial applications.

The Challenge

MATLAB® and Simulink® from MathWorks were chosen as the main numerical platforms for control-related teaching in the course. Therefore, it was imperative to find a matching real-time solution that worked and was compatible with the chosen MathWorks products. Ease of set up and use by students still learning about the real-time environment were also crucial requirements. In addition, the solution needed to be general enough to support diverse interfaces and functions.

The Solution

Speedgoat products, the Baseline Education real-time target machine (hereinafter Baseline) and simultaneous sampling 16-bit analog I/O module, the IO183 EDU-Baseline, were chosen as a solution because Speedgoat

products were specifically designed to work within the MATLAB® and Simulink® environment.

The Results

In a recent course project work, up to four students of each group implemented and executed real-time methods and algorithms for the operation of a large-scale hydraulic machine using a Baseline as their universal controller that interfaced with the developed identification, rapid-prototyping and discrete-time tests, including control routines and algorithms. The Baseline-based control unit accessed the equipment-specific third-party embedded hardware through a real-time UDP interface to drive the hydraulic loader crane.

Thanks to the seamless integration of Speedgoat products with the MathWorks product family, it allowed the students to quickly implement and execute these real-time methods and algorithms without having to worry about setup issues or having to do cumbersome modifications of the software or hardware first to get the system working.

The Key Benefits

An additional benefit of working with Speedgoat products was the educational value of teaching the students about strict real-time constraints, deterministic execution of numerical routines, sampling, quantization-related issues, amongst other things.

The simple one-click compilation to produce a real-time executable code from the efficient Simulink-based programming allowed students to make a rapid prototype design of the control systems and test them on real industrial equipment without exchanging or adapting interface components.

The attractive product pricing and fantastic performance allowed UiA to acquire enough Speedgoat platforms to adequately equip all

course students. As a result, within just three months of using the Speedgoat-MathWorks solution, a total of 42 students in the course were able to efficiently work simultaneously in smaller groups to create a fast plug-in operation of the target hydraulic loader crane and successfully complete their ambitious experimental control-related projects without any resource restrictions, such as access reservation or waiting times.

The Speedgoat product within the MathWorks software environment are now a permanent part of the practical project work assessment in the UiA's Control Theory course. Further use will be explored for other Mechatronics master's program courses taking place in the spring semester.

- **Ease of setup and configuration**
- **Quick implementation and execution of real-time methods and algorithms**
- **One-click compilation of code**
- **No cumbersome hardware or software modifications thanks to MathWorks product compatibility**
- **Attractive price-performance ratio allowed 42 students to work in smaller groups simultaneously**

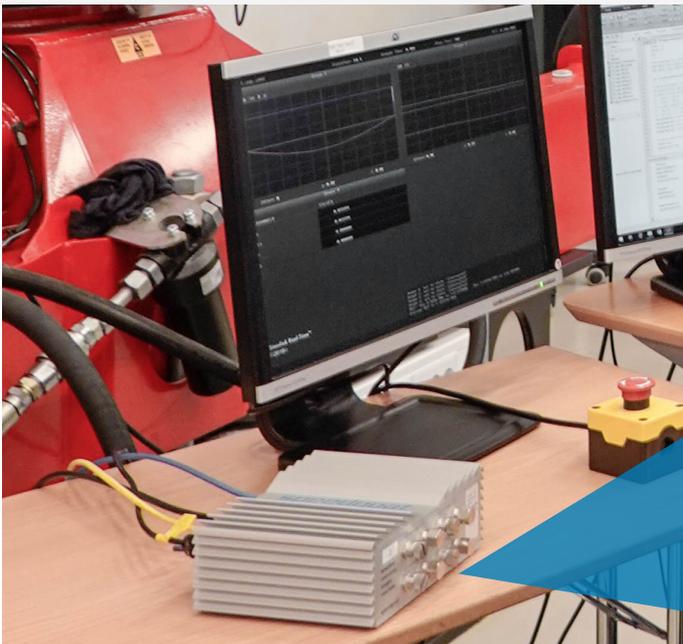


“ The Speedgoat platforms helped bridging the control theory and practice when teaching the students. It allowed focusing on the methods and algorithms and forgetting about the tediousness of software and hardware interfacing.

- Professor Michael Ruderman

“ A well-designed and user friendly real-time target which made teaching nearly a dozen student groups easy and also for them to use afterwards to fulfill their projects.

- Course assistant Philipp Pasolli, MSC



Top left:
Hydraulic loader crane in action
Middle right:
Professor Michael Ruderman
Bottom right:
Baseline real-time target machine



Utilized Speedgoat products:

- » Baseline Education real-time target machine
- » Simultaneous sampling 16-bit analog I/O module, IO183 EDU-Baseline

Utilized MathWorks products:

- » MATLAB®
- » Simulink®
- » Simulink Real-Time™
- » Simulink Coder™
- » MATLAB Coder™



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