USER STORY

HUSCO International Designs Intelligent Valve-Control System for a 20-Ton Excavator with Simulink® and xPC Target®

Manufacturers of excavators, earth-moving machines, and other heavy-duty industrial equipment are constantly seeking new ways to improve efficiency, reliability, and productivity while continuing to meet safety standards.

HUSCO International, a global leader in the development and manufacture of hydraulic and electrohydraulic controls, met this challenge by developing Intelligent Control Valve (INCOVA) technology. "By electronically controlling the valves with INCOVA technology, we increase excavator efficiency in terms of earth moved per unit of fuel, increase reliability by reducing the number of high-pressure hoses, and shorten cylinder cycle times," explains Darren Hartman, Software Team Leader at HUSCO.

HUSCO created a real-time prototype of an INCOVA system for a 20-ton excavator using MathWorks tools for Model-Based Design. The system receives input from the operator joystick, valve pressure sensors, and engine speed monitor and then sends control signals to hydraulic valves on the excavator's travel, slew, bucket, arm, and boom functions.

"Simulink®, Real-Time Workshop®, and xPC Target® enabled our systems engineers to focus on control algorithm design and cut development time by more than 50 percent," Hartman says.

A 25-ton excavator with hydraulic functions controlled by HUSCO's INCOVA system.

THE CHALLENGE

In HUSCO's former design process, systems engineers captured control requirements in a Microsoft® Visio® diagram. Software engineers then used this diagram as a specification to manually write C code for the control system. This cumbersome process made it difficult to complete multiple design iterations.

"We had no way of numerically validating the requirements captured in our static diagrams," explains Hartman. "Our software engineers had to interpret and hand-code both the original design and all subsequent changes. That meant long delays between the capture of a control algorithm and our ability to run it on a machine."

HUSCO needed a way to validate their designs, improve communication between systems and software engineers, and shorten design iterations and development time.

THE SOLUTION

HUSCO engineers designed, modeled, and validated the INCOVA control system using Simulink software. They then used Real-Time Workshop to generate C code from their Simulink models and xPC Target to implement a real-time prototype.

A graphical user interface developed with MATLAB® GUIDE tools was used to input the machine's system parameters, which included items such as the number of hydraulic

THE CHALLENGE

To design and implement an intelligent valve control system for large hydraulic machinery

THE SOLUTION

Use MathWorks products to model and validate the control system then automatically generate and run code on real-time rapid prototyping hardware.

THE RESULTS

- Development time cut by more than 50 percent
- Design modifications completed in an hour
- 100% of controller design reusable

> *In the past, our systems engineers had to consider hardware details such as the number of bits of accuracy and worry about communicating the design to the software engineer. With MathWorks tools for Model-Based Design, the system engineer can focus on controls, not on the details of the target hardware.*
>
> **Darren Hartman, HUSCO International**

cylinders and the area and velocity of each cylinder. System engineers used Simulink to develop the control algorithms that translate joystick movement to cylinder movement. Simulink enabled them to segment the model and divide the design effort among engineers specializing in filter design and proportional-integral-derivative (PID) controllers.

After assembling all subsystems into a complete Simulink system model comprising more than 1000 blocks, the team simulated the system. "Debugging a control system on a live excavator is not safe," says Hartman, "By working in Simulink, we could debug and tune the design from our desks."

To visualize simulation results, the team used MATLAB to post-process the captured output, calculate energy consumption, and plot joystick position versus cylinder movement.

HUSCO software engineers generated C code from the Simulink model using Real-Time Workshop. They then used xPC Target® and xPC Target Embedded Option™ for standalone operation of the control code on real-time PC hardware from Speedgoat, an xPC Target system integrator.

To validate the control system, the team developed a plant model of the excavator in Simulink. They linked the plant model with the control system model running on xPC Target. The validated control system was then connected to the actual excavator for further live tests and fine tuning.

The excavator is currently operating with the control system running on xPC Target. HUSCO plans to use Real-Time Workshop® Embedded Coder™ to generate code for their target production hardware.

THE RESULTS

- **Development time cut by more than 50 percent.** "Using our previous process, we took six to seven months to develop a spec, design a system, and create a prototype," explains Hartman. "With Simulink and xPC Target, we reduced that time to two or three months."
- **Design modifications completed in an hour.** "When we had to update our hand-written code every time we made a design change, it took about eight hours," says Hartman. "With MathWorks tools we can update the model, re-generate the code, and make the same change in an hour or less"
- **100% of controller design reusable.** "For us, the biggest change from machine to machine is the number of cylinders, so we made that a variable in our Simulink model of the control system," explains Hartman. "As we develop control platforms, we plan to reuse 100% of that control system."

To learn more about HUSCO International, visit *www.huscointl.com*

APPLICATION AREAS

- Industrial automation and machinery
- Rapid prototyping
- Data analysis
- Code generation

PRODUCTS USED

- MATLAB®
- Simulink®
- Real-Time Workshop®
- xPC Target®
- xPC Target® Embedded Option™

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