manroland Develops High-Precision Commercial Printing Press Controller

manroland's state-of-the-art printing press.

The Challenge

Implement a new design process to support development of a precision controller for a state-of-the-art commercial printing press

The Solution

Use MathWorks products for Model-Based Design to design and model the controller, run real-time simulations, and deploy a production system

The Results

- Development time reduced by over 50%
- Design iterations completed in minutes, not weeks
- Error analysis streamlined for manroland customers

As the world's second largest manufacturer of printing systems and market leader in web-fed offset, manroland AG has been driving innovation in print technology for more than 160 years. To meet customer demands for further advances in print quality, including improved image clarity and more accurate positioning of the image on the page, manroland needed a new approach to design—one that would enable them to try out multiple ideas and integrate testing with design. Today, they develop high-precision controllers using MathWorks tools for Model-Based Design.

"We had reached the limits of what we could achieve with our existing design processes and software," notes Thomas Debes, lead software engineer at manroland. "We needed a solution that would enable us to achieve new levels of quality. With MathWorks software, we can very quickly test new ideas and control algorithms and then bring those algorithms into our production systems."

The Challenge

On a recent project, manroland engineers sought to improve the accuracy of the cut registers on one of the company's commercial printers. Cut registers position the printed material beneath roller blades before it is cut into individual pages. For high-quality print magazines, cuts must be accurate to within 0.3 mm. Because the printed material travels through the printing press at speeds of up to 15 meters per second, the control algorithm has just 10 milliseconds to position the cut register. "To deliver the required speed and accuracy, we would have needed to completely rewrite our existing control software," Debes says.

manroland engineers needed a development environment that would enable them to test new control algorithms, simulate and compare designs, and rapidly build a real-time controller for final testing and deployment.

The Solution

manroland used MathWorks tools for Model-Based Design to design, test, and implement a production-ready control system for the cut registers on its state-of-the-art printing press.

Working in Simulink®, the project team built a plant model of the press that incorporated performance data gathered from an operating press. They then developed a Simulink model of the control system based on a proportional integral derivative (PID) controller and conducted open-loop testing of several control strategies to identify the optimal approach. The model incorporated counter and filter blocks from DSP System Toolbox™. Stateflow® and Simulink Coder™ were used to implement a finite state machine to control the operational states.

After linking the plant model with the controller model, the engineers ran closed-loop simulations in Simulink to validate the controller. When they were confident that the controller met the functional requirements in non-real-time simulations, manroland engi-

"MathWorks tools made it easy for us to test ideas, introduce new algorithms, and compare one controller against another without having to think about implementation details. We could quickly change the structure of the controller and immediately see the results. The ability to perform rapid iterations enabled us to optimize quality and functionality while greatly reducing development cycle time." —Thomas Debes, manroland

neers used Simulink Coder to generate C code from the plant and controller models.

Using xPC Target™, they ran real-time simulations, executing the plant model code on a standard PC and the controller model code on a second PC. The two systems communicated via User Datagram Protocol (UDP) and a fieldbus.

In the controller model, the engineers used Simulink to implement a TCP/IP interface that enabled them to remotely configure set point values, such as machine speed, from a third computer.

They used the Simulink plant model to simulate abnormal press behavior, which is often difficult to reconstruct on real hardware. "We were able to test the controller under many error conditions that we would not otherwise have been able to test," says Debes.

The engineers optimized performance by fine-tuning the controller model and then re-generating and deploying the controller using Simulink Coder and xPC Target.

They then disconnected the xPC Target PC from the plant model and reconnected it to the production printing press at a manroland customer site using the same fieldbus and network interface. Because the simulations were so accurate, the controller immediately worked as designed in the production environment, and has consistently met the customer's specifications for error rate, accuracy, and response time.

The Results

Development time reduced by over 50%. "It took us about 10 months to develop the controller using MathWorks tools for Model-Based Design, saving us at least one year of development time," explains Debes. "The main benefit was a much shorter time to market, resulting in a competitive advantage for manroland."

Design iterations completed in minutes, not weeks. "Even with a very complex model we completed our design and debug iterations in about 10 minutes," says Debes. "When we changed the controller structure in Simulink, we simply re-generated the code using Simulink Coder. Using our standard methods, it would have taken a week or longer to perform a similar change."

Error analysis streamlined for manroland customers. "With MathWorks tools we can collect data from the production press and simulate the error condition in-house," notes Debes. "This considerably reduces time to resolution for our customer, as well as our own support and travel expenses, because our printing presses are sold all over the world. Furthermore, we are not bound to customers' production time and do not consume their manufacturing resources while we are troubleshooting."

Industry

- Industrial automation and machinery

Application Areas

- System design and simulation
- Rapid prototyping
- Verification, validation, and test
- Control systems
- Mechatronics

Products Used

- MATLAB®
- Simulink®
- DSP System Toolbox™
- MATLAB Coder™
- Simulink Coder™
- Stateflow®
- xPC Target™
- xPC Target Embedded Option™

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