SIEMENS

Case Study

Revolutionary obstacle avoidance system uses Siemens S7-300 PLC and SIMATIC Nanobox PC technologies to help crane operators improve plant safety and efficiency.

Trutegra

Customer: Trutegra is a global full-service supplier and integrator of high-quality control and automation systems.

Challenge: Help overhead crane operators avoid obstacles along their in-plant work routes, increasing safety while avoiding substantial maintenance and downtime costs.

Solution: A precision, laser-guided obstacle avoidance system, using Siemens S7-300 PLC and SIMATIC Nanobox PC technologies.

Results: Greater plant productivity, uptime and safety.

Bridge cranes are the workhorses inside heavy industry plants throughout the world, lifting massive loads that are either production inputs or the outputs of a plant's manufacturing process. The metals industry, for example, uses these cranes in all stages of production – from pouring feedstock into furnaces to loading 60-ton coils onto inventory racks or finished goods onto trucks or rail cars for shipment.

One of the world's leading sources of controls for this type of crane is Trutegra, a supplier and integrator based in Charlotte, N.C. and a long-time Siemens customer. Founded in 1990, the company provides a wide range of control and automation systems for industrial applications. It has developed a reputation as a reliable supplier of sophisticated crane control solutions, with about half its business involving the intelligent positioning and control of cranes and hoists.

Challenge: Help overhead crane operators avoid obstacles along their in-plant work routes, thus increasing safety while avoiding substantial maintenance, potential injury and downtime costs.

Among its customers for crane and hoist controls, Trutegra learned that many were incurring ongoing safety issues as well as substantial maintenance and downtime costs when the cranes would accidentally bump into various objects or structures as they moved along their work paths. "The problem is a chronic one and can have huge if not grave consequences," says Paul Vogt, Trutegra's vice president of Research & Development. "If a significant incident occurs, plant downtime can be in the millions of dollars and lives could be at stake."

The sheer size of bridge cranes and their massive loads almost ensures that accidents are never "minor." A crane's bridge is typically overhead and can be as high as a six-story building. Its length can span 100 feet or more. It typically features a trolley positioned on the bridge which runs on rails that can extend the length of six football fields. Finally the trolley has a massive hoist system to lift loads. In many cases the crane includes a rotating mast in combination with its hoist, so the crane can also rotate a load. Together these components form a system that allows the crane operator to grapple and move massive loads quickly and effortlessly around a facility. The cranes may be manual, semi-automatic or fully automatic, with the trend toward the latter. Manually controlled ones can be operated from an onboard operator cabin or remotely via video cameras.

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Many of Trutegra's metal industry customers use bridge cranes with rotating masts that have hoists with a "horn" to lift huge coils of metal. Crane operators sit in an air-conditioned cab on the mast and move the coils at three meters per second from the end of the plant's production line to a row of racks where they make a 90-degree turn into a 12-foot aisle. They then move the coils down to an open rack space and deposit them. With just eight inches of clearance on either side of the coils, the operators' margins for error are extremely small.

From this situation arose a chronic problem of incidental contact between the cranes and existing structures. When a large crane contacts a rigid structure, tremendous forces are transmitted to the crane's mechanical components. In these cases, even the slightest contact between the load and the rack structure or another load in storage can generate enough impact to damage the gearbox that drives the mast rotation. Replacing or repairing these rotational axis gearboxes takes a crane out of service and can cost thousands of dollars each time it happens.

Solution: A precision, laser-guided obstacle avoidance system, using Siemens S7-300 PLC and SIMATIC Nanobox PC technologies

In coming up with a solution, Trutegra worked with selected customers to carefully study their plants' interior spaces, their cranes' work routes and all obstacles along the way. After completing its investigation, the company developed a precision, laser-guided Obstacle Avoidance System (OAS) that prevents the crane from touching any of those obstacles, whether it's controlled manually or automatically by computer. The solution is so unique that Trutegra has applied for a patent.

Trutegra's OAS solution works in three steps:

- First, Trutegra maps the obstacles in the work area starting with a CAD drawing. The drawing is converted into an efficient database format, and is stored on a Siemens SIMATIC Nanobox PC. Trutegra chose to use Siemens Nanobox technology for many reasons according to Vogt: "Siemens Nanobox was ideally suited for the factory floor application, because it's powerful, has no moving parts, is fanless, rugged, well-priced and it mounts on din rail. We searched for the right hardware for our technology and this was clearly the best option." The device is an industrial-grade, maintenance-free PC, which features a powerful yet energy-efficient Intel Atom E6-family processor in a small, quart-size form factor. It communicates over wireless Ethernet to a Siemens S7-300 PLC that helps the operator control the crane's motion.

- Second, Trutegra maps the size, shape and velocity of the crane and its load. It then uses laser-enabled distance meters, encoders and other means to monitor the real-time position and velocity of the crane. The devices help the OAS determine the crane's position to within millimeters at any given instant. Its field of obstacles is constantly changing, too, depending on its elevation and position over the plant floor. These data are fed in real-time to the Siemens SIMATIC Nanobox PC, which is in constant communication with the Siemens S7-300 PLC.

- Third, using high-speed calculations afforded by the Nanobox PC, Trutegra's OAS server does the calculations needed to predict future collisions. The system intervenes "on-the-fly" to rapidly decelerate the crane, if it detects that the crane is traveling along a vector that will result in a collision.

Vogt explains that the geometry gets even more complex and dynamic as the crane rotates and whether it's carrying a load or not. "The server software running on the Siemens SIMATIC Nanobox PC carries two sets of data, along with the direction and velocity of the crane," he says. "The system is constantly assessing all these parameters to determine whether to apply the brakes in any particular axis."

Preventing collisions. The Trutegra OAS software can override manual or automatic control, if the crane gets too close to an obstacle, risking a collision. When needed, the OAS automatically intervenes and slows the crane, while still at a safe distance from the obstacle. The algorithm that controls the braking action is sensitive to all of the dynamically changing conditions of the crane. This includes the position and velocities of all axes of motion, as well as the size and orientation of the load.

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For example, one combination of variables might start slowing the crane at a distance of twenty meters while another set might begin to intervene at half that distance. "So, if an operator has the crane a half a meter from an object and wants to nudge the crane a bit closer to the object, the OAS will permit that because it knows the crane is moving very slowly and has the ability to stop," Vogt says.

Siemens provided training and support in the development of the Trutegra OAS application. Vogt notes that the open architecture of the Siemens S7-300 PLC and the Siemens SIMATIC Nanobox PC enabled his programmer to develop the solution built on a third-party application and using XML. This way Trutegra can use the solution with other vendors' PLCs as well. "Like Trutegra, Siemens has long advocated open standards in a world that's too long been subject to closed, proprietary solutions," says Vogt. "Openness is a first principle for both our companies and a cornerstone of our partnership."

Results: Greater plant productivity, uptime and safety

With Trutegra's OAS deployed in their cranes, customers report that operators have quickly accepted the new technology as a productivity-enhancer because it allows them to execute crane operations faster. "They gain greater confidence in operating their cranes, as they experience how the OAS will slow the crane down for them," Vogt says. "As a result, they feel more comfortable operating at higher speeds."

Downtime and costs due to mechanical repairs to components such as gearboxes are all but eliminated because the OAS prevents even small collisions and the massive forces that can accompany them. The OAS also mitigates collision risks to other plant structures that, if damaged, could compromise plant output and incur the huge costs of production delays or complete disruptions.

Above all, the customer's plant operations are much safer than before. Vogt explains that in the past two years, safety issues have been brought into sharp focus. "This is especially true in industries that use large equipment like bridge cranes," he says. "Trutegra's OAS solution using the Siemens SIMATICS Nanobox PC and its PLCs can provide an important margin of safety by reducing dangerous crane collisions."

One example is Trutegra's first installation at a major manufacturing facility, which once had an ongoing and expensive problem of bridge cranes bumping into structures. That has been reduced to zero, he says. "But more importantly, the operating environment is much safer for crane operators now as well as for everyone working around the cranes. After all, you can't measure the value of human safety."

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