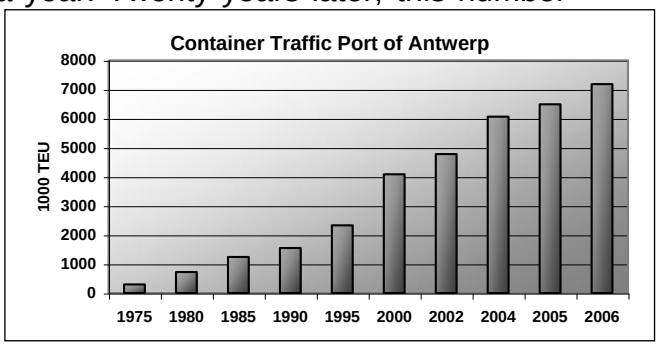
Application

Septentrio
satellite navigation

GPS/GNSS technology for container yard operations

Increased container traffic poses challenging problems

The last twenty years, container traffic is booming. In 1975, the Port of Antwerp was only handling 300,000 containers a year. Twenty years later, this number has increased to almost 7.2 million containers in 2006. These containers are transported in huge ships of which some have a capacity of 14,500 TEUs (twenty-foot equivalent units).



Handling these large amounts of containers requires a complex organization to avoid loosing or misrouting containers. When a ship arrives at the dock of the container terminal at one of the container terminals in the Port Of Antwerp, the containers are first unloaded by giant rail-mounted quayside cranes (RMQC). Next, they are picked up by straddle carriers (16m high cranes that can easily pick-up containers weighing up to 60 metrics tons) and stored temporary on the container yard. Finally, another straddle carrier will pick up the containers and move them to another location where they will be loaded on a truck, a train or on another vessel. After all containers have been unloaded from the ship, other ones need to be loaded. These containers follow the opposite way: from a truck or a train to the container yard, then from the yard to the quay and finally onto the ship. To increase the efficiency, these containers are stored on the yard already in function of the sequence at which they need to be unloaded in the port of destination. This whole process is controlled by central yard management software that plans, keep track of the container locations and creates work orders for the different straddle carriers.

However, as these straddle carriers are controlled by human operators; there is always the risk of human error. Working under constant time pressure, they sometimes pick up the wrong container or drop it at a wrong location on the yard. As soon as the actual position of the container on the yard does not correspond with the position in the

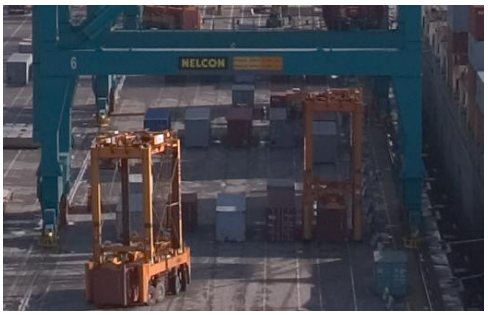
Application

yard management system, it is 'lost'.

The only option to retrieve the container is by sending a person onto the yard to look for the container. This is a dangerous and time-consuming task. Failing to find the container will lead to damage claims, which can be millions of dollars, from the cargo owner. Typical error rates range in the several percents, leading to thousands of "lost" containers a year. Hence a solution was desperately needed.

Using GPS technology to track the containers

This is where the Global Positioning System or GPS comes in. A GPS receiver can be used to log the pick-up and drop location of each container. This will allow the planners to quickly detect mistakes by the straddle carrier drivers and correct them instantaneously. To make sure that the position of the container can unambiguously be tracked in the system, the GPS receiver needs to deliver a solution which is accurate to 1.7m. 1.7m corresponds to ½ width of a standard container. Additionally, unlike other technologies (e.g. using induction loops), GPS does not require extra infrastructure on the yard. This allows introducing a flexible yard management system, which can easily be modified to match future needs.



However, for a typical GPS receiver, a container yard is a harsh environment. The receiver needs to be fully functional 24 hours a day, 7 days a week, as the work on a container terminal never stops. When straddle carriers are working on the quay, the GPS signals will be blocked by the large rail-mounted quayside cranes and by the ship which is docked at the quay. To allow continuous service, the GPS receivers need to be able to recover very quickly after such signal interruptions.
Further, on a container terminal, there are plenty of metallic surfaces (thousands of containers, docking ships, cranes…) which will cause reflections of the GPS signals (called 'multipath'). Without multipath mitigation techniques, large errors can be introduced, resulting in assigning the wrong yard location to the containers..

The heart of the system: Septentrio's EGNOS enabled PolaRx2 receiver

That is why Septentrio Satellite Navigation was called in to work out a solution. Septentrio, located in Leuven (Belgium), designs and manufactures high-end, reliable and accurate GPS receivers. Septentrio products are already used in machine control applications all over the world, for example to steer tractors and other agricultural vehicles.

Application

The PolaRx2 receiver is capable of providing accuracies from 1.2-2m down to 2-5cm, depending on the technique that is used. Special firmware is used to limit the influence of reflections and to re-acquire the GPS signals very fast after signal interruptions. This last feature is important as the straddle carriers are often moving beneath the large cranes, where GPS signals are sometimes obstructed.

Simple GPS on its own cannot provide the required accuracy To be able to provide the required accuracy, 99.9% of the time, it was decided to use information from the European Geostationary Overlay System (EGNOS). EGNOS consists of a network of ground stations, spread out all over Europe, and 3 geostationary satellites. The ground stations continuously monitor the performance of the GPS system. This information is used to compute corrections, which are transmitted to the users by the geostationary satellites.

A GPS receiver capable of receiving EGNOS signals, like the PolaRx2, can use these corrections to improve their position solution. Unlike other differential GPS (DGPS) techniques, this approach does not require a separate reference receiver. There is also no need for a radio infrastructure to send corrections from the reference receiver to the receivers on the straddle carriers.

For this project, Septentrio worked together with the staff of the container terminal to create a link between the PolaRx2 receiver and the central yard-management software. A special firmware has been implemented which sends out a position message every time a container is picked-up or dropped-off. If the straddle carrier driver picks up a wrong container, or drops one of at the wrong location, the yard-management system will automatically send a warning to the dispatcher. The dispatcher then contacts the driver to take corrective actions.

No more lost containers….

“In a first phase, Septentrio equipped all straddle carriers of one container terminal in the harbour of Antwerp. Since the system has been deployed, no containers have been lost or misplaced. “Before we started using GPS to track our containers, the position of a significant number of containers on the yard did not match the expected position”, says Noel Thielman from PSAHNN. “And with the new system installed this is number had been reduced with more than 90%. After investigation these remaining errors were traced back to situations

Application

where the straddle carrier driver did not follow the instructions correctly. However, thanks to the logging of the positions in our system, we could find them back easily."

For PSAHNN, it has lead to an increased performance on the container yard, reducing the throughput time and the costs. Also, maybe the one of the most important benefits, it has increased the safety on the yard as no one needs to go looking for the containers anymore. Because of this success, the system will be deployed on several other terminals of this container handling company. It has already been rolled out on a second terminal, and more are about to follow.

.Other applications of Septentrio technology

Multi-antenna RTK solution for auto-steering RTGC's

Septentrio's PolaRx2eH, a dual-antenna receiver, is ideal for implementing auto-steering systems on rubber tired gantry cranes (RTGC). Auto-steering can be used to increase the efficiency on the yard. It will also improve the security as it reduces the risk of diver fatigue and it can be used for anti-collision systems.

With RTK technology, the PolaRx2eH is able to provide a position solution with a horizontal accuracy of 3 cm, 99.73% of the time (3-sigma). Additionally, the PolaRx2eH will provide the relative position of the second antenna with regards to the main antenna, with cm-level accuracy, and the heading and pitch of the vehicle. This information can for example be used for anti-skew steering for large RTGC's and RMQC's to decrease the wear of the equipment. Only one receiver is needed for each vehicle as the PolaRx2eH is the only single-board, multi-antenna system with 2 dual-frequency antennas on the market.

Automatic container and yard traffic management

The PolaRx2e can reliably provide a position with accuracies down to 1.2-2m, without needing to use additional infrastructure. This allows accurate tracking of all the container moving equipment on the yard. This information can be fed into an automated container and yard traffic management system. This will enable dispatchers to make sure that every piece of equipment is used as efficiently as possible.

Application

Septentrio
satellite navigation

Data logging for traffic and operations analysis and optimization

As mentioned before, each container terminal handles hundreds of thousands of containers a year. To be able to handle them, straddle carriers and other equipment are continuously moving around containers. As time is money, continuous effort is needed to improve the organization on the container yard to increase efficiency and to reduce throughput time.

The PolaRx2e is capable of logging positions for several days. All data is logged internally, to the 2GB sized memory, eliminating the need for a computer or a PDA. Based on the analysis of all these movements, improvements can be made to the container yard lay-out or to optimize the procedures.

For more information:

Septentrio Satellite Navigation
Jan Van Hees
Sales & Business Development
Email : sales@septentrio.com
Website:www.septentrio.com
Tel +32 16 300 800
Fax +32 16 221 640