

Position Detection of Containers and Container Vehicles

Rapid, accurate and reliable measurement

- Simultaneous evaluation of all vehicle lanes
- 3D real-time laser scanner for automatic detection of container or container vehicle position
- Reliable position detection:
No shadowing from other containers
- Easy and simple configuration and integration into existing crane control system

The Task

Container transport volume is expected to grow worldwide from 137 million TEU (2017) to approx. 175 million TEU (2022). This makes it more and more important for container crane manufacturers as well as for container terminal operators to raise their automation degree gradually to autonomous operation. The enormous competition situation demands e.g. increasing efficiency in loading and unloading cycles. Crane movements have to be optimized, i.e. they have to be more reproducible to shorten the transshipment duration without reducing the safety of port personnel, vehicles, machines and goods to be transported.

At most STS cranes manually operated or automatically controlled container vehicles will be positioned to given positions under the container crane and the spreader will pick the containers up from the vehicle or set them down onto it. For the container vehicles there are several lanes available (*Multi-Lane Approach*, at present max. 9 lanes), either one or even more of them allocated to one container crane. Depending on the vehicle type the vehicle either stays in its target position till loading/unloading has finished or it sets the container down at the target position and leaves the position immediately.

A big challenge by loading and unloading a container is the accurate positioning of the container vehicles to a container crane, which is independent of manual or autonomous operation of a STS container crane. To avoid time consuming repositioning it is utmost important, that the given vehicle position is reached as exactly as possible. If this is not the case, either the vehicle or the container crane itself has to be repositioned; i.e. the movement of the spreader will be interrupted just before the container, its relative position to the container will be determined and, if required, adjusted. Finally the spreader will be driven to the target position.

For the partly or fully automated operation of a container crane the accurate position detection of container vehicles is

therefore indispensable. This makes it possible for the automatic control system of the container crane to adjust the relative position between spreader and container vehicle. Optimally this takes place without interrupting any loading or unloading container movement.

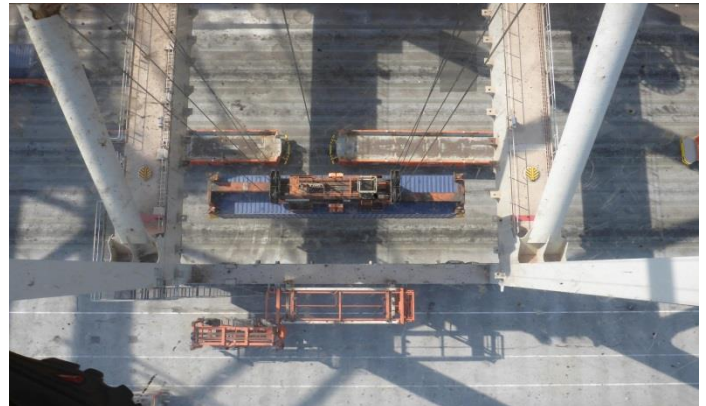


Figure 1: Automated guided vehicles (AGVs) on a single lane; spreader with container

To detect the vehicle position there are currently many systems in use, which are not accurate or reliable enough to be used in fully automated operation. In some systems it cannot even be excluded that e.g. vehicles on other lanes disturb or prevent the position detection.

Therefore, it is necessary to integrate into the control of partly or fully automated container cranes a solution, which detects the position of container vehicles **rapid, accurate, and reproducible** on every lane. **iSAM®** sensor technology for container cranes delivers this information as a complete package, consisting of modern sensor components and an easily configurable evaluation unit with interfaces to all common control systems. This enables manufacturers and operators of cranes to focus on their core business without investing time in developing complex software for sensor data processing.

we deliver solutions ...

The Solution

The **iSAM® Multi-Lane Container Vehicle Position Detection (CVPD)** system is based on a sensor technology, which iSAM uses successfully in fully automated bulk goods transshipment operations worldwide. The system mainly consists of three advanced 3D light detection and ranging (LiDAR) sensor systems connected to one evaluation PC. The **iSAM®** evaluation software uses combined point cloud data to evaluate the container vehicle position in real-time on all lanes. The currently measured container vehicle positions on all lanes are provided to the crane control system via an industrial bus interface. Here it can be used e.g. for controlling traffic lights of each lane to indicate the position information to the container vehicle drivers or to automatically adjust the position of autonomous transport vehicles.

The Technology

The advanced 3D LiDAR scanner is a ruggedly built sensor with an unrivalled field of view, designed to exceed the demands of the most challenging, real-world industrial applications including autonomous vehicle control, mobile mapping, aerial mapping, security and surveillance. The sensor measures only 2.86" high by 4.07" in diameter and weighs less than two pounds. Its compact size and weight make it ideal for all LiDAR applications, in particular those with constrained form-factors and mounting requirements.

The sensors innovative laser array enables the **iSAM** Multi-Lane **CVPD** system to observe more of its environment in real-time than any other comparable 3D LiDAR sensor. The sensor utilizes 16 lasers aligned from +15° to -15° (2°) to provide a vertical field of view and its internally rotating head design delivers a real-time, 360° horizontal field of view with a resolution of 0.1° - 0.4°.

The sensor generates a point cloud of up to 300,000 points per second with a range of 80-100 meters and typical accuracy of +/- 3 cm at 10 Hz. The sensor does not have any visible rotating parts, which makes it highly resilient in challenging environments (rated IP67) while operating over a wide temperature range (-10°C to +60°C).

The laser unit is a Class 1 laser product which is considered as eye-safe. The following picture shows a 3D real-time scan (3D point cloud) taken by the 3D-LiDAR system to determine the container positions. The containers on the vessel, the spreader as well as the spreader holding ropes are also clearly identified.

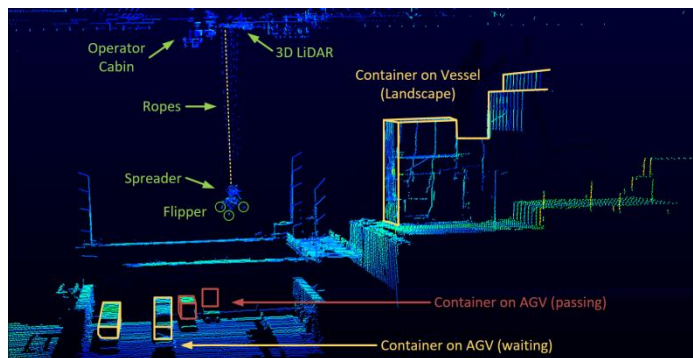


Figure 2: 3D point cloud taken by 3D LiDAR (100 ms) used for **iSAM® CVPD** real-time application

Highlights

- Real-time position detection of container or container vehicle
- Rapid, accurate, reproducible and reliable
- Simple integration in existing control systems
- Easy service and maintenance
- Assistance and facilitation for manually operated cranes
- Essential system for autonomous operation of STS container cranes

Competitive Advantages

The use of **iSAM®** sensor technology for container cranes means a **significant reduction in development costs and project risk** for manufacturers and operators of the machines thanks to

- the use of proven technology, which is already every day in operation in the biggest ports in Europe
- preprocessing of complex sensor data for simple use in conventional controlling
- a completely modular system architecture
- simplified certification because of existing certified reference installations

Facts

References: Similar technology in use for iSAM autonomous STS cranes at:

- Hansaport Hamburg, Germany
- EMO Rotterdam, Netherlands

Equipment:

- Velodyne 3D real-time LiDAR scanning systems
- iSAM evaluation unit and software

Key features:

- Solution package is an essential part of autonomous container crane operation
- Reliable and accurate detection and tracking of containers or vehicles on multiple lanes in real-time
- Enabling optimized cycle times by eliminating idle time

Interfaces:

- Ethernet TCP/IP
- Modbus TCP
- Profibus
- Profinet
- Digital / Analog