Automation of Grab Ship Unloaders (GSU) for Bulk Materials

Driverless Grab Unloader for Ships

- Automated unloading of coal and ore – even below the hatch coaming

- Driverless operation under virtually any weather conditions

- Integrated safety system for persons on the ship and the quay

- Monitoring of up to four ship unloaders by one operator from a central control station

The Customer
With a volume of more than 135 million tons per year, the Port of Hamburg is a central hub for the transshipment of materials from countries all over the world. Hansaport, the specialist for iron ore and coal, is integrated into the former as an open harbor where four unloading bridges are available for rapid unloading of seagoing vessels. Leading-edge technology allows large volumes of coal or ore being put into store or reclaimed in a minimum of time. In combination with advanced weighing technology, computer-controlled equipment ensures utmost precision when transshipping bulk materials.

The Task
Unloading operations should be handled **fully automatically – without any operator** being present on the unloader – for the four existing ship unloaders in a reliable and effective manner.

The Solution
The task of operating a grab unloader driverlessly and fully automatically is a great challenge, if not a mission im-possible. But with a combination of a newly developed 3D laser scanner, field-proven RTK GPS positioning solutions and leading-edge control technology, iSAM was nevertheless successful in solving the problem.

At Hansaport, four ship unloaders were equipped with the **iSAM** Grab Unloader Automation System – and since the beginning of 2011, the whole system is operational.

One of the key components of the automation system is the intelligent grab tracking system based on the 3D real time laser scanner. The new high-tech scanner is fast enough to track the crane ropes and the grab itself in real time to measure sway and grab attitude.

In most installations – with the exception of the largest cranes and special crane geometries – the same sensor can be used to track the grab, measure the hatch positions and generate the material profile inside the hatch.

In the control system, data from the grab tracking system ensures a continuous update of the energy and position model for the grab's moving path. This allows a precise "landing" of the grab at any given point with a precision of about 0.5 m in the cargo hold – in almost all weather conditions, at low tide and high tide.

we deliver solutions …
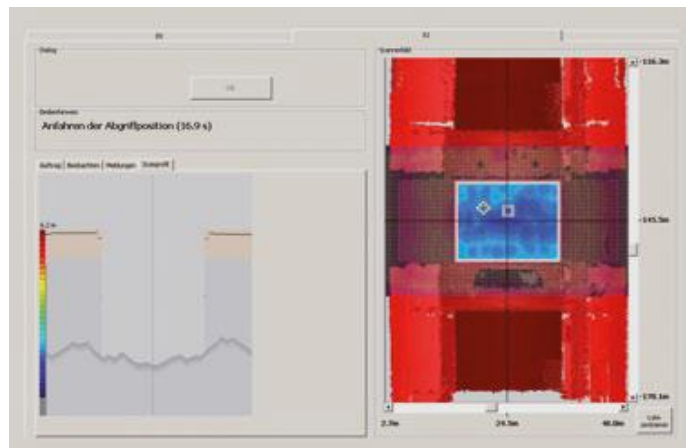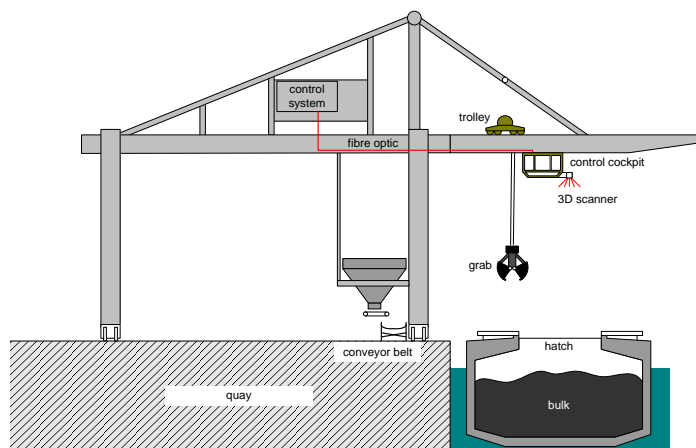
3D laser scanning – hatch and bulk material

The position of the unloader is permanently tracked by a RTK-GPS. A high-precision 3D laser scanner delivers the exact position of the ship and its hatches as well as data about the material distribution in the cargo hold. The scanner is even able to reliably detect coal from a distance of up to 100 m, under virtually any weather conditions.

Whereas the 3D scanner is the **"eyes"** of the automation system, a high-performance industrial PC is mounted into the unloader and connected with the PLC – the **"brain"**. Eventually, the best unloading strategy is determined here depending on the design of the ship, the material data and the current sensor data.

Knowing the different material properties, for example a "performance-oriented" strategy with a reduced cycle time is chosen for materials that flow well, for instance pellets. For coal and ore which have poor flowing properties, however, it is necessary to unload right from the start "out of the corners".

In contrast to a human operator, the control system is not only able to calculate the current position, but also the **kinetic energy of the grab at any point on the moving path**. This makes sure that the grab does **not collide with the hatch or the unloader structure** during the whole cycle – not even in case of "hard" stops, for instance when an emergency stop is pushed.

Highlights

- Real-time determination of the grab's position
- Automated unloading, even under the hatch coaming
- Real full automation, not a remote control
- Possibility of manual intervention from the central control station
  - □ "Freeing" from an extraordinary situation (for instance a buried grab due to collapsing material walls)
  - □ Change of hatch
- Permanent update of data for the energy and position model for the grab's moving path
- Operation of all equipment from a central control station, i.e. minimum stress for the operator in the central control station thanks to a maximum degree of automation

Competitive Advantages

The use of fully automated grab unloaders for ships means a significant **reduction in personnel expenses. One operator** in the central control station handles four ship unloaders.

- Very uniform unloading performances
- Lower wear and tear because mechanical performance limits are respected in automated mode
- Fulfilment of operational guidelines and safety rules
- Improved working conditions

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Facts

Client/Location:	Hansaport Hafenbetriebsgesellschaft mbH, Hamburg, Germany	Sensors:	■ 3D laser scanner for the detection of ship, hatches and material distribution
Industry:	Transshipment of bulk materials		■ 2 RTK GPS receivers for determination of the position of the grab unloader
Hardware:	■ 19" industrial PC		■ 3D grab tracking system
	■ PLC-based control system		■ 4 TOF sensors – 3D camera according to the light time-of-flight principle
Software:	iSAM grab unloader automation system	Commissioning:	January 2011