Performance Improvements for Stockyard Equipment with Existing, Conventional Automation

Advanced 3D Vision Systems

- Real-time capable, obscurant penetrating 3D LiDAR
- 1500 nm wavelength laser, easily penetrating even dense fog or dust
- Full virtualization of the control system
- No need for a control PC on the machine
- Automated stacking and reclaiming even for difficult stockpile geometries – also after landslides during rainfall or manual processing by e. g. dozers

History

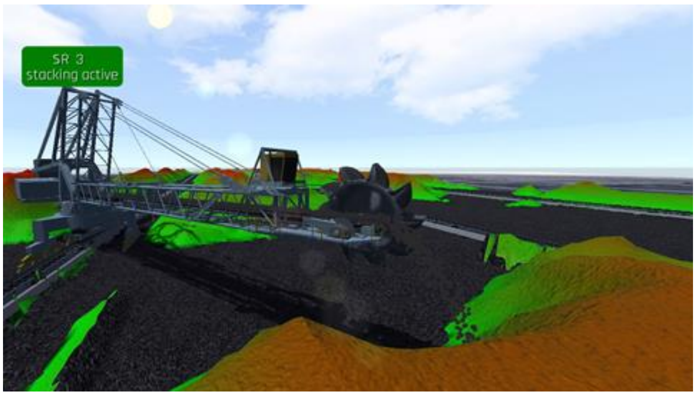
iSAM built the first fully autonomous stacker/reclaimer in the Port of Hamburg in 2000. To date, there is still no better alternative to the fundamental technology behind the system – 3D LiDAR and RTK GPS.

While the original technology focused primarily on the autonomous operation of manually controlled equipment, the current generation of systems also features significant performance improvements for conventionally automated machines.

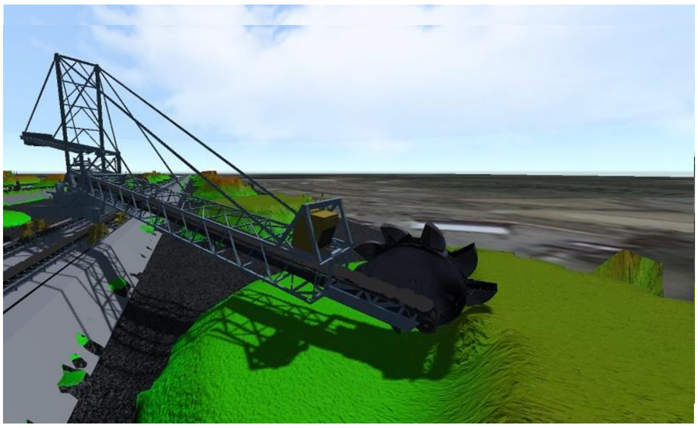
Conventional Automation

During the world-wide roll out of the technology, iSAM came across many sites which already operated their stockyard equipment automated. However, “automated” means for these machines that during automated stacking a terrain model is built via a stacking simulation using the machine position and the flow rate from belt weighing system. During reclaiming, this model is used for calculating the face-up to the pile as well as the slew turnaround points and bench changes. These solutions generally work, but when it comes to performance, the usually implemented, conservative stacking and reclaiming strategies are not fully utilizing the nameplate performance of the equipment.

The main reasons that the piles are not 100% as simulated are often inaccurate encoder systems and belt weighers as well as slumps of material or dozers pushing and compacting the product between stacking and reclaiming. This leads to stacking algorithms which can only deal with empty stockyard terrains and with reclaiming algorithms that include unnecessary safety margins. The latter often cause a couple of “air-digging” slews before hitting the pile for the first time during face-ups as well as slew turnaround points which are often outside of the pile, causing further air-digging at each turn around. The result is usually visible on the yard conveyor as the product stream is not homogenous, showing frequent interruptions which can be traced back to each slew turn-around. At the same time, these systems cannot deal with sudden product slumps which often cause overload on the bucket wheel.



3D vision system, real-time processing of terrain data for optimized stacking



3D vision system, real-time processing of terrain data for optimized reclaiming

Benefits of 3D Vision Technology for Conventional Automation

So, how can conventionally automated machines benefit from 3D vision technology without further complicating the existing control systems? Well, the latest generation of advanced 3D vision systems cannot only be used to autonomously operate machines at optimum performance which were previously operated manually, but they can also just interface the pre-processed vision data to the PLC, enabling the existing control algorithms to max out the equipment performance.

But how does this work? The system integrates 3D vision and GPS technology which both have cm-level accuracy. The GPS data is converted into local stockyard coordinates and also into long travel, slew and luff positions/angles and interfaced to the machine PLC for accurate position control. At the same time, the 3D vision data is processed, and optimized data such as

- optimum positions for long travel, slew and luff for initial face-up without air-digging
- optimum slew turnaround points for current slew
- optimized slew speed control setpoints even considering material slumps in proximity of the machine
- optimized bench height calculation

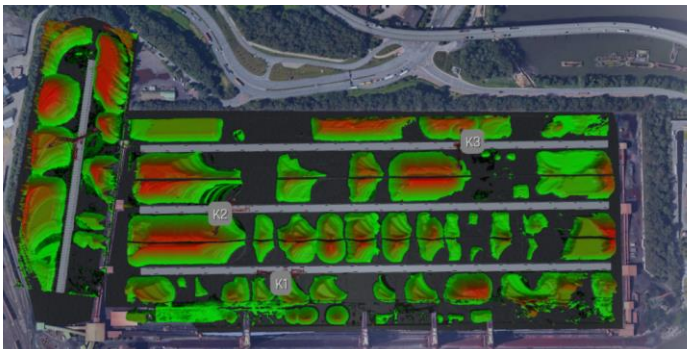
is interfaced to the PLC. All this data is usually already used in the existing algorithms; i.e., the implementation is more or less an exchange of conservative, simulation-based values for measured, real-time values.

Terrain Model and User Interface

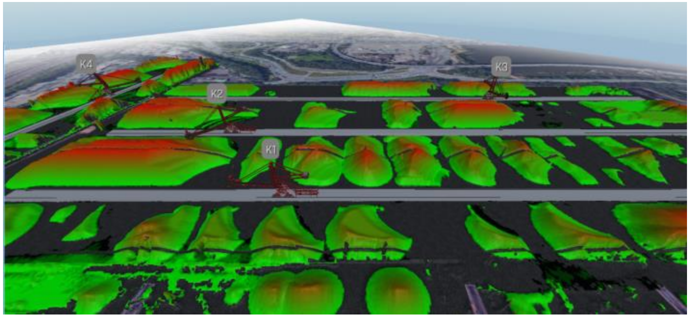
A new user interface is also not required as the flexible interfaces of the 3D vision system blend seamlessly into the existing PLC and SCADA solutions. For the Central Control Room (CCR) operator, the main noticeable difference is the better equipment performance.

However, the internal 3D terrain model can also be visualized in the CCR, be it in a 2D color-coded bird's eye view or a full 3D rendering.

The system can also process product quality data and provide e. g., cross section views of a pile to show the different product quality distribution after stacking.



3D vision system, 2D height color-coded bird's eye view



3D vision system, full 3D real-time rendering of a terminal

Highlights

- Optimized autonomous 24/7 operation under virtually any weather conditions
- No loss of time due to additional scanning runs; permanent update of the terrain model
- Short return on investment due to
  - optimized stockyard utilization as a result of flat-surfaced, trapezoidal stockpiles with an almost perfect layout ensuring optimum reclaiming performances
  - less "air-digging" and bucket wheel overloads resulting in homogenous material flow during reclaiming
- Automated stacking and reclaiming even for difficult stockpile geometries – also after landslides during rainfall or manual processing by e. g. dozers
- Reduced environmental impact (e. g. dust emissions and energy consumption) by automatically minimizing the distance between boom and stockpile

Facts

Customers:	■ Numerous import and export terminals in Germany, the Netherlands, Italy, Australia, Canada and the US	Software:	■ iSAM Stacker/Reclaimer Automation
Industries:	■ Bulk material export and import terminals ■ Mining and bulk product processing facilities	Data output:	■ Fieldbus/Ethernet to machine PLC ■ Variable interface to 3rd party planning system
Hardware:	■ 3D LiDAR scanner with obscurant penetration ■ RTK GPS system for machine positioning	Visualization:	■ iSAM 3D Stockyard Model ■ iSAM S/R Visualization