Description of
Stockyard Volume Measurement System

The Stockyard Volume Measurement System supplied is described below

Stockyard Volume Measurement System

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Stockyard Volume Measurement System

1   System Components

The Stockyard Volume Measurement System is a combination of 2 subsystems:
- The 3D Scanner System
- The Control and Calculation System (Stockpile Management System- SMS Software)

2   Task of the Stockyard Volume Measurement System

The tasks of the Stockyard Volume Measurement System are to
1. Derive data for the movement control of the stacker cum reclaimer machine through the **encoders** on the Stacker Machine. **(Number of Stacker Machines – 1 Numbers)**
2. Produce a continuous flow of data of the surface geometry of the stored bulk material to provide a real time 3D Profile.
3. Calculate the volume of the bulk material stored in the stockyard.

The 3D Sensor System of the Stockyard Volume Measurement System is mounted on top of the pylon of the stacker or reclaimer. The 3D Scanner delivers a constant flow of 4 profiles in 4 scan layers. The movement over the rotary table allows for complete stockpile area coverage with integration and synchronization of each coordinate 4 times.

EXAMPLE OF STOCKYARD STACKER MACHINE
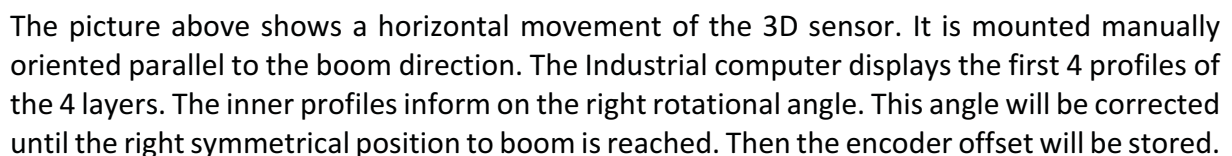
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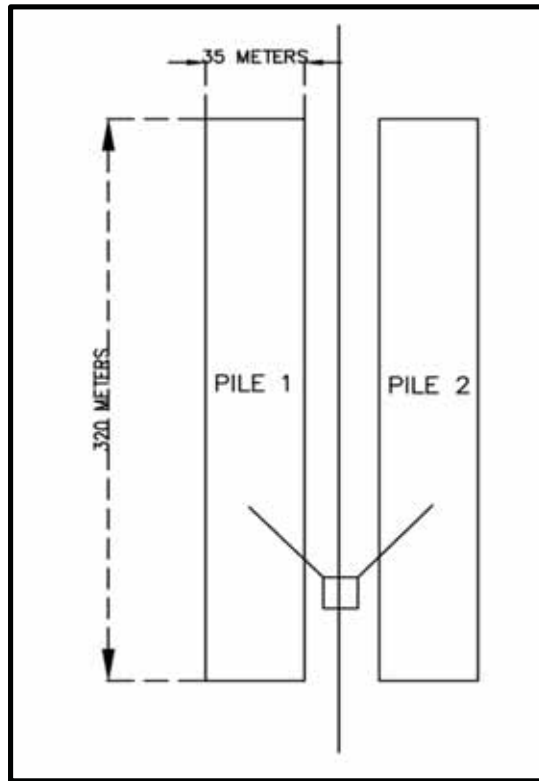
GA OF STOCKPILE

The 3D Scanner has a fix position in boom direction and delivers 2scan-layers left and right of the boom. The profiles are within a fixed coordinate system relative to the mast of the stacker or reclaimer.

In a special function, the Control and Calculation System can activate the Rotary Table of the 3D System to rotate within a defined angle. During this rotation, the 4 profiles are delivered continuously but only the outer left or right profile according to the rotation direction is used for volume calculation. This special function completes the data set for volume calculation.

2.1   3D Laser Scanner position and operation

The 3D Laser Scanner will be installed at the top the machine, on the mast or on the superstructure, depending of the machine design. The figure below shows an example of 3D Sensor position with a side viewing. In this example, the sensor is installed in the superstructure, without inclination movement, but in some cases the sensor will be in the mast, with luffing moving.

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- 3D Scanner (4Lavers)
- Boom luffing 9,5°
- Pile aprox. 20
- Vertical scan angle

The figure below shows a top view of the machine with the 3D Sensor.

Sensor with horizontal moviment

Scanner Laser 3D

Park position of the 3D sensor (0°)

Left turn (0 to -170°)

Feixes Laser (4 Layers)

Rigth turn (0 to + 170°)

The picture above shows a horizontal movement of the 3D sensor. It is mounted manually oriented parallel to the boom direction. The Industrial computer displays the first 4 profiles of the 4 layers. The inner profiles inform on the right rotational angle. This angle will be corrected until the right symmetrical position to boom is reached. Then the encoder offset will be stored.

The Industrial PC controls the horizontal 3D sensor movement. The parking position of the sensor will be at the 0° position (see above: offset.) The 3D sensor will not make horizontal movement continuously. This movement will be started and stopped by the Industrial PC, preferred when the machine is stopped. The main movement of the 3D sensor will be one scan turn, from 0° to +170° and from 0° to -170°.

Those angles mentioned above can be adjusted after the beginning of the project, but the sensor can be positioned in any angle according the Industrial PC commands.

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3 Volume measurement

3.1 System structure

The SMS software (Stockyard Management System) has some modules and communication drivers responsible for the functionalities of the system. All modules and drivers are processed in parallel using thread techniques.

3.2 3D profile calculation

For the pile volume calculation, first the system creates a height map of the stockyard that represents the 3D profile of the piles. The height map consists of a grid or matrix with the dimensions according the stockpile size and the resolution.

The figure below shows a pile 3D surface with a wireframe view where can be able to see the vertices.
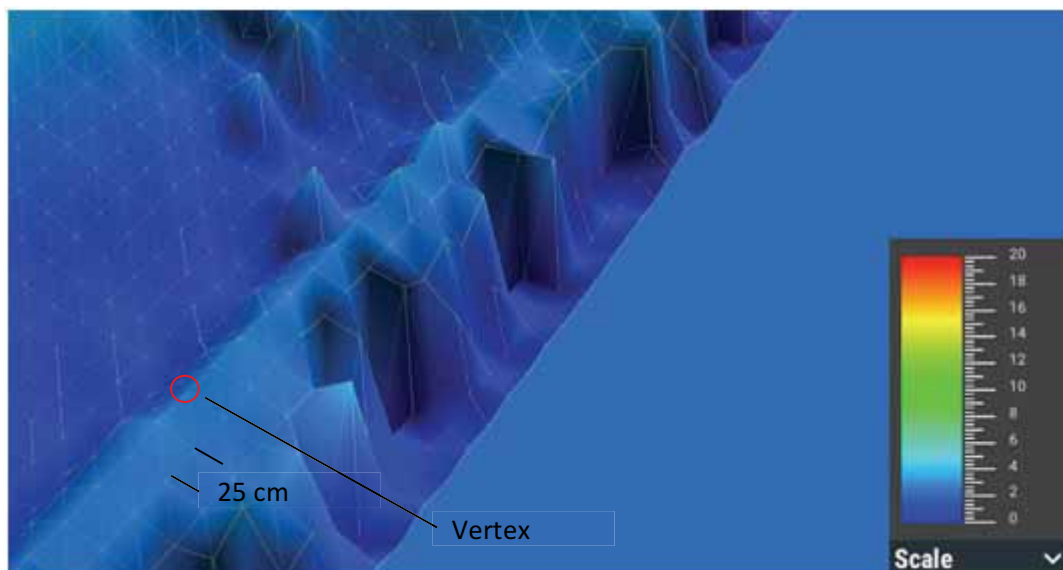
**3D surface of the system from the grid (heightmap)**

To calculate the volume of the pile the system has a manual and a automatic procedure.

3.3 Manual procedure

For the manual procedure of the volume calculation, the system integrates all heights inside of a determined region selected by the user from the 3D interface. First the user selects the pile to calculate the volume by clicking around the pile on the interface.
Then the user must choose some points in the interface to determine the base plane of the stockyard by clicking on known areas scanned that represent the base of the stockyard, outside of the pile. The user can insert a manual value for the base plan.

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Selected points to determine the base plan

Selected region to the volume calculation (red line)

Base plane of the pile (opaque green)
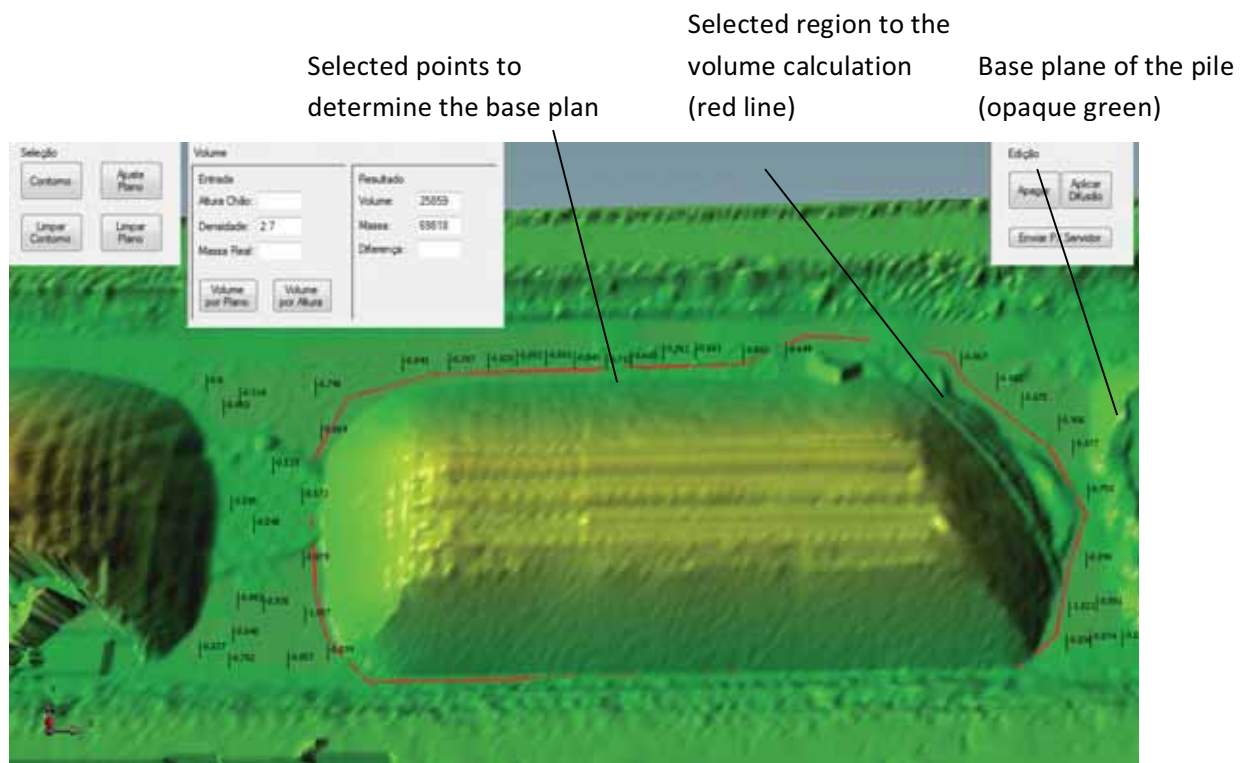
System interface to calculate the volume of the pile in manual procedure.

If the pile has some non scanned surface or holes, the user can select this region and close this surface.
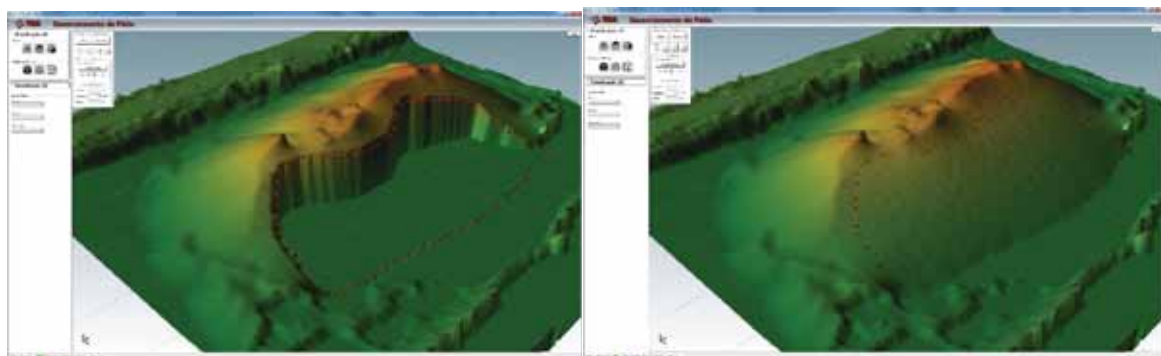
Non scanned region filled by the system.

Finally, the user must insert the average density in the interface and click on the button "calculate" to determine the volume and the mass of the pile. Then the system integrates all heights on the grid, subtracting the base plan and multiplying by the density.

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3.4 Automatic procedure

For the automatic procedure of the volume calculation, the system use the same principle described above. The difference of the automatic procedure is that the user does not need to select the region and the base plan. Normally, the stockyard has fixed areas determined for the pile formations. Using this information and a average base plan, the user need only to click on the button "auto calculate" to calculate the volume of all piles in the stockyard.

In additional, the user have two cursors in the interface to determine a minor region if needed.