MINDING THE GAP

Using Ground Based Rotating Lidar for 3d Viewing and Measuring

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ABSTRACT

A geospatial technology firm from the United Kingdom has developed and tested a custom suite of hardware and software for measuring a railway's loading gauge. Called "OmniGauge™", the system is designed to achieve high speed surveys of railways and other networks with complicated infrastructure. OmniGauge™ is a laser gauging implementation that provides a complete solution for scanning tunnels, platforms, trackside objects and roadbed. The profile of a tunnel, for example, can be scanned with the vehicle running at 60mph, whilst keeping data loss to a minimum to enable a 3-dimensional reconstruction of the tunnel's interior.

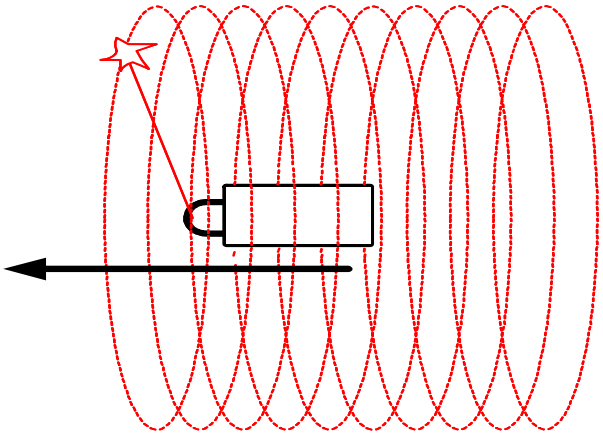
INTRODUCTION

The United Kingdom's railway network is one of the most intensively used in the world. In 2005, over 19,000 trains were scheduled per weekday, an 11% increase since 1995. Traffic was about 32billion passenger kilometers and 15billion ton kilometers per year. Top train speeds are currently 125mile per hour, with the new tilting trains cleared to run 140mph on the West Coast Main Line. Accommodating such performance within an infrastructure largely implemented in the 19th century requires a continuing emphasis on high quality measuring systems. Many of the 2500 stations warn passengers of dangerous train to platform edge openings, with the ubiquitous phrase, "Mind the Gap".

OmniGauge™ is a high-speed scanning and gauging system developed by Omnicom Engineering Limited, York, with assistance from an UK university. It provides a solution for scanning, inspection and gauging of tunnels, bridges, platforms, trackside objects and infrastructure, employing leading-edge laser technology. It is a highly integrated system comprising several interacting electro-mechanical sub-systems.

Attached to a moving survey vehicle, the system generates a beam of laser light which is scanned in a lateral circular path. This creates a helical scan of the rail infrastructure through which the survey vehicle passes. Each rotation in the scan creates a slice of infrastructure data.

This system is installed on a rail/road (hy-rail) vehicle and runs over the track to be surveyed. Using a precise pulsed laser transmitter, a sensitive photo diode detector, an advanced timing device and a fast rotation scanner, a 360 degree profile of the network is obtained.



Once the field work is completed, data is processed off line and files produced for analysis using specialist end user software. The software allows the user to view a survey profile. This can be used to provide(results are shown below):

* a comprehensive 3-dimensional image
* platform gauging
* landside and limited clearances
* bridge and tunnel structure gauging.

Providing for the proper clearances between rail vehicles and infrastructure are vital for safe operation. New line side infrastructure conforms to a current loading gauge but some old structures relate to gauges created some 150 years ago. Vehicles in motion describe a swept envelope in which the dynamics of the vehicle needs to be taken into account. Assessing vehicles moving on adjacent tracks is also important to avoid collisions and to permit the maximum carrying capacity for vehicles such as those conveying freight.

Hence the need for a comprehensive set of datapoints, that need to be acquired in areas where access is quite restricted.

MEASUREMENTS

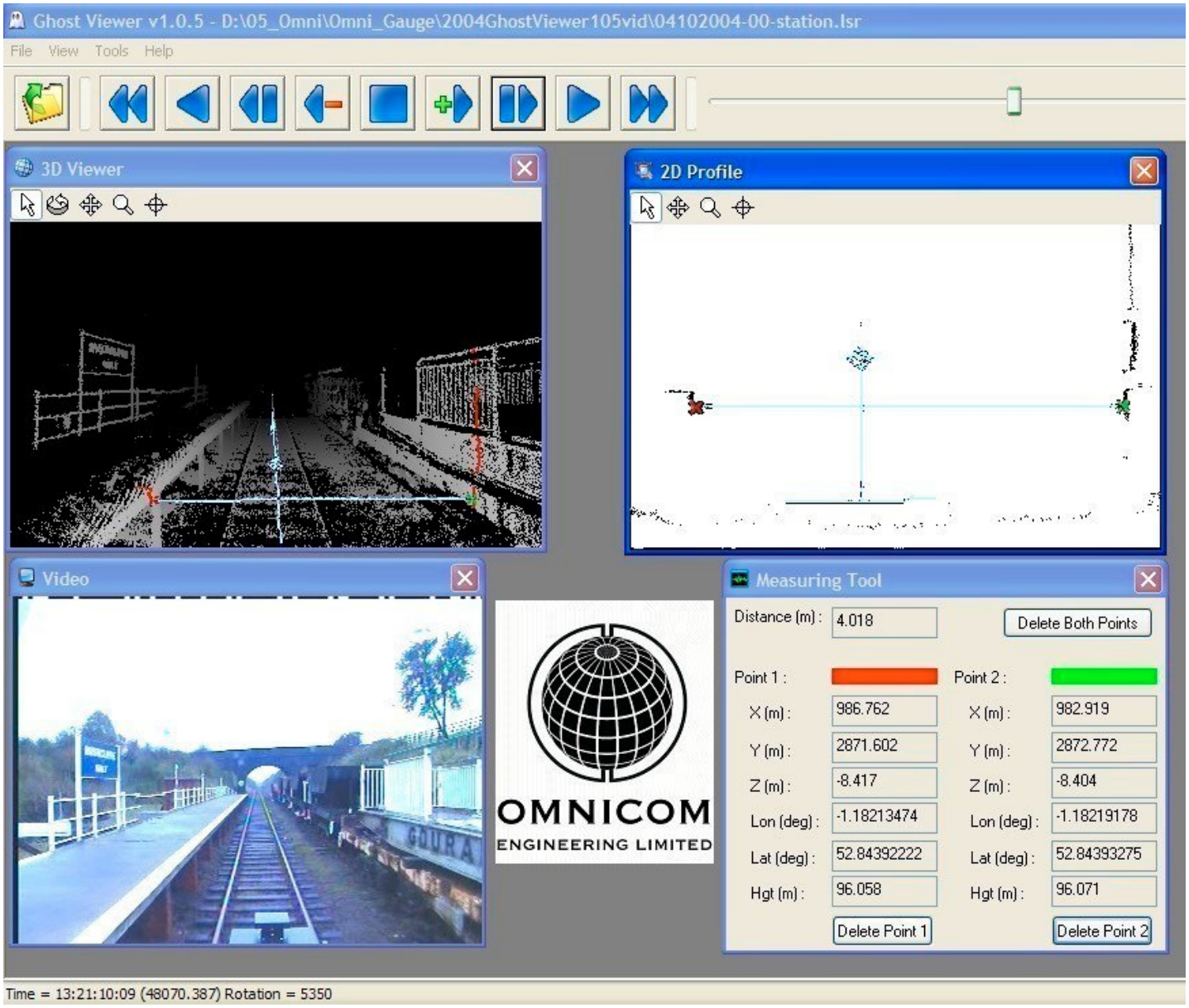
In its third hardware configuration, the fast rotating class 3R laser has been successfully tested in the field and has achieved accuracy of +/-10mm up to 2.5m from center line of scanner and up to +/-20mm between 2.5m and 6m from center line of scanner. The system provides fast surveying within the constraints of road-rail use and fast turn around of data. Each rotation of the scanner generates a set of datapoints. The helix oriented scans are shaped by the linear speed of the moving platform. The faster the hyrail goes, the wider the data sweep. The quantity of data produced is large but of scales that can be handled by modern PC's. A slower rotating scanner has also been tested.

The purpose built software provides for viewing of the point cloud generated by the rotating scanner as well as measuring and analysis. This viewer allows a three dimensional image to be viewed for orientation and a two-dimensional image used for measurement. Video imagery is also available for asset identification. All images are locked against a synchronized time base, and location in the chosen grid referencing system is provided at all times. There are tools for operating through the point cloud, as well as measuring clearances, right on screen. Tools are also provided for the automated inclusion of cant and clearance, for determining standards compliance, for placing various origins of measure, step through processing, differential platform key measurements, and user definable structural, swept, kinematic, and ballast envelopes.

RESULTS

On-the-rail results from actual sites in England show the powerful results obtained from the unique rotating scanner.

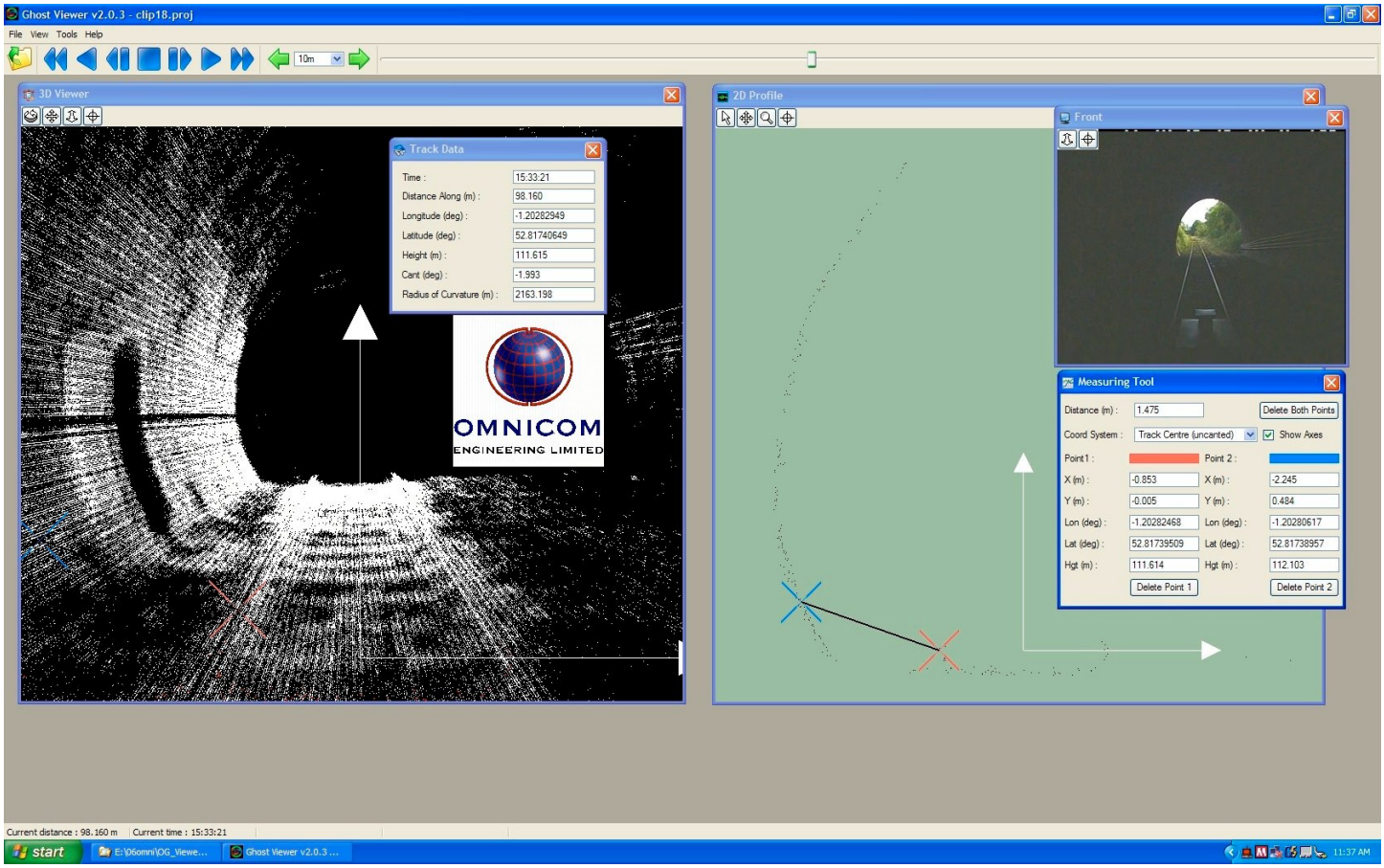
The system makes use of the fast rotation laser scanning and inertial technology to produce a true spatially referenced 3D point cloud as well as the track properties.



It also enables track clearances to be dynamically viewed and measured in the software within both the point cloud and the video imagery.

The entire profile of a tunnel, for example, can be scanned to enable a full three-dimensional reconstruction of the tunnel

interior. By manipulating the point cloud, the user can view and measure distances within the survey imagery from a virtual camera position as well as display the track geometry at the vehicle position.



The image on the left represents the point cloud. The image on the right represents a slice from the point cloud which can be used to determine the tunnel geometry. Each view has a virtual camera capability with the three-dimensional view enabled for rotation, zoom, pan and tilt allowing close-up inspections of interest within the tunnel. Note the refuge on the left, and piping on the right.

The management of the passage of a rail vehicle through the infrastructure is the art of clearance management and a new dimensioning tool is now available.

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