

GEOScaN – Remote Data Acquisition for Hydrographic, Topographic and GIS Surveying

Laurence WATERHOUSE, United Kingdom

Key words: remote sensing, hydrographic, laser scanning, GIS

SUMMARY

British Waterways' *GeoScaN* is an integrated system for GIS and profile surveying. The components that are incorporated within *GeoScaN* are off-the-shelf items, or straightforward modifications of existing systems. The software necessary for acquiring the data and processing is an adaptation of existing packages. However, the conceptual design, integration and application as applied to canals/rivers for gathering data both below and above the water line in a single, continuous pass is, as far as can be ascertained, unique.

The sub-surface data is measured using an acoustic mechanically scanning high-frequency profiler. Simultaneous data acquisition of the above water profile takes advantage of a scanning laser profiler system.

Real-time position and time comes from a system-integrated differential GPS positioning system. Data from the various sensors is logged and processed within a PC based system running a real-time survey acquisition program.

GEOScaN - Remote Data Acquisition for Hydrographic, Topographic and GIS Surveying

Laurence WATERHOUSE, United Kingdom

1. INTRODUCTION

British Waterway's *GeoScaN* (GIS Profiling System) is designed for low cost, non-invasive survey and asset location.

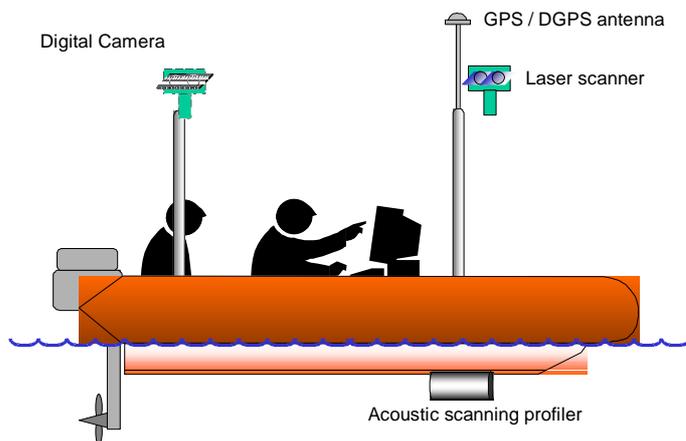
We have developed a boat/vehicle-borne mapping system, which uses laser scanners as the primary data acquisition devices. Through GIS systems all spatial data is integrated, managed and manipulated. Line cameras for texture information supplement the system and as usual combination of GPS, INS and odometer is used for position and attitude information. The mobile mapping system utilises digital video with CCD cameras. A combination of GPS with either INS or Gyro is used for navigation purpose.

It has been developed for boat use but can easily be used on a vehicle or railcar platform.

1.1 GeoScaN - The Future of Data Acquisition

The *GeoScaN* system comprises a number of integrated system components all of which are current technology and well proven. The unique feature of the system is its ability to simultaneously acquire surface and sub-surface data in one pass.

Fig 1



GEOSCAN's systems comprise:

- Laser scanning profiler for measuring above water profiles
- A differential GPS system to give position
- A survey data acquisition and processing system
- Acoustic scanning profiler for measuring underwater sections.

All these component parts, together with the system operator, are carried in a Rigid Inflatable Boat (RIB). Alternatively the system can be platform mounted by excluding the scanning acoustic profiler.

Fig.2

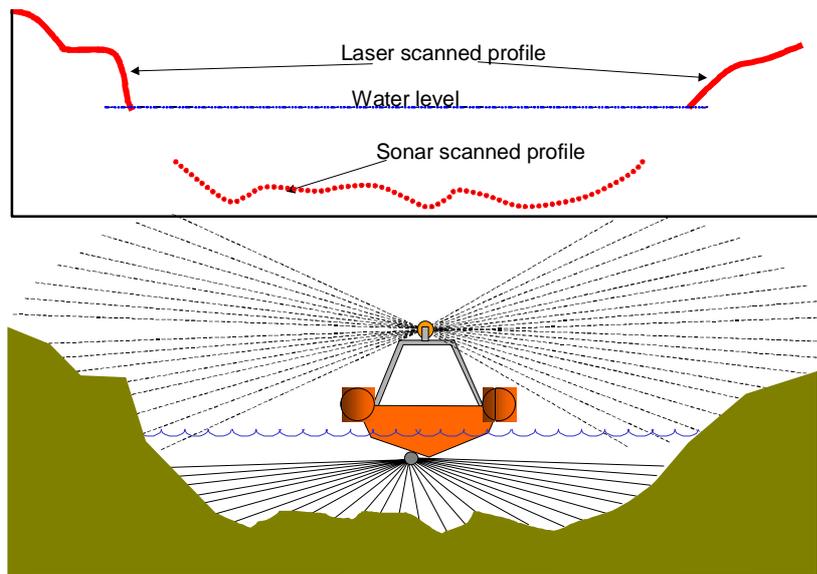


Fig 2. Combined Acoustic and Laser scanned Profile

The *GEOSCAN* system offers a cost-effective, efficient and competitive alternative to traditional hydrographic surveys, incorporating GIS. It will deliver a far superior product, more accurate than traditionally surveyed sections hence providing civil and GIS engineers with reliable data leading to significant cost savings through optimal design.

The specification that has developed is the result of the survey demands of British Waterway and preliminary consultations with identified system providers. As a minimum, the *GEOSCAN* system is capable of:

- Acoustically scanning profiles in waterways between 0.8m and 5.0m deep and between 10m and 40m in width and producing a full cross sectional profile of the waterway.
- Laser scanning profiles above water level in waterways between 10m and 40m width and with the capability of producing 2D scans of the banks, soffits, cills etc. to either side.
- Deriving position from a differentially corrected GPS (DGPS) positioning system with a horizontal accuracy $<0.75\text{m}$.

- Logging all raw profile data (acoustic and laser) and deriving X,Y, Z for each data point as co-ordinates transformed into the OSGB36 reference frame.
- De-skewing profile data to a common time/reference frame and relative to the DGPS system.
- Deriving vertical positioning relative to the ambient water level to an accuracy of <0.05m.
- Option - canal/river bed profile soundings from conventional echo sounder and;
- Producing final drawings in plan, profile and cross section; outputting data for DTM processing, GIS and for developing profiles for dredging design and other applications.
- Option - measurement of sediment layer(s).
 - Locating culverts and utilities.
 - Locating BW assets.

1.2 Above Water Data Acquisition. Laser profiler

The laser profiler provides a profile of the corridor from water level or road surface to a fixed cut-off elevation. The profile is similar in form to that produced by the acoustic scanning profiler except at a higher resolution.

The shaft encoder of the system has a Zero point, nominally the horizontal, from which angular elevations and depressions will be measured.

An attitude sensor is incorporated in the system to compensate pitch and roll. The first (and last) return from the scanner is at water level – reflections from water level cannot be relied upon. The acquisition software checks if the Z of the first (last) return from one side is the same as the other and, if not, apply a correction. At 20m, 5cm subtends a vertical angle of 0.14°.

Fig.3

1.3 Under Water Data Acquisition. Echo Sounder

As can be seen in Fig.2, an underwater profile of the canal or riverbed can be achieved using an Echo sounder. Due to the nature of British Waterways work, the scanning sonar is an integral and essential part of the BW survey system. Bathymetric data is collected via the underwater scanning sonar and a series of sonar swathes collect a profile that allows us to build an image of the bed characteristics.

The profiler is mechanically operated, comprising of a small transducer array mounted on an electro-mechanical stepper motor. Scanning profilers operate at much higher frequencies than echo sounders and consequently have much reduced ranges and very little material penetrative capability. Due to this, a dual frequency transducer array is used to collect both hard and soft bed depths.

1.4 Data Positioning System

The *GeoScaN* obtains its real-time position using differentially corrected GPS. A single frequency (L₁) GPS receiver will be used incorporating, within its firmware and antenna

array, a differential error correction capability. These units are commercially off-the-shelf items and have a well-proven and reliable track record. Differential corrections will be acquired in real-time from a number of sources including:

- IALA radio beacons (free)
- EGNOS geo-stationery satellite broadcasts (free)
- Thales *LandStar*® or Fugro *OmniStar*®

Given that the GPS is now free of Selective Availability, the stand-alone accuracy of the system is quoted as 37m. With differential corrections, this is improved to <3m from public broadcasts and <0.5m from commercial broadcasts.

1.5 GIS and Data Acquisition System

The data acquisition system comprises a rugged laptop PC running real-time acquisition and logging software. The on-line package takes data from the scanning profiler, laser scanner and positioning system. Then post-processing software de-skews data to common epochs (or use another approved method) to derive relative X, Y and Z ordinates. We use GPS Time as the common time stamping standard that will be used to correct PC Time.

The data processing system is capable of transforming WGS84 X and Y positions to OSGB36. Vertical Z ordinates is derived relative to ambient water level, itself related to OS Datum Newlyn entered into the software at the time of survey.

Finally, the system outputs a file of corrected X,Y and Z co-ordinates suitable for plan production processing in the standard BW mapping package.

The data sets are digitised by hand tracing line and polygon data sets and specific height data, with respect to weirs, locks and bridges, is inputted manually to the database management system.

2. CONCLUSIONS

GeoScaN is proving an invaluable tool in the collection of ever-expanding data sets. The integrated system has allowed British Waterways to collect and analyse topographical and hydrographical information in a one-pass corridor survey. The use of GIS to view spatial data and manipulate information through one single view and to data share with all colleagues is proving essential.

CONTACTS

Laurence Waterhouse
British Waterways
Fearn's Wharf
Neptune Street
Leeds
LS9 8PB
UNITED KINGDOM
Tel.+44 113 284 5212
Email: laurie.waterhouse@britishwaterways.co.uk