Coastal Applications for High Definition Survey / Laser Scanning Technology

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Abstract

Laser scanning surveys represent an emerging survey technology with distinct advantages over traditional methods for specific applications. Laser scanning surveys provide high resolution, three dimensional geo-referenced data at costs comparable to traditional survey methods. This paper provides an evaluation of this technology with respect to coastal engineering applications.

Introduction

Laser scanning surveys represent an emerging survey technology with distinct advantages over traditional methods for specific applications. Laser scanning (or High Definition Scanning) surveys provide high resolution, three dimensional geo-referenced data at costs comparable to traditional survey methods.

While this technology has been readily adopted for transportation and structure applications, to date the technology has not been commonly applied to coastal engineering projects. This paper provides an evaluation of this technology with respect to coastal engineering applications and assesses the relative merits of its use.

Comparison to Conventional Survey Techniques

Laser scanning equipment consists of a tripod based scanner that is deployed in a manner similar to standard or GPS based survey equipment. In addition to the scanner itself, reference targets may also be used to provide geo-referencing to the scanner base station. While the measurement of object distance to the scanner is relatively automated, geo-referencing of the scanner position by accepted survey techniques is required. A single deployment of the equipment will produce measurements of object positions relative to the scanner within the line of sight of the scanner. Multiple deployments of the scanner are typically required to provide a full three-dimensional representation of the surveyed area. Survey data may be reviewed immediately following data acquisition and may be imported directly into CAD based software.

In comparison to traditional survey methods, perhaps the most significant negative point is the high initial equipment cost of the system. This cost is offset by reduced manpower costs in the long term as fewer individuals are required to deploy the system. With respect to coastal engineering applications, the most significant limitation

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is the inability of the system to scan below the air-water interface. The system is therefore limited to upland applications.

Coastal Engineering Applications of Laser Scanning Surveys

Laser scanning surveys provide distinct advantages for the following Coastal Engineering applications:

Upland Beach Condition Surveys – laser scanning technology can be easily adapted to provide a high resolution survey of upland features including dunes, beach cusps, scarps and vegetation. Survey effort (and cost) are on the order of standard rod and level techniques. However, survey resolution far exceeds that which can be obtained through traditional methods. This allows for surveys of unprecedented detail.

Volume Estimates – Given the resolution of laser surveys, the technology may be used to develop highly accurate estimates of placed fill volumes. This application has been readily applied to similar uses within upland quarries and more traditional civil engineering excavation calculations. Survey data collected in this manner exceeds that of traditional survey methods both in terms of precision and accuracy. This application is particularly useful in the determination of placed fill volumes for dune projects in which the volume density of the placement is small and the existing topography varies significantly.

Structure Surveys – Laser scanning technology is particularly adaptable to the surveying of complex structures with both vertical and horizontal dimensions. Specific coastal engineering structures for which this technology is particularly adaptable include:

- Pile Structures – This technology allows for the efficient surveying of pile structures to a high level of accuracy including the position of each individual pile and support.

- Seawalls and Revetments – The technology can capture a high level of detail including adjacent structures and finer elements such as pipe outfalls. The data is of sufficient detail to allow for measurements of structure deflections over longer time scales.

- Groins and Jetties – While traditional survey methods tend to provide a general assessment of such structures, laser scanning technology can produce a survey of these structures sufficiently fine as to capture each individual armor stone. Subsequent surveys could be undertaken to determine to a high level of detail the rate and direction of structure settlement.

Survey Example

As an example of the potential uses for this technology, a survey of a typical beach segment was undertaken. The survey was conducted using a Leica HDS 3000 laser scanner (Figure 1). A single deployment of the equipment was undertaken from the beach berm (Figure 2). The survey was completed in approximately 15 minutes and covered an approximately 500-foot segment of beach from the waterline to landward of the dune line. Inspection of the survey data indicates a high level of detail within the survey data including electric transmission lines landward of the dune and footprints within the beach (Figures 3 and 4). Visualization of the data was undertaken immediately following completion of the survey and manipulation of the data was found to be straightforward. (Figure 5).

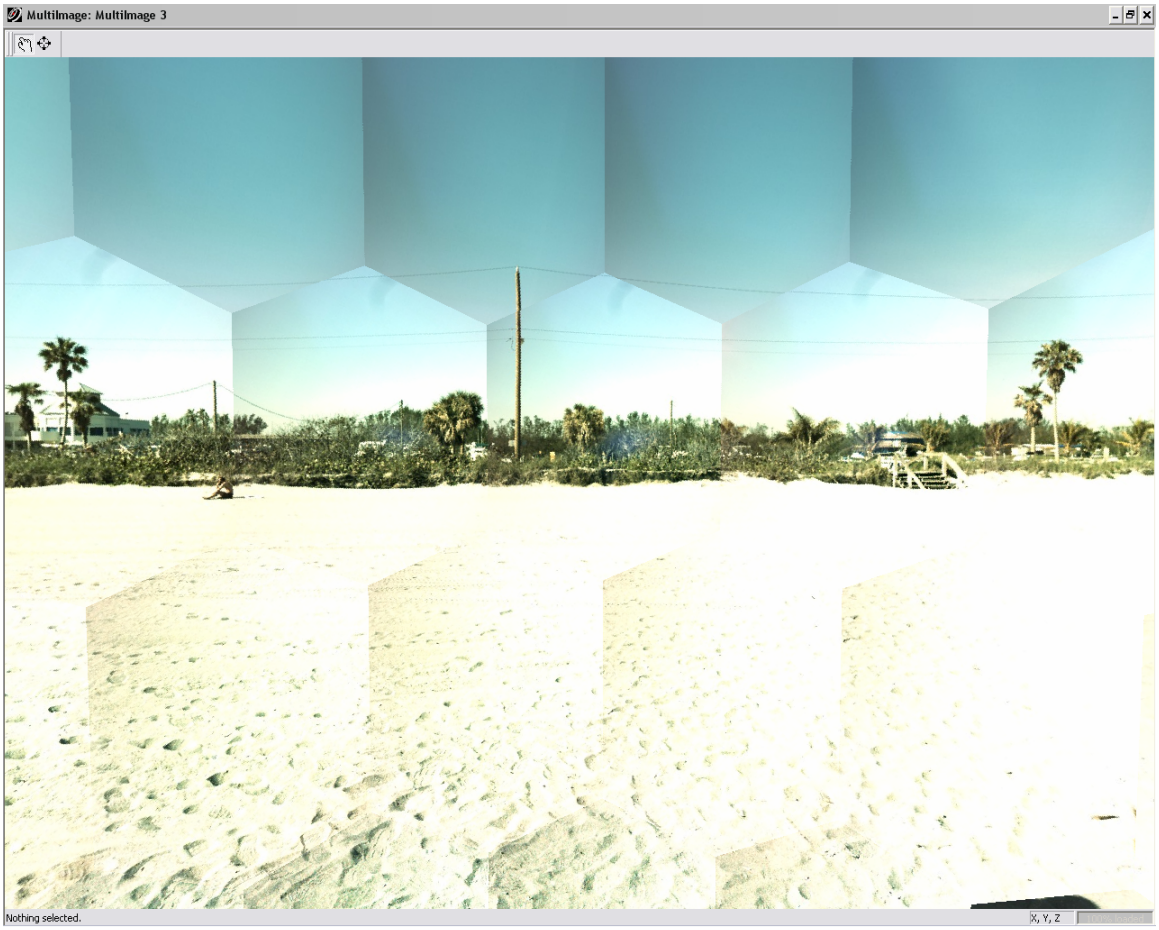

Figure 1. View of surveyed beach area. Note the dune overwalk, vegetation and overhead power transmission lines.

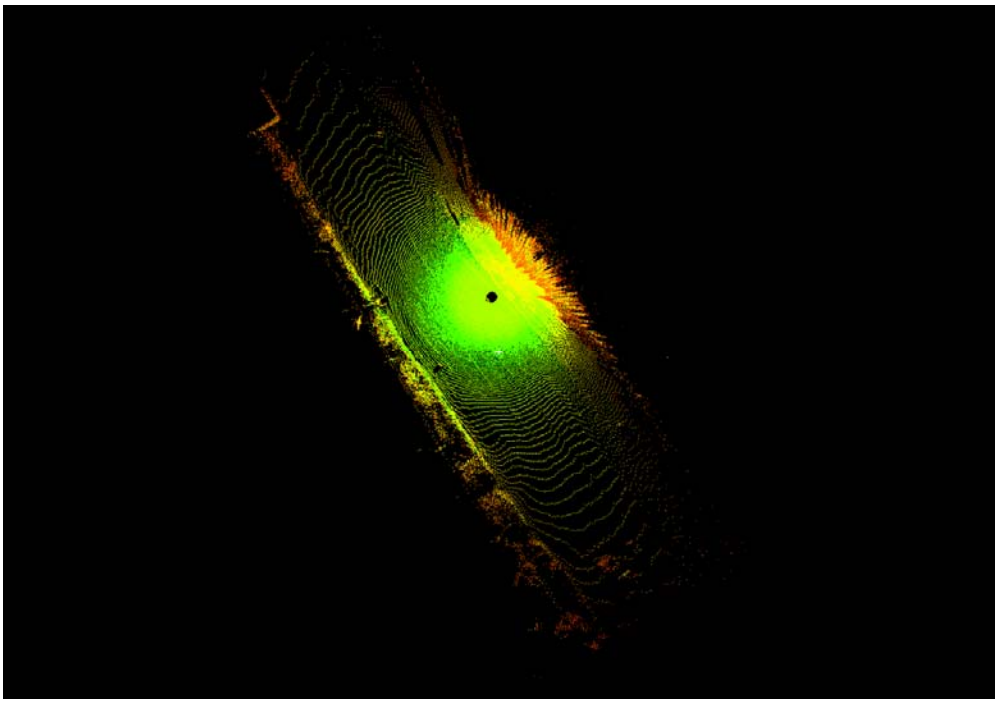

Figure 2. Planform view of survey data. The circle in the center of the data indicates the position of the laser scanner.

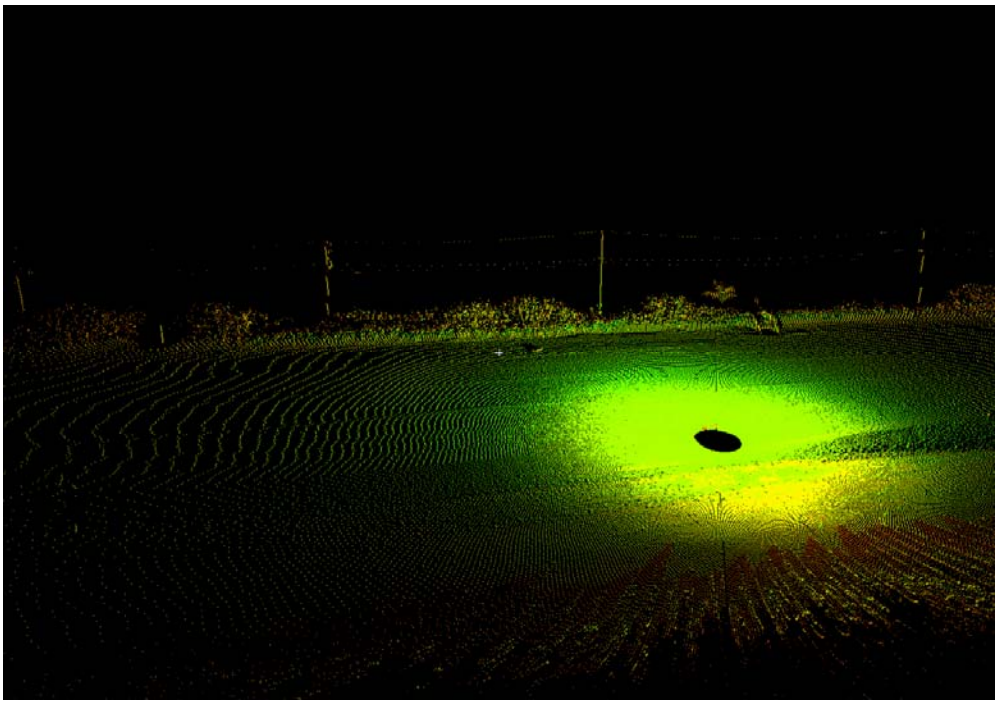

Figure 3. Oblique view of survey data looking landward. Note the dune overwalk and power transmission lines captured within the survey data.

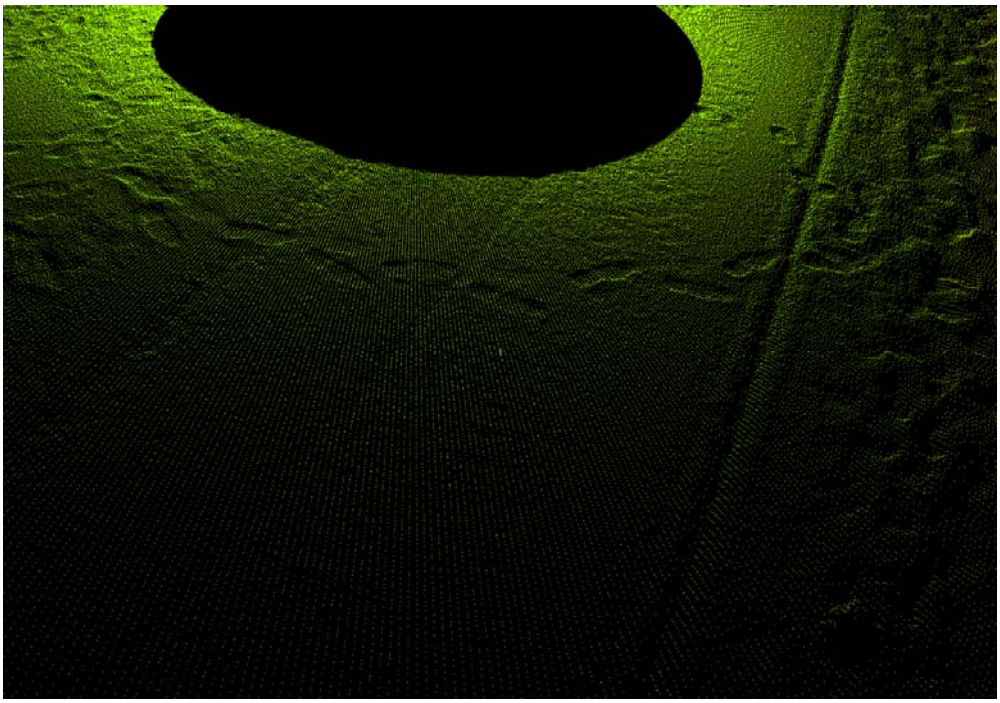

Figure 4. Close-up of survey data on beach berm. Note the footprints clearly resolved within the survey data.

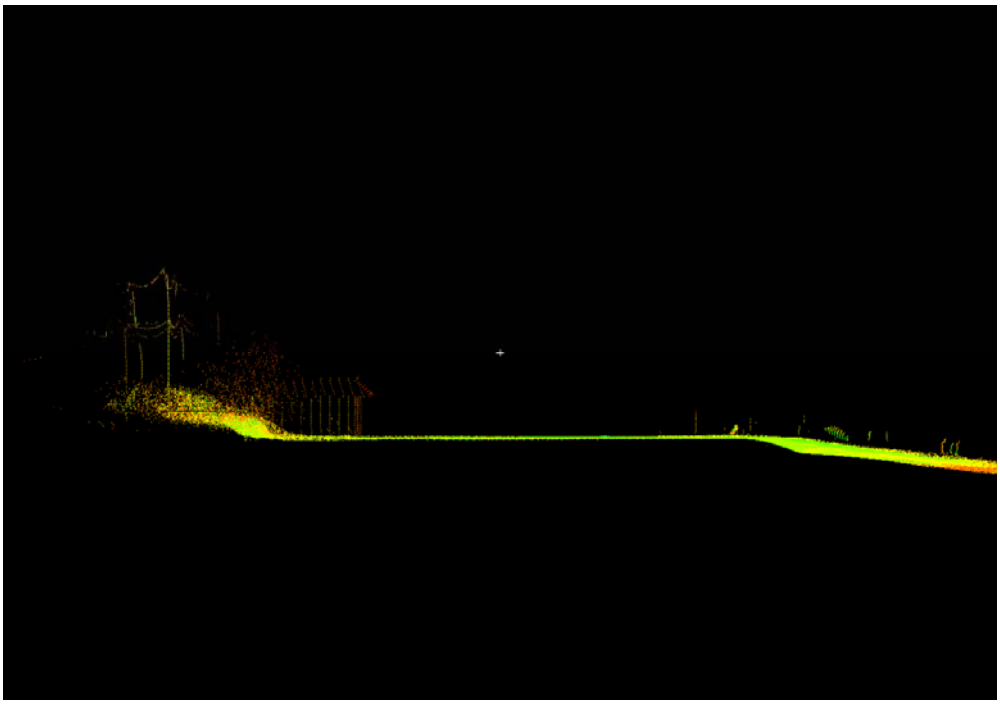

Figure 5. Profile view of survey data. The data can be visualized immediately after the survey is complete or may be directly imported into CAD-based applications.

Conclusions

Laser scanning technology provides an attractive alternative to traditional survey methods for specific coastal engineering applications. The technology is particularly adaptable to upland beach and above water structure surveys. In general, this technology can provide high resolution survey data at cost and time requirements similar to traditional survey methods.

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