

3D Spatial Definition of a Water Surface

Matthew Harry¹, Hong Zhang¹, Charles Lemckert¹, Gildas Colleter²
¹Griffith School of Engineering, Griffith University, Gold Coast, Australia
²Aurecon Australia, Brisbane, Australia

ABSTRACT

Remote sensing of the environment with laser scanners can provide highly accurate 3D spatial definition of surfaces; however difficulties arise if the target surface is water. A feasibility experiment and a field test of terrestrial laser scanning technology for water surface measurements has been carried out and the results are summarised in this paper. The paper finds that a disturbed water surface as found in the surf zone is a suitable target for laser scanning and a case for further research utilising laser technology for water surface measurement is presented.

KEY WORDS: Remote sensing, terrestrial laser scanner, wave measurement

INTRODUCTION

The measurement of water levels and to some extent water surface profiles has spanned many centuries. Starting with basic methods such as manual level readings, initial technology could only provide limited information for people interested in monitoring water levels. Thanks to the development of accurate electronic sensors over the previous century water measurement devices have become autonomous and highly accurate. Water level measurement is an essential part of planning, design and monitoring in areas such as water supply, seafaring, agriculture, construction and scientific investigation. Laser scanning technology is investigated in this paper for the purpose of wave measurement and in doing so presents the technology as a mechanism for collection of data for numerical model calibration.

Remote sensing technology

The most common method for wave measurement in the field is the in-situ approach. Remote sensing has recently become a high-tech method for spatial data collection, especially in surveying, and provides an alternative to the in-situ approach to wave measurement. When compared it is evident that there are certain advantages and disadvantages of either in-situ measurement or remote sensing. As technology improves the advantages of remote sensing will increase and as a result hold the potential to become a powerful tool for spatial

definition of water profiles and surfaces.

In relation to the measurement of wave parameters, such as wave height, wavelength and wave period, in-situ measurements are achieved by instruments located on the surface of or within a water body. Wave gauges, pressure transducers and wave buoys are examples of in-situ instruments (IOC, 2006) and are commonly used for coastal monitoring due to their accuracy and performance. These instruments collect data that can be presented, for example, as time series describing wave parameters at certain points within the study area. This is a limitation of in-situ instruments in that if the size of the study area is extensive or many intervals are to be monitored then a large number of instruments may be required.

However, this is not only a problem for in-situ instruments as some remote sensing devices can only provide time dependent location data. Examples of this type of instrument are acoustic measurement devices that collect water surface elevation data through ultrasonic time-of-flight calculations. Again, this device monitors a single location only and data is limited to a time series.

There are a number of remote sensing methods available that can provide 3D spatial data for a target location. Photogrammetry, or in particular videogrammetry, can be used for remote sensing through the analysis of images taken from multiple locations to construct geometry in three dimensions. Another method is particle image velocimetry, commonly used in laboratory experiments, that can obtain velocity measurements for 2D profiles and with special techniques a series of rapid profiles can provide 3D volumetric analysis.

In relation to remote sensing of water elevation satellite altimetry is the only method commonly used, however data is only collected on large scales, and generally only mean values for parameters such as wave height are recorded. Radar systems are another modern technology that can be used for remote sensing of water properties. Their main function is to measure water surface velocity although some systems such those installed on ships can provide limited surface elevation data. Based on currently available methods and instrumentation there is no evidence of a commercial product that can undertake remote sensing of a water surface with a degree of accuracy that compares to in-situ methods. The only exception to this is airborne LIDAR, although as discussed in the