Deformation Monitoring of a Steel Structure Using 3D Terrestrial Laser Scanner (TLS)

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Abstract. Terrestrial Laser Scanner (TLS) offers a new approach of deformation analysis. Different from conventional equipment such as Global Navigation Satellite System (GNSS) and Total Station (TS), the entire surface of observed structure can be analysed by contactless measurement. However, until recently the application of laser-scanner is still limited to long-term deformation monitoring. Using TLS to monitor dynamic response faces some challenges, such as scan time delay and its data characteristic. This project proposed a new approach by applying the function of helical mode of a TLS in order to solve these issues. The proposed method was tested on a high-rise artwork deformation monitoring case, the Aspire Sculpture in Nottingham. The result showed that scan time delay can be solved. Then TLS can be used to observe the sculpture dynamic deformation. New approach of point cloud processing was introduced in order to extract the deformation, leading to promising results that prove that there is potential of TLS to be used for monitoring the dynamic response of a civil engineering structure.

1. Introduction

Terrestrial Laser Scanner (TLS) has been introduced in deformation monitoring the last 15 years. Lichti et al. (2002) did the earliest attempt using TLS for structure deformation monitoring. They used TLS to monitor bridge deformation on loading test and compare the result with the result achieved using photogrammetry technique. Schneider (2006) used TLS to determine bending line of television tower and to observe the deformation of dam water. For long-term deformation monitoring, laser scanner has been proven to be a reliable technique. On the other hand, monitoring dynamic motion, such as structural response, is still a very challenging task. Even though, there are TLS with the capacity to scan in high sampling-rate (>1Hz), there are restrictions in the function of the TLS, which limit their application for monitoring of dynamic motion. Such a difficulty is the scan time delay between the successive scans, causing complication in the time-stamping of the scans and generally in monitoring moving or oscillating object.

2. Literature Review

In deformation monitoring applications, there are two main steps that are followed; the field measurements followed by the data processing and data analysis to extract the information expressing the deformation of the object, which was monitored. Furthermore, the estimation of the deformation is based on the comparison of each measurement/sample with a reference initial sample. Until recently, the main geodetic monitoring applications were based on GPS and conventional surveying techniques (levelling, total station), leading to monitor specific number of points, restricting the estimation of the deformation of the object only to the specific points. The latter may lead to limited information of the deformation, which could result to misinterpreting the response and the health condition status of the structure. On the other hand, the deformation monitoring using TLS allows getting massive points as point clouds, as it can be considered as remote sensing technigue. However, the main challenge