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Laser & Optoelectronics Engineering

Department

Laser Eng. Branch

The Use of Terrestrial Laser Scanning and Close-Range Photogrammetry in the Accurate 3-Dimensional Documentation of Iraqi Tangible Heritage

A Thesis Submitted to the Laser and Optoelectronics Engineering Department of the University of Technology in Partial Fulfillment of the Requirements for the Degree of Ph.D. in Sciences in Laser Engineering.

by

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ABSTRACT

The site of the Al-Mustansiriya School is an important archaeological site of the Abbasid Islamic civilization in the city of Baghdad (the Republic of Iraq). It was recently nominated to join the World Heritage List. In this study, the practical work can be divided into three parts.

In the first part, various analyses were carried out on this archaeological site using remote sensing techniques and terrestrial laser scanning (TLS). Several specialized pieces of hardware and software have been employed in this regard. The outputs from these devices and software packages are 2D images and 3D point clouds, such as output, can be utilized in the archaeological site analysis, especially, the analysis related with precise surveying of the surrounded irregular building, these buildings represent places of the so-called visual pollution. the specialized software package Leica Cyclone is used to view and analyze the 3D point cloud scenes that are obtained from the TLS. The study concluded the importance of primary surveys based on current, high-resolution spatial satellite images. The current study identified a number of places adjacent to the archaeological site in which the manifestations of visual pollution were concentrated, which were represented by the facades of random buildings, small gables, and iron roofs in places near the site. The study emphasized the need to remove these manifestations of visual pollution from the area near the archaeological site because their presence negatively affects the requirements for its inclusion in the World Heritage List.

The second part of the current study is concerned with a photogrammetric survey within the above-mentioned archaeological site; this part carried out photogrammetric surveying of two sub-parts within the school building, the first being the internal courtyard of the school, and the second being the mosque hall within the school building. The idea of the study depends on evaluating the accuracy of the three-dimensional point cloud obtained photogrammetrically for

both parts of the study. Taking into consideration the identification of a few numbers of checkerboard targets in order to reduce the surveying cost as well as the distortion caused by placing such targets on the walls of the archaeological building.

The third part of the study is to employ terrestrial laser scanning technology in 3D lasergrammetric documentation of Al-Mustansiriya School. This building was selected as a case study. This part can be summarized in six stages. In the first stage, the Leica GS15 GNSS system was used with the Leica Geo Office software package for the purpose of installing two ground control points (GCPs within the inner courtyard of the Al-Mustansiriya school building. In the second stage of the work, based on the two GCPs, the Leica TS06+ Total Station device was used to determine the ground coordinates according to the UTM Universal Transverse Mercator UTM coordinate system for a set of checkerboard targets installed on the walls of the school building. In the third stage, the 3D point clouds were obtained by installing the Leica ScanStation C10 TLS device in different positions within the Al-Mustansiriya School site. In the fourth stage of the work, the Leica Cyclone software package was used to implement the registration process between point clouds registered in the TLS internal coordinate system and the global coordinate system UTM of the Checkerboard Targets in order to obtain point clouds according to the UTM coordinate system. It should be noted that the engineering transformation used in the registration process is a 3D on formal coordinate transformation with six parameters. In the fifth stage of the work, the 3D point clouds were collected and unified into a single 3D point cloud. Finally, noise and unwanted objects were cleaned and removed from the final 3D point cloud.