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THREE DIMENSIONAL BUILDING RECONSTRUCTION BASED ON AIRBORNE LiDAR, AERIAL PHOTOGRAMMETRY AND TOPOGRAPHIC DATASETS

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AUTHOR'S DECLARATION

I declare that the work in this thesis/dissertation was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

3D building model of man-made objects supports a diversity of applications such as urban planning, flood mapping and telecommunication. At present, a total automation towards the construction of a detailed and accurate 3D city model is not possible. In order to reduce the time of constructing the 3D building models, an integration of reliable dataset is explored. In mapping technologies, sophisticated sensor has been developed to serve the mapping community. Airborne LiDAR (Light Detection and Ranging) technology has changed the conventional method of topographic mapping, and the increasing interest of these valued datasets for the construction of 3D building models is an active research agenda. Airborne LiDAR provides three dimensional (3D) information of the earth surface with high accuracy point clouds. In this study, the capability of remotely sensed data for the reconstruction of 3D building models is explored, namely; LiDAR dataset, aerial images, digital topographic information and terrestrial photographic images. The study area comprised of residential buildings situated in Putrajaya within the Klang Valley region, Malaysia, covering an area of two square kilometers. The process of the reconstruction 3D building model includes integration of LiDAR dataset, aerial photo, digital topographic information and low cost terrestrial images couple with processing software namely the ArcGIS and SketchUp. Valuable building parameters are extracted based on automated retrieval from the normalized Digital Surface Model (nDSM) as a result from LiDAR DSM and LiDAR Digital Terrain Model (DTM) separation. Orthophotos are used as backdrop and generated using digital aerial photographs based on photogrammetric technique and height information from the derived digital models. The Root Mean Square Error (*RMSE*) of the vertical component (*RMSE*z) for the derived (DSM and DTM) for LiDAR dataset are ±0.15m and ±0.14m respectively. As for the digital photogrammetric models, the *RMSE*z for the photogrammetric DSM and DTM are ±0.68m and ±0.52m respectively. Accuracy of the topographic DTM is assessed and found to be ±2.49m. It should be pointed out that, the noblelity of the study include, assessment of LiDAR dataset and the determination of building footprint. The best accuracy utilizing various digital models for the constructed orthophotos to act as the backdrop for the 3D urban model was found to be ±0.37m using DTM LiDAR. The final 3D building models constructed were assessed having an accuracy of ±0.94m and ±0.61m for the vertical and horizontal component (*RMSE*z and *RMSE*x,y) respectively. Based on the qualitative assessment, the constructed 3D building models were found to be adequate in supporting the LOD3 (Level of Detail of Level 3) applications. In this study, an automatic evaluation of LiDAR dataset is highlight and automated determination of building footprint is proposed. Evaluation of all dataset in used as well as the accuracy of the 3D building models were critically assessed and found that the integration of remotely sensed dataset and terrestrial images were of high value for 3D building model reconstruction.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

The technology in representing the earth topography is growing rapidly. The effects of rapid development in emerging technologies make the conventional Survey method forgotten. The spatial information has become one of the most important information sources in human life. It is expected that more information shall be associated with spatial information provided through systems such as the Geographic Information System (GIS).

The way of representing objects has evolved from two-dimensional (2D) paper maps to a three-dimensional digital (3D) model. Among the differences of cartographic products, 3D city models have shown to be valuable instruments for a diversity of applications such as urban planning, 3D cadastre, environmental planning, land monitoring, mobile telecommunication, 3D visualization, architecture and tourism (Tack et al., 2012). 3D reconstruction has been rigorously studied by many researchers in computer vision and photogrammetric field (Fraser & Edmundson, 2000; Cheng et al., 2011; Ghazali et al., 2011; Verhoeven et al., 2012). Due to the importance of object reconstruction, especially the buildings to human life, various researchers have contributed fundamental concepts and methods to the enhancement of automatic building reconstruction (Zlatanova et al., 2002; Haala & Kada, 2010; Wang et al., 2012). As an example, the generation of Digital Surface Model (DSM), Digital Terrain Model (DTM) and Digital Orthophotos are proven suitable for a variety of mappings and environmental monitoring tasks (Kato et al., 2010). DSM models the earth topography which includes above surface features such as buildings and trees. On the other hand, DTM (Digital Terrain Model) depicts the earth surface only.