Enhancing Accuracy in Building Dimension Measurement through Photogrammetry of Google Earth Building Images

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Abstract. Considering the older buildings, the absence of architectural designs poses a significant obstacle, particularly during retrofitting endeavours. Project managers face the daunting task of acquiring missing information, which not only proves challenging but also consumes considerable time in the process. One of the main challenges is to measure the exterior dimensions of the building as measuring the height of the building is a tiresome process and often leads to inaccuracies in the observational readings. To address this, the study introduces a methodology for generating 3D model of a building by amalgamating building images sourced from Google Earth and has been conducted on an operational building. The methodology integrates advanced algorithms like photogrammetry for accurate measurements of the building exterior dimensions.

Keywords: older buildings, architectural designs, 3D model, Google earth, photogrammetry, building exterior dimensions

1 Introduction

Urbanisation is a worldwide trend that is dramatically reshaping the landscapes. According to the Union Nations, approximately 68% of the population will live in the Urban areas by 2050, which will be a substantial rise from the current 55%. This shift is predicted to add around 2.5 billion people to urban areas, while Asia and China will account for nearly 90% increase of the population in the urban areas [1], [2].

These massive shift mandates precise and accurate data and advanced IoT sensory networks to assist the urban planning and management. However, the developing countries have constraint in accessing the advanced remote sensing technologies like Unmanned Aerial Vehicle (UAV) that can be hindrance on their way to urban planning and management [3], [4], [5]. To address this, a framework is provided for accurately

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measure the building dimensions using techniques like photogrammetry, which can assist urban planning and management. The photogrammetry conducted in this study is based on the historical data, publicly available Google Earth platform.

Photogrammetry used in this study, is an algorithm used for turning a set of images into a 3D model. These images could be of a structure or an object. Photogrammetry has gained its popularity for scanning the objects such as heritage buildings and to further assess their health based on image processing algorithms.

The study is novel as it employs photogrammetry using Google Earth to facilitate the developing countries for the broader adoption of the innovative approaches for urban development analysis of those areas where there is data scarcity [6]. The model generated from photogrammetry in this study, is converted into point cloud. These point clouds along with the 3D model could be used for measuring the building dimensions. In addition, they could be imported in software like Building Information Modelling (BIM) [7], [8].

2 Structure from Motion Based Photogrammetry

In this study, Structure from Motion (SfM) algorithm using the Autodesk Recap is implemented which is a sophisticated photogrammetry technique. SfM reconstructs the 3D images from the provided image dataset that contains a series of photos taken of an object by moving a sensor or camera module. Identical to the stereo vision, SfM detects the identical points based on their shape from the provided image dataset, reconstructing their position in 3D space as a function of camera displacement or satellite imaging displacement, resulting in a point cloud. In geosciences, this technique is widely implemented for generating digital elevation models with high spatial resolution for the analysis of rocky outcrops, monitoring of mining, and in geotechnical studies [9], [10].

3 Method Details

For this research, an institutional building with unknown exterior dimensions was selected. The building has complicated building dimensions, making the conventional methods of the measurements challenging. To resolve this challenge, building imagery was collected using the Google Earth. By rotating the building in all dimensions, a comprehensive video feed of the building was collected.

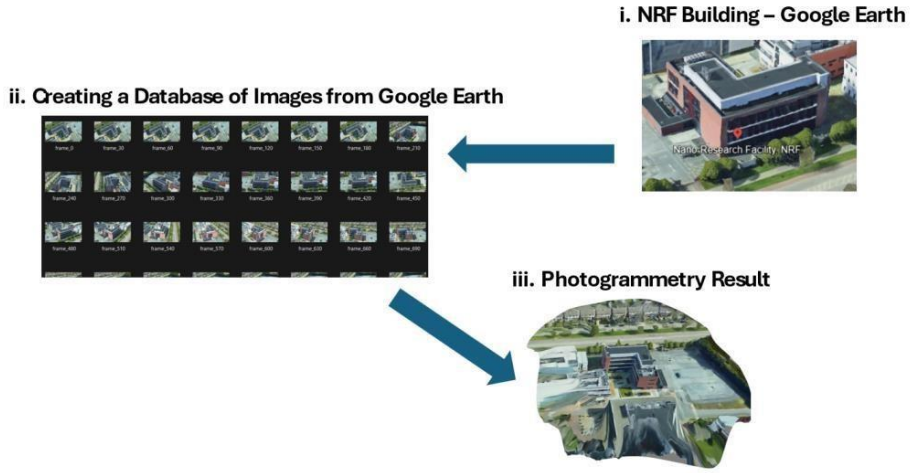

Fig. 1. Methodology of the proposed study

The video was processed using OpenCV for splatting the video into individual frames, converting the dynamic visual information into a dataset of the building images, and was then stored in a local directory as seen in figure 1, from which photogrammetry was performed.

For the photogrammetry, Autodesk Recap was employed for its following functions:

a) Feature Extraction and Matching: The key features of the building like corners, edges and patterns were identified from each of the image frames.
b) Structure from Motion (SfM): SfM analysed the positions of the matching features from the given images to determine the orientation and position of the building by capturing the camera's movement around the surface.
c) Dense Point Cloud Generation: Following SfM, Autodesk Recap creates the dense points that represent the surface of the building.
d) Meshing: The generated dense points (point cloud) are converted into 3D mesh by combining the interconnected polygons of the building, which can be used for the determination of the building shape.

Following that, the Autodesk Recap measurement tool was implemented in which the key dimensions of the building were annotated directly on the point cloud as seen in the figure 2. These measurements included the length and width of various sections of the building which were complicated to be determined using the conventional measurement

methods. The final annotated model of the building was saved and could be exported into building information model software like Revit.

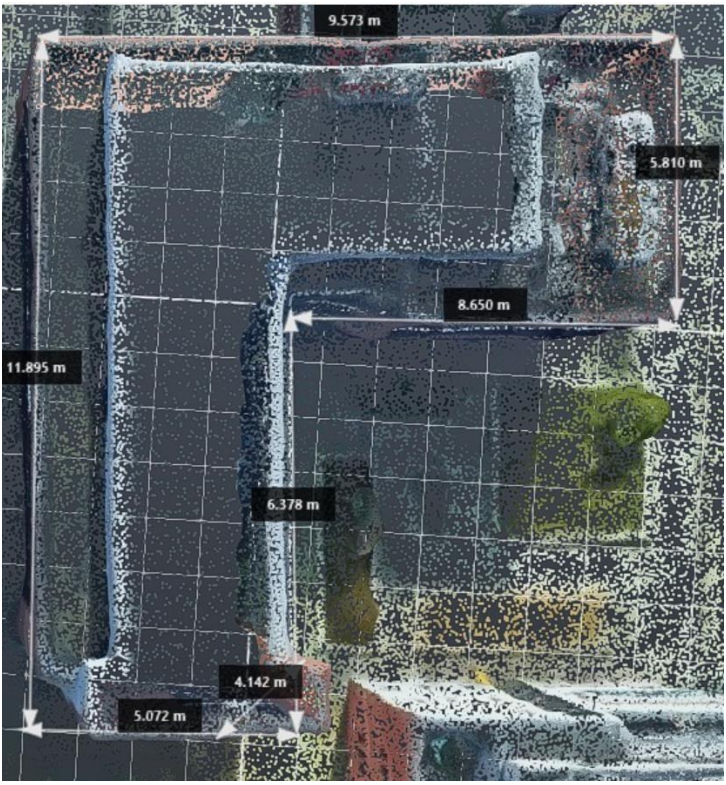

Fig. 2. Measured exterior dimensions of the selected building

4 Conclusions

The study addresses the challenges posed by the absence of architectural designs in older building, which could prove to be hindrance during their retrofitting. By introducing this methodology that combines the images of the building from different angles using photogrammetry, the 3D models of the buildings could be created at an ease. The methodology was validated through its application on an operational institutional building which was selected for this study, demonstrating its efficiency in overcoming complexities associated with measuring exterior dimensions of the building. This approach not only mitigates the ineffectiveness of the conventional methodologies but also the extensive work of the labour that they endure during the measurement of the building dimensions could be reduced. In addition, the proposed technique offers a

reliable and efficient tool for the project manager that could be used for the enhancement of the precision and efficiency of retrofitting endeavours for older buildings.

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