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Automated 3D Model Reconstruction of Disaster Site Using Aerial Imagery Acquired By Drones

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Abstract: Due to harsh conditions of disaster areas, understanding of current feature of collapsed buildings, terrain, and other infrastructures is critical issue for disaster managers. However, because of difficulties in acquiring the geographical information of the disaster site such as large disaster site and limited capability of rescue workers, comprehensive site investigation of current location of survivors buried under the remains of the building is not an easy task for disaster managers. To overcome these circumstances of disaster site, this study makes use of an unmanned aerial vehicle, commonly known as a drone to effectively acquire current image data from the large disaster areas. The framework of 3D model reconstruction of disaster site using aerial imagery acquired by drones was also presented. The proposed methodology is expected to assist rescue workers and disaster managers in achieving a rapid and accurate identification of survivors under the collapsed building.

Keywords: 3D Model, 3D Reconstruction, Disaster, Drone, Topography, Unmanned Aerial Vehicle(UAV)

I. Introduction

Due to harsh conditions of disaster areas, understanding of regional and geographic information is critical issue for disaster managers. Rapid and accurate understanding of disaster site information about current feature of collapsed buildings, terrain, and other infrastructures facilitates decisions toward increasing life-savings during rescue process. However, because of difficulties in acquiring the geographical information of the disaster site such as large disaster site and limited capability of rescue workers, comprehensive site investigation of current location of survivors buried under the remains of the building is not an easy task for disaster managers.

To overcome these circumstances of disaster site, this study makes use of an unmanned aerial vehicle (UAV), commonly known as a drone to effectively acquire current image data from the large disaster areas. This paper presents a process of an automated 3D model reconstruction of disaster site using aerial imagery acquired by drones. This paper begins with a review of various applications of drones in the area of civil engineering. The hardware and software components are then explained. Process of 3D model reconstruction of disaster site is presented. Lastly, research contributions and recommendations are summarized.

II. Literature Review

Drones with digital cameras are now widely used for various civil engineering application and their successful attempts proves that drones with digital cameras have great potential to rapidly acquire information of the large site [1]. For bridge inspection processes, a UAV have been used to acquire the images of bridge structure [2]. The mission of the UAV was to find location of defects and cracks on the bridge structure. A UAV technology also have been used to rapidly and autonomously acquire mobile three-dimensional (3D) mapping data of earthwork construction site [3]. Irizarry et al. [4] tested small unmanned drone to assess a usability of drone technology as safety inspection tools on construction site. Zhang and Elaksher [5] developed an UAV-based imaging system for 3D measurement of unpaved road surface distresses.

Ⅲ. Automated 3D Model Reconstruction of Disaster Site

A. System Architecture

Fig. 1 shows the system architecture of drone-based 3D model reconstruction of disaster site, consisting of four subsystems: drone module, depth map generation module, 3D viewer module, and volume analysis module. The drone module was composed of various sensors and stereo-vision camera. Its purpose was to acquire image data

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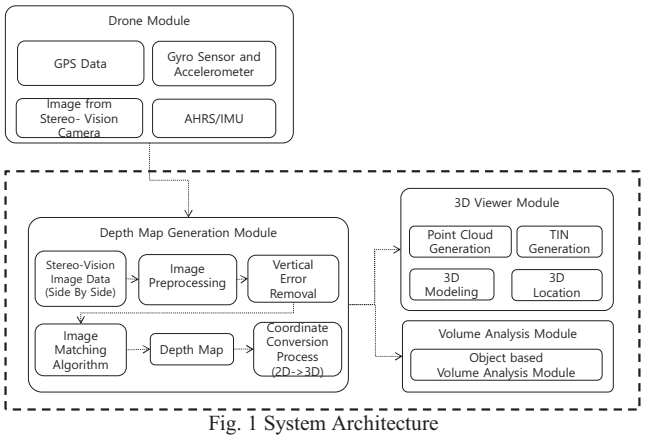

Fig. 1 System Architecture

of the disaster site. The depth map generation module generate depth map data for 3D model reconstruction of disaster area. The 3D viewer module visualize 3D model of disaster site. The 3D model about current feature of collapsed buildings, terrain, and other infrastructures is visualized on the 3D viewer module. The volume analysis module calculate the volume of each 3D object based on 2D-based terrain model of disaster site.

B. Process of 3D Model Reconstruction

Fig. 2 shows the process of 3D model reconstruction of disaster site. To acquire point cloud data of the disaster site image data from the stereo-vision camera on the drone module was processed through image preprocessing and stereo-vision image matching processes. Then, based on the reference point data, 3D model was reconstructed to visualize the current feature of collapsed buildings, terrain, and other infrastructures. The volume of each 3D model was also analysed based on 2D terrain model.

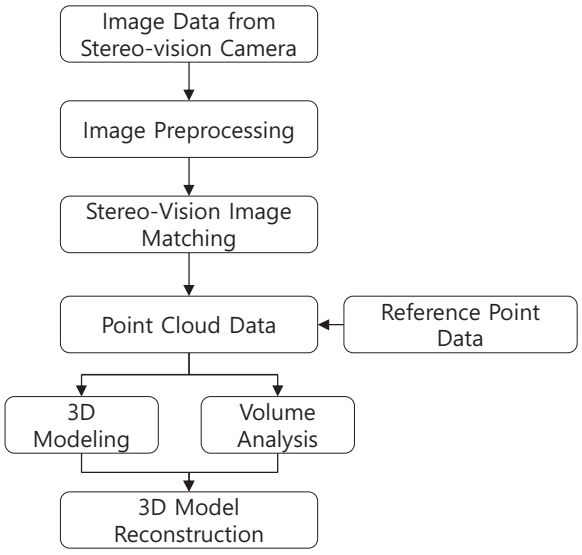

Fig.2 Process of 3D Model Reconstruction

Ⅳ. Conclusions and Recommendations

The purpose of this study was to develop an automated 3D model reconstruction of disaster site using aerial imagery acquired by drones. The proposed system consisted of four subsystems: drone module, depth map generation module, 3D viewer module, and volume analysis module. The image data was acquired by the drone module and the image data was converted to the point cloud data through the depth map generation module. The volume information of each 3D model object was analyzed from volume analysis module. Lastly, the 3D model of collapsed buildings, terrain, and other infrastructures was visualized on the 3D viewer module. For the future study, the field tests are required to improve the applicability and reliability of the developed system.

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