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A Study on the Construction of a Background Model for Structure Appearance Examination Chart Using UAV

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ABSTRACT

Appearance examination and the construction of an appearance examination chart are important procedures, particularly in the inspection and diagnosis of a structure. However, traditional appearance examination charts are constructed based on the design plans, and such constructions are difficult when there is no existing design information. In addition, there are practically no relevant studies regarding the aging of structures that lack design information, despite the difficulties in drawing the appearance examination charts. Therefore, this study was conducted to establish a background model for the appearance examination chart of a facility by utilizing an unmanned aerial vehicle. In this study, UAV-based aerial photography was conducted for buildings. Furthermore, by utilizing the aerial images the spatial information of the subject was established, and the background model of the associated appearance examination chart was formulated based on the established spatial information.

1. INTRODUCTION

In recent years, with the construction in Korea reaching its peak, the demand for maintenance of buildings, rather than for new constructions is expected to increase rapidly (Shim 2011). In such a scenario, efficient safety inspection and diagnosis (hereby referred to as inspection diagnosis) are of utmost importance to maintain the functionality and prolong the lifespan of aging structures (Lee 2004). The inspection diagnosis of a facility follows the order: appearance examination and establishment of an appearance examination chart, durability examination, status and safety evaluation of the facility, and repair/reinforcement based on the results of the preceding steps (Oh 2006). Among the series of tasks for inspection diagnosis, the step of appearance examination and establishment of an appearance chart is particularly important for obtaining fundamental data for selecting priority control points, analysis of damage

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evolution, and determining the repair and reinforcement tasks (Hwang 2008). Existing appearance examination charts are drawn based on the design plans of the buildings; however, for a number of the aging structures that are the main targets of inspection diagnosis, there is a lack of sufficient design information (Ko 2016). In addition, there are practically no relevant studies regarding the aging of structures that lack design information, despite the difficulties in drawing the appearance examination charts.

Therefore, this study was conducted to establish a background model for the appearance examination chart of a facility by utilizing an unmanned aerial vehicle (UAV). In this study, UAV-based aerial photography was conducted for buildings. Furthermore, by utilizing the aerial images the spatial information of the subject was established, based on which the background model of the associated appearance examination chart was formulated. The flow chart of the study is shown in Fig. 1

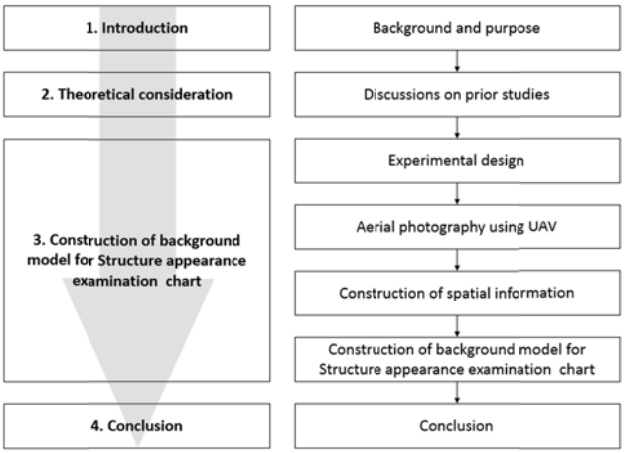

Fig. 1 Flow chart of research

Based on our results, we expect that the method for constructing a background model as proposed in this study will be of significant use in generating an appearance examination chart of an aging structure lacking in design information in the future. Additionally, once the damage information is quantified and mapping studies are conducted in the future, it is expected that the appearance chart, in conjunction with the background model presented in this study, will have a major application in the inspection diagnosis of structures.

2. REVIEW OF PREVIOUS STUDIES

An appearance survey of existing structures is usually conducted with the naked eye of a technician with relevant experience and skills. Subsequently, office work is performed to generate the appearance examination chart. (Lee 2008) developed and reviewed an image processing program for conducting appearance examination for resolving the problems of existing appearance examination of existing bridges. (Baek 2010) analyzed the current status of maintenance and appearance examination of urban railway structures and investigated the efficiency and possible introduction of a tunnel scanning system for complementing these tasks. (Park 2017) suggested a UAV-

based integrated management code system for efficiently storing and managing information of a damaged bridge collected by a UAV. There have been numerous studies on appearance examination and generation of an appearance examination chart. Nevertheless, the appearance examination charts continue to be drawn based on the design plans of the buildings, and there are difficulties in formulating charts for structures without design plans. Thus, this study focused on the generation of an appearance examination chart background model of a structure using a UAV.

Compared with photography using a satellite or aircraft, a UAV-based aerial photographic survey is easier to set up with the required equipment and is more economical. In addition, a UAV-based aerial photographic survey can easily photograph hard-to-reach or unapproachable spots, and can be used widely because it can obtain data immediately. Consequently, UAVs are being increasingly used currently (Kim 2017).

(Lee 2016) investigated the asbestos cement slate roofs of a downtown area using UAV-based low-altitude, high-resolution aerial photography. (Lee 2015) recognized the limitations of traditional survey methods and investigated the changes in the coastline using a UAV. (Yun 2016) examined an optimal imaging technique using a UAV to remotely survey the growth of farm products. Similarly, the technique of utilizing a UAV can resolve the problems of traditional remote sensing, and numerous studies on this are being conducted in various fields.

3. CONSTRUCTING APPEARANCE EXAMINATION CHART BACKGROUND MODEL

3.1 Experiment outline and acquisition of aerial image

The study is aimed at constructing an appearance examination chart background model of a structure using a UAV. Among the structures, the building was chosen as the targets for performing aerial photography. Specifically, the Korean Medicine Building in the Samsung Creative Campus of the Daegu Haany University was selected as the study site. UAV-based aerial photography was conducted to collect the spatial information. General information of the study site is given in Table. 1

Table. 1 Overview of the study site

Classification	Content
Survey area	
Site	Hanuidae-ro, Gyeongsan-si, Gyeongsangbuk-do, Korea

The UAV used in this study is Inspire2, manufactured by DJI Co., Ltd. Its imaging sensor is Zenmuse X5S, built by the same company. General specifications of the UAV and its camera system are given in Table. 2

Table. 2 Specification of UAV

Model	Inspire2
UAV type	Rotary-wing
Flight altitude	2,500m (Max)
Flight time	27min
Flight speed	94km/h (Max)
Camera model	Zenmuse X5S
Camera resolution	4:3, 5280x3956 16:9, 5280x2970 20.8MP

The aerial photography was initiated on May 10th, 2017. Flight time was approximately 13 min, and 452 photographs were acquired. Some of the original images (raw data) captured are shown in Fig. 2

Fig. 2 Raw data by aerial photography

3.2 Spatial information to construct an appearance examination chart

Orthoimage and the digital elevation model (DEM), which are the spatial information required to construct an appearance examination chart of a structure, were established by utilizing the raw data presented in Section 3.1. In this study, the point cloud method that uses three-dimensional (3D) point group data was used to collect the spatial information. Generally, image processing employing the point cloud method can be described as shown in Fig. 3 (Lee 2016, Mendes 2015)

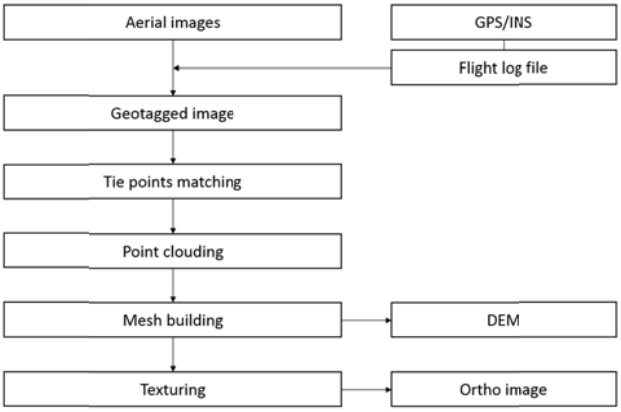

Fig. 3 Point cloud-based image processing

First, geotagging was performed, in which the GPS/INS location information recorded in the flight log files is input as the metadata of the captured images. Next, a tie point was extracted from the overlapping area of the geotagged images. Subsequently, the point group data were generated with respect to the tie point that was extracted by cross-referencing the overlapping area. Finally, based on the point group data as generated above, mesh formation was performed for the 3D modeling. Based on the 3D model, the DEM is constructed. By mapping the textures of the raw data onto the 3D model, a two-dimensional orthoimage can be obtained. The Fig. 4 below displays the spatial information of the study site established by the point cloud method.

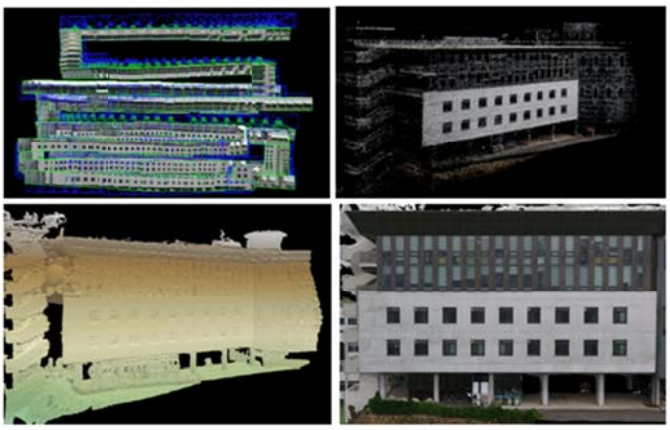

Fig. 4 Spatial information of the study site

3.3 Constructing the appearance examination chart background model

The aim of the study is to establish a background model of the appearance examination chart of a structure. To achieve this, Computer-Aided Design (CAD) based on the spatial information described in Section 3.2 was conducted to build the appearance examination chart background model. The model is as shown in the following Fig. 5

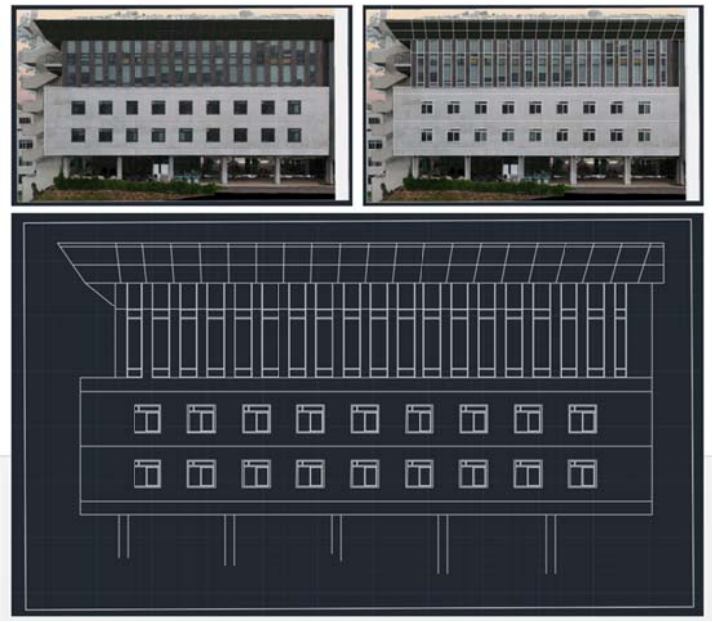

Fig. 5 Background model for appearance examination chart

4. CONCLUSIONS

Appearance examination and the construction of an appearance examination chart are important procedures, particularly in the inspection and diagnosis of a structure. However, traditional appearance examination charts are constructed based on the design plans, and such constructions are difficult when there is no existing design information. Therefore, in this study, a UAV was used to generate a background model for an appearance examination chart.

1. Aerial photographic survey was conducted using a UAV to collect the spatial information of the structures (orthogonal projections and DEM).
2. Based on the spatial information, the appearance examination chart background model was constructed.

Based on this study, it is expected that the method for developing a background model as proposed in this study will be of significant use in generating the appearance examination charts of aging structures that lack design information in the future. In addition, once the damage information is quantified and mapping studies are conducted in the future, the appearance examination chart together with the background model of this study is expected to be widely used in the inspection diagnosis of structures.

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