

# THE ANALYSIS OF ROAD SLIDE SLOPES USING RC HELICOPTER PHOTOGRAMMETRIC SYSTEM

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**KEY WORDS:** RC Helicopter, Aerial Photography, Point Cloud Data, Slide Slopes, Non-Contact Measuring

### ABSTRACT:

In this study, the results of slope data obtained with a non-contact measuring method of aerial photography by using the photogrammetric system of RC helicopter without approaching the slope collapsed by sliding, first, the photogrammetric system of RC helicopter allowed mobility, accessibility, and hovering flight so it was possible to obtain images of the areas that cannot be approached due to risk of collapse with the non-contact photographing method. Second, from the obtained images, it was possible to generate the three-dimensional spatial information in the form of point-cloud data regarding the collapsed slopes with the 3D image matching. This high-precision point-cloud data could be used as important positional data for safety of the collapsed slopes on roads. Third, this photogrammetric system makes it possible to obtain the high-precision information of the collapsed slopes in shorter time than the existing measuring technology, and the mean values were 0.056m in the x-axis direction, 0.082m in the y-axis direction, and 0.066m in the z-axis direction.

## 1. INTRODUCTION

In order to manage and maintain the existing slopes in designing structures such as roads, railways, watercourses, and dams in the area of land development, the slides that are inevitably opened, and the slopes that are already completed, two methods to construct the data of slopes are used: the existing survey method using total station and the latest method using laser scanner to obtain numerous point clouds. However, the former includes a method to approach collapsed slopes taking risks with actual measurement and interpolation and a method to indirectly obtain the data from collapsed slopes with no-target total station. However, they have the danger in approaching a collapsed slope and a problem with accurate data collection due to selectively obtaining the needed data. The latter is advanced equipment that is much used in construction, architecture, and cultural assets. Even though it can obtain

accurate and numerous point cloud data, it is expensive equipment inappropriate to be employed in actual field. Also, the equipment is large and heavy so it is difficult to move it. Therefore, in order to address these problems, this study aims to explain the method to obtain the data of slide slopes from aerial photos taken without approaching the collapsed slide slope by using photogrammetric system of RC helicopter, which is actively researched in South Korea.

## 2. RC HELICOPTER PHOTOGRAMMETRY SYSTEM

Regarding to RC helicopter photogrammetric system, recently as the width of demand on leisure activities is gradually increased along with the execution of the five-day workweek in

the domestic, the leisure cultures using the instruments which are enjoyable in the suburbs are being activated. Especially, as the cultures using the instruments controlled by radio are introduced along with the advance of computer simulation technology, these are being frequently utilized to photograph the bird's-eye-view in the area of engineering works, architecture and cultural properties, etc in the domestic also.

This RC helicopter photogrammetric system means the body of small helicopter controlled by radio, Gimbal Mount equipment making it possible to photograph as equipping the camera on the skid of the prop of helicopter and the system controlling to photograph the images that the captured scenes while the helicopter moves are photographed through the monitor on the ground like the Figure 1 and Table 1. The vibration or the rolling and the pitching, the reason of the tremor of camera, can be controlled with over 1/250 seconds as the shut speed of camera. Accordingly, this system photographed with the shut speed of camera of 1/4000seconds

Especially, RC helicopter in this study is seemed to be excellent at the aspect of economic efficiency, mobility and speed as it can be directly controlled after the piloting technology being learned within the short period along with the low expense of the plane and the advance of computer simulation technology. And as the body of helicopter used in this study is controlled by the radio, the control from the ground can be said to be unlimited but it makes it possible to photograph while keeping the flying altitude at the safe distance(about 200m) where the shape of plane can be confirmed with the eyes of controller. The stabilizer was equipped to help the convenience of photograph and to make the level flight at the high altitude by the beginners and the highly applied controllers also easy and makes the

stable images even at the high altitude available .



Figure 1. The Monitor on the Ground

Name	FREYA EVO 90 grade
Length	1,375 mm
Height	453 mm
Width	200 mm
Main rotor diameter	1,561 mm
Tail rotor diameter	270 mm
Gear ratio	7.9 : 1 : 4.77
Maximum payload weight	4,900 g
Maximum operation radius	200m(depends on flight conditions)
Endurance	approximate 10 ~ 20 minutes
Typical Applications	photogrammetry, surveying, cartography, archeology, environmental protection, architecture, civil engineering, marketing

Table 1. Specifications of RC Helicopter

RC helicopter used in this study was FREYA EVO 90grade of HIROBO Company. The shape and the specification are as per Figure 2 and Table 1. RC helicopter used in this study was lightly and solidly made with the high impact materials and propels the main rotor and the tail rotor with a Glow engine(14.95cc) like Table 2. The capacity of fuel was as much as it flies for about 10~20 minutes generally

And the proportional, the radio controller which can control the camera, is designed to be able to make the axis sloped in the above and the below(about 90°) and in the left and the right( 360°) in order to control the image photographed by the camera on the ground. And the Figure 2(b), as the take-off and landing equipment of helicopter, is the part of grate composed of the light aluminum and the small(35mm) camera and the digital video camera can be set on such camera installing bar to be used. and when the middle(6×4.5cm), panorama(6×12cm), DV(6mm 3CCD) and 35mm Film Movie, etc are setup, the helicopter with gasoline engine(26cc) as the plane of helicopter with the excellent capability may be selected.



Figure 2. Model of RC Helicopter

Name	O.S MAX 91SX H RING C-SPEC PS
Displacement volume	14.95 cc
BORE	27.7 mm
Stroke	24.8 mm
Output	3.1ps/16,000 rpm
RPM	2,000~16,000 rmp
Weight	581 g

Table 2. Specifications of RC Helicopter

And the proportional, the radio controller which can control the camera, is designed to be able to make the axis sloped in the above and the below(about 90°) and in the left and the right( 360°) in order to control the image photographed by the camera on the ground. And the Figure 3, as the take-off and landing equipment of helicopter, is the part of grate composed of the light aluminum and the small(35mm) camera and the digital video camera can be set on such camera installing bar to be used. and when the middle(6×4.5cm), panorama(6×12cm), DV(6mm 3CCD) and 35mm Film Movie, etc are setup, the helicopter with gasoline engine(26cc) as the plane of helicopter with the excellent capability may be selected.



Figure 3. Construction of gimbal mount

### 3. THE METHOD OF FIELD OBSERVATION AND ANALYSIS

To obtain the information on road cut failure slope, as seen in the Figure 4, this study investigated the slope of a part of STA. 2+720 of the 2nd section of works of Pusan-Ulsan Expressway, Gijang-eop, Gijang-gun, Pusan, South Korea which is the topography composed of the andesite belonged to the kind of volcanic rock and the inferior ground such as the weathering soil or the weathering rock, etc. and of which the 1st collapse was occurred from the sliding by localized heavy rain occurred from July to September in 2005 and the 2nd collapse was additionally occurred by localized heavy rain occurred recently.



Figure 4. Road Cut and Failure Slope

This study, as the method to obtain the information of the failure slope with such danger, performed the control survey of the slope by total station without target and obtained the images of failure slope through the hovering by the stabilizer at the altitude of about 40m as using RC helicopter photogrammetric system like the Figure 5.

And the centers of obtained 2 images were united to make 3D model as the first and then make the precise second model. After the characteristic points were minutely adjusted, the ortho 3D model was made as inputting the coordinates of control survey with total station without target, which was appeared as per the Figure 6.

And the Figure 7 is to be appeared in the form of CAD file as drawing the scope of failure slope and the cross section of each slope and the Figure 8 is to be appeared as overlapping it with the file of the Triangulated Irregular Network(TIN) along with the data, which appeared the method to obtain the information of failure slope.



Figure 5. The Hovering by the Stabilizer

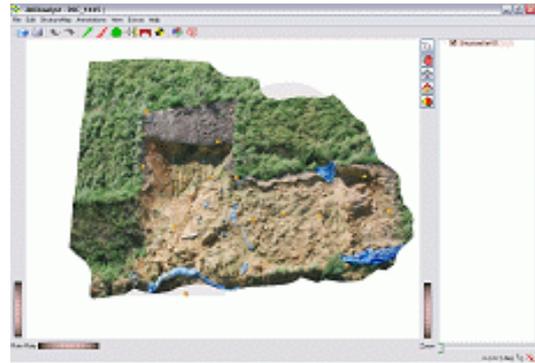


Figure 6. Ortho 3D Model

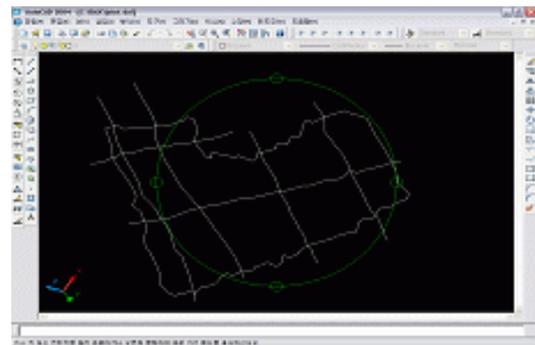


Figure 7. The Cross Section of Each Slope

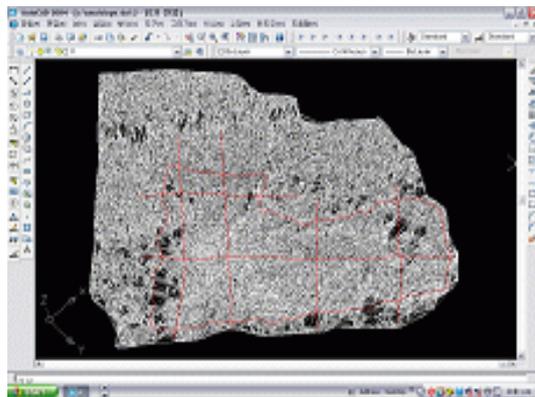


Figure 8. Triangulated Irregular Network

### 4. CONCLUSION

According to the results of slope data obtained with a non-contact measuring method of aerial photography by using the photogrammetric system of RC helicopter without approaching the slope collapsed by sliding, first, the photogrammetric system of RC helicopter allowed mobility, accessibility, and hovering flight so it was possible to obtain images of the areas that cannot be approached due to risk of collapse with the non-contact photographing method. Second, from the obtained images, it was possible to generate the three-dimensional spatial information in the form of point-cloud data regarding the collapsed slopes with the 3D image matching. This high-precision point-cloud data could be used as important positional data for safety of the collapsed slopes on roads. Third, this photogrammetric system makes it possible to obtain the high-precision information of the collapsed slopes in shorter time

than the existing measuring technology, and the mean values were 0.056m in the x-axis direction, 0.082m in the y-axis direction, and 0.066m in the z-axis direction.

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