3D model construction of nuclear power plants using UAV

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1. Introduction

On March 11, 2011, in Fukushima Daiichi nuclear power plant, some accidents, core melting and hydrogen explosions occurred by the Great East Japan Earthquake. Pollution simulation was already carried out by a particle model. But, 3D models of the nuclear power plant were not obtained at that time. In the future, 3D models are required for pollution simulations of nuclear power plant accidents each place. In this study, 3D model of Genkai nuclear power plant was constructed with UAV. Automatic navigation software was used for the UAV flight. UAV route maps were created under the condition of 300 m away from the site boundary with 150-m altitude. 3D models in RGB and IR were constructed from the aerial images.

2. Method

Litchi for DJI was used to create automatic navigation route maps around Genkai nuclear power plants. The created route map is shows in Fig. 2. In Civil Aeronautics Act, at the flight of UAV over nuclear power plants, the access within 300 m from the site boundary and more than 150-m altitude flight are prohibited. Then, the altitude was fixed at 150 m each. All routes were more than 300 m away from the site boundary. Phantom 4 professional was used in this study. The near infrared images were acquired by attaching IR 76 filter (760 nm transparent). The images were taken automatically every two seconds. PhotoScan was used to create 3D models. The setting for each step is shown in Table 1.

Fig. 1 Location of Genkai nuclear power plant

Fig 2. Automatic navigation route map

Table 1 PhotoScan setting for each 3D model

	Genkai	
	RGB	IR
The number of images	62	44
Alignment	High	High
High density-cloud	High	High
The maximum number of polygons	90,000	
Mapping mode of texture	Average	Average

Fig. 4 RGB 3D model of Genkai nuclear power plant

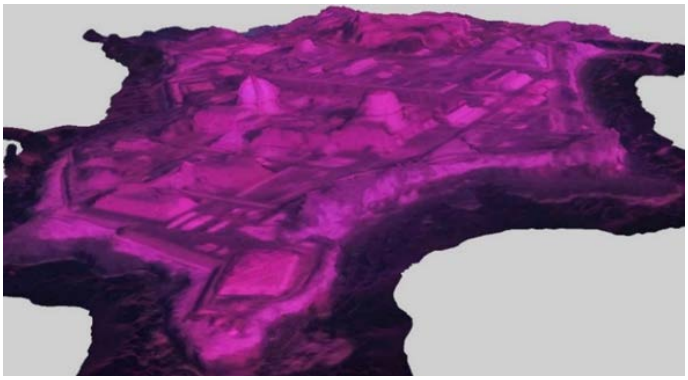

Fig. 5 IR 3D model of Genkai nuclear power plant

3. Results

3D model of Genkai nuclear power plant is shows in Fig. 4. The relief and arrangement of the structure were three-dimensional as actual Sendai nuclear power plant. IR 3D model of Genkai nuclear power plant is shown in Fig. 5. In both 3D models, since operating was automatic navigation, the shooting interval was kept constant. The lapping ratio was 90% or more. These flights finished only 15 minutes. Even when the altitude is 150 m and more than 300 m away from the site boundary to comply with Civil Aeronautics Act, if one round shooting of the nuclear power plant is taken, a higher quality three-dimensional model would be created.

4. Discussion

For RGB 3D model, accuracy form was constructed. While, for IR 3D model, some distortions were occurred bysuch as construction materials. In IR photogrammetry, vibration of images tends to occur during photography. In consideration of the limit of the battery, IR images were obtained by moving UAV, however in order to suppress the vibration, it is better to acquire IR images in a stationary state. This method would need necessary to consider compatible with battery consumption for construction of more accuracy IR 3D model.

5. Conclusions

Conventionally, UAV has a high-resolution image and high-precision GPS function. By incorporating automatic navigation into UAV, photogrammetry with a lap rate of 90% or more was carried out in a short time. In RGB 3D model, high accuracy 3D model was constructed by these methods. Furthermore, there is a function for automatic shoot at fixed intervals in UAV. Therefore, anyone can create a high-resolution 3D model by automatic navigation and automatic shooting easily. These technologies would be applied for a pollution simulation at nuclear power plant accidents. On the other hand, in IR 3D models, by the influence of vibration and exposure, the accuracy of IR 3D model was lower than RGB. More accurate 3D models would be constructed by applying the exposure correction and shooting in a stationary state.

References

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