APPLICATION OF UNMANNED AERIAL VEHICLE (UAV) IN LANDING SITE SURVEY

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Abstract: Landing Site Survey for submarine cable system is necessary to be conducted in the area surrounding the proposed beach manhole location to locate all natural and man-made features, and conventional topographic surveying technology s by surveyor to measure point by point is usually utilized during survey. With the development of technology, Unmanned Aerial Vehicle (UAV) technology has been widely used in mapping survey.
In this paper we brief present Landing site survey in a submarine cable system with the help of UAV technology for the first time, which is more cost-effective and faster data acquisition than traditional survey but with acceptable reliability. This paper focuses on successful experience of UAV application based on aerial images captured in landing site survey and production of point/line drawings for cable route planning and cable installation.

1. INTRODUCTION

Unmanned Aerial Vehicle (UAV) as a new platform has been broadly applied in agriculture, site inspection, and other areas associated with photogrammetry technology. Drone can capture data to generate point clouds, or othophotos and digital terrain models [1]. It is a safe and cost effective with less or no survey lines inshore/onshore, they are the potential tool relevant to seabed and topographic surveying [2].
This case study focuses on experience of UAV application in a recent delivered cable project, it is first project having the UAV result officially applied for topographic survey at submarine cable landfalls. More than 5200 aerial images for four landing sites were recorded.

2. DATA VALIDATION

We used UAV for trail in tandem with the traditional mapping survey firstly. Survey team produce a validation survey map of landfall survey, one drawing we did using the traditional topographic survey with a total station (Leica TCR803 Total station with reflector) and one is using UAV technology. Accuracy analysis shows UAV images photogrammetric measurements compared to mapping by total station have acceptable accuracy and spatial distribution of the data points (Figure 1).

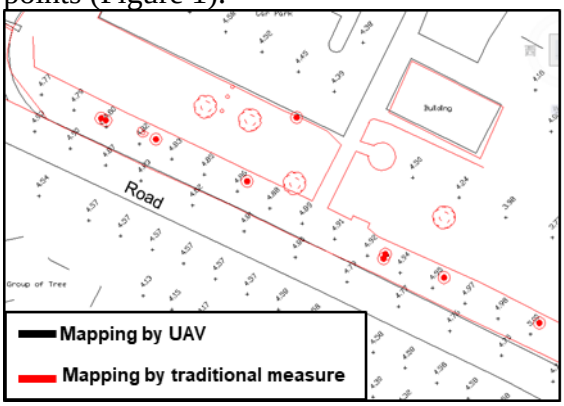

Figure 1. Mapping Comparison

3. DATA ACQUISITION AND PROCESSING

3.1 Equipment

The Phantom 3 Professional UAV aircraft was used to fly and obtain overlapping aerial photograph of landing area. The drone

camera with an effective pixels 12.4 megapixel sensor and camera lens with a focal distance of FOV 20 mm (Figure 2) [3].

Figure 2: UAV aircraft [3]

Prior to the commencement of UAV survey, to make sure high accurate of the images geolocation, Ground Control Points (GCPs) was established for geo-reference and quick check at the landing site. And their positions were obtained by using DGPS surveying and total station. Normally 8 to 10 GCPs were established within a survey area (e.g. five as control points, three point as check points should be set for an area 500m X 500m), all GCPs had a clear sky view without any obstruction (Figure 3).

Figure 3: One of Ground Control Point established on site

3.2 Photogrammetric images acquisition

After all GCPs are ready, a proper flight planning was established to determine ground coverage, flying height, overlapping, and estimate ground sample distance to confirm the precision of aerial photos [1]. Then actual images acquisition flight operation was carried out.

Pix4D Capture was used to make drone flight planning for optimal mapping and 3D modeling data. Images are recorded from 60m to 80m above ground level according to really condition of landing sites, with an overlap of over 5 images for every pixel. Camera is set to low ISO value - ISO 100, high shutter speed - 1/100 to 1/1000 sec. and focal length 3.6mm.

3.3 Data Processing

Geo-reference aerial photos are processed and matched between all the images automatically by Pix4D Mapping. The disabled images were deleted while false match between each other. Below is an example of matched orthomasaic images.

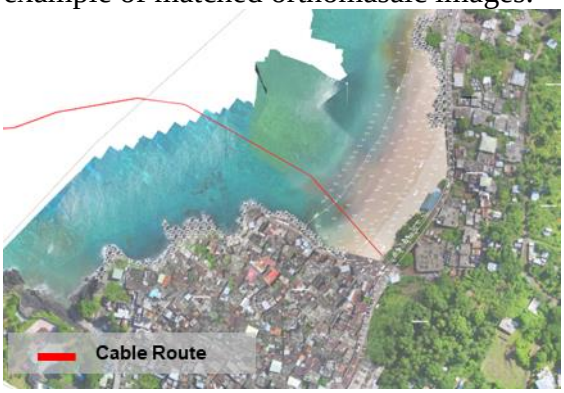

Figure 4. Example of orthomosaic images in one landing site

Positions of Ground Control Points are taken into account to provide geo-referencing. All the aerial photo will be input to Pix4D Mapping along with GCPs geolocation. Each GCP in each aerial photo was digitalized. The aerial image location will be adjusted after all GCPs were digitalized, finally all aerial photos were be combined into a Point Cloud Model (PCM) (Figure 5).

Figure 5: Example of 3D Point Cloud in one landing

Localization accuracy assessment of generated data was performed based on

ground control point errors. According to the quality report generated by the Pix4D Mapping, the following GCPs errors were observed, the mean error of about 0.1~0.2m in xy directions and less than 0.3m in z direction.

4. MAP PRODUCTION

Preliminary deliverable for UAV survey is geo-reference aerial photos which can give a seamless overview for target area. Since the aerial photo does not provide elevation data, therefore we will not apply aerial photo to digitalize features directly.

Line features were manually digitalized from the Point Cloud which can be generated automatically and export as DWG file (Figure 6). Manual digitalization is more accurate and easier to handle in such small area for topographic survey in cable industry. Map reference datum can be adopted easily subject to project requirement.

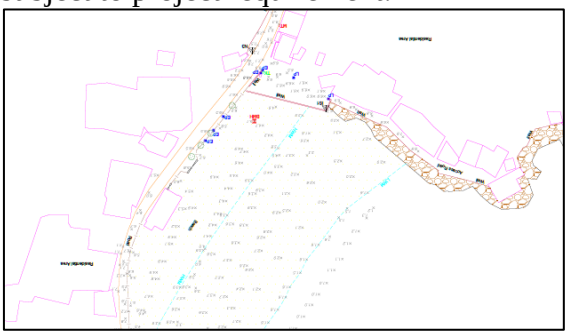

Figure 6: Line feature producing from PCM

5. CHARACTERISTICS OF UAV SURVEY

5.1 Efficiency

UAV survey with camera can provide thousands of points in short time while two experienced surveyors only can obtain positions of approximates 100~200 points per hour. Normally, it is need 2 days for one landing site mapping with traditional survey by two surveyor. With drones help, 1-2 hours spent on site to acquire aerial images. At least save 7 days for four landing site survey. It's an effective mapping technology, especial suitable for cable project with multiple cable landing sites.

Topographic survey mapping from images are produced 2 - 3 times faster than in the case of traditional surveying methods as most of data processing are running automatically. And it took surveyor short time to draw lines and points from aerial images, corresponding to 1-2 days survey map produced with measurements from total station.

5.2 Contactless and Safety

As we know, marine survey is a high risk and dangerous job, especially some remote and inaccessible area nearby surf zone. In this case, complex landing environments such as rocky cliff, coral reef, strong wave, and marshland along shore were experienced, where cannot be safely accessed. And some landing sites survey corridor are including private residential area with building, amount of restriction to access and blockage of direct eyesight if we use traditional mapping with total station. Hence, UAV technology make us safer in the same time full coverage of data in survey corridor with aerial images.

The characters of contactless and does not interfere with work processes in the mapping area offers a new though for topographic survey.

5.3 Convenience for Route Engineering

UAV technology are contactless and can clearly record the ground condition in margin of the land and sea, which minimize data gap in this area to a great extent. And even the existing in-service cables with articulated pipes within the survey corridor were recorded clearly by drone (Figure 7).

We used digital topographic map in form of AutoCAD sourced from images as a basis for route designs without any problems. Besides, ground geological condition and feature at submarine landfalls are visualized without missing any items benefit from the enhanced data coverage and high resolution aerial

images, cable route can be easily adjusted and optimized to avoid risk area.
The following cable installation of this case show that the topographic survey drawing by UAV supported all four cable landing delivery successfully without any different as traditional mapping.

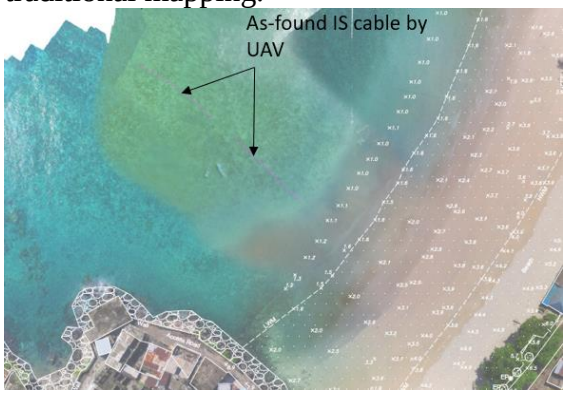

Figure7 As-found in-service cable by UAV

5.4 Permitting Issue

In recent years, many governments around the world have tightened their restrictions on drones and introduced relevant laws and regulations to control drones application.
Fortunately, this case did not need to apply the aerial permit in all relating countries. But it's a crucial thing that aerial permitting should be consideration in the implementation landing site survey with drones.

5.5 Limit of UAV Application in Landing Site Survey

UAV have obvious advantage of reduce human infield working time, but it have limit in some scenarios such as the area cover by tree, obstruction or access point, significant reference, and underwater survey data. To improve the data quality and coverage, different flight directions was made to overcome this issue if area cover by obstruction. Additional information to obtain underwater survey data and reference points from the traditional method were taken by the Total Station.
In other side, data acquisition is quiet easy and fast, but in order to ensure quality and accuracy, interpretation the aerial images need more experienced surveyor compared to traditional measurement.

5.6 UAV Application for bathymetric survey

We did not use UAV for bathymetry survey in this case, but it already has some shallow water sensor with compact and lightweight LiDAR system can be installed on UAVs that can carry out bathymetric surveying task as new technology are developing rapidly [4].

6. CONCLUSION AND FORESEE

Experience of UAV mapping in this case show that it is a fast data acquisition alternative to deploy landing site survey, especially it has obvious advantage and can save lot of time for multiple cable landings. Meanwhile, it can enhance to the data coverage with acceptable accuracy to support submarine cable delivery.
There are few changes in survey methods in submarine cable industry in recent decades. This case is a try to allow new technology in optimising our survey efficiency.

7. REFERENCES

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