

# **Too Detail to Survey!?**

## **UAV, Photogrammetry and Remote Sensing for Construction Projects**

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**Key words:** UAV, Drone, Photogrammetry, Remote Sensing, Construction, Construction Management, Project Management

### **SUMMARY**

Although Unmanned Aerial Vehicle (UAV) has been developed for decades, it has only been broadly used in different aspects for the past few years. Nowadays UAV is no longer a military weapon only but also an entertainment as well as a productive tool for many professions such as film making.

In construction industry, the equipment can be used for site inspection, progress photo, mobile mapping, topographic survey, volumetric calculation, project management, etc. The result would also be integrated into other modeling platforms for further application. Due to relevant breakthrough technology, the operation and processing time of photogrammetry would be greatly reduced comparing to traditional surveying methods. Thanks to the endeavor of hardware and software developers and academic institutions, UAV and relevant technologies becomes more user-friendly, time-saving and cost-effective for surveyors as well as other construction professionals.

Mr. Lit-yin LAM have implemented aerial and close-range photogrammetry to ordinary projects in order to accelerate the pace of land and engineering surveying and enrich the whole surveying field. Mr. LAM has been invited by many professional organizations as speaker for the issue. In this paper he would share experience of using UAV and relevant technologies in Hong Kong for various projects enhancing the effectiveness of project management.

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### **1. INTRODUCTION**

Traditionally engineering surveyor conducts surveying work by a point-to-point approach. Although surveying equipment has been developed from totally manual operation (e.g. chain and tape measurement) to semi or total automatic measurement system (e.g. theodolite plus EDM, automatic TotalStation, etc.), the measurement pattern is basically unchanged.

However, revolution has come. Benefited from to the endeavor of hardware and software developers and academic institutions, technology of remote sensing (including photogrammetry, laser scanning, LIDAR, etc.) has significant grown as well as their application. Window of new market is opened for land surveying professional (named Engineering Surveyor here). New application and workflow of relevant technology and knowledge is under discovering.

### **2. LATEST REMOTE SENSING TECHNOLOGY**

#### **2.1 Photogrammetry**

Although Unmanned Aerial Vehicle (UAV, or called Drone) has been developed for military purpose for decades, it has only been broadly used in different aspects (such as film making, individual entertainment, surveying, safety, security, etc.) for the past few years. Many manufacturers (such as DJI, YUNEEC, DroneDeploy, etc.) have entered the market, production cost was lowered, software for different applications have been developed (such as Propeller, Pix4D, Skyward, etc.) .... are the reason of the widespread usage of UAV. Nowadays UAV is no longer a military weapon only but also an entertainment as well as a productive tool for many professions such as film making.

#### **2.2 Laser scanning**

Today laser scanner has been employed for many purposes other than construction and surveying. Criminal investigation for police, insurance evidence for underwriter, historical record for researcher are all using laser scanner for capturing shapes of objects, buildings and terrain rapidly. Although initial cost is still high, user would benefit from its new function and easier operation process.

#### **2.3 LIDAR**

LIDAR here means those remote sensing technologies using airborne or satellite equipment. Latest equipment could measure a wide range of objects by ultraviolet, visible or near infrared light. Product resolution could provide terrain up to 0.1-meter. This enhance the efficiency and

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effectiveness in town planning, regional development project and large scale geospatial-related research.

### **3. NEW WORKFLOW FOR SURVEYING AND CONSTRUCTION**

#### **3.1 Experience in Hong Kong**

##### **3.1.1 Tender stage**

Engineering surveyor was seldom involved in tender team. General topographic drawing would be the only resource that architect and design engineer could refer to. Nowadays detail survey result in form of 3D point cloud, Mesh, orthophoto and animation of target site could be obtained by using different remote sensing technologies.

Travel time and cost for design and tender team is reduced a lot, and detail site condition could be study and review whenever they need. Preliminary investigation would be conducted with measurement to the 3D model in CAD, BIM and/or GIS platform. Members of the team in different location could discuss and exchange idea by online platform sharing the same geospatial material. Quantity surveyor and/or cost engineer would have a more precise estimate in budget by reviewing any geospatial/dimensional matter from the model.

If BIM approach is required as a technical issue to the tender, BIM consultancy/designer could commence the design based on the detail terrain model. Underground utility and/or geologic information would be consolidated with the terrain model providing a whole picture for designer. Moreover, engineering surveyor would then advise the best surveying solution (including survey and IT-related matter) to the project team.

##### **3.1.2 Pre-construction stage**

Having gained the project, the team would develop detail design, commence sub-contracting arrangement, etc. Land surveying team would conduct any further surveying work if necessary. If BIM technology is employed, project team would conduct virtual construction process for reviewing site planning, developing detail method statement for approval, phasing the construction activities, etc.

Engineering surveyor plans the survey control network and form his/her survey team. Preparation for relevant remote sensing solution should also be commenced. For example, application of flight permit would be submitted if UAV will be used in later stage of the construction. Training of laser scanning operation would be arranged before commencing any field work.

If geospatial information and survey result would be shared among stakeholders (including client, main contractor, sub-contractor, and public), relevant IT support would be arranged. Right of data access, format of survey record, storage capacity, etc., are issues that should be handled among engineering surveyor together with others.

### 3.1.3 Construction stage

Construction activity would be commenced under relevant approved or agreed method statement. Engineering surveyor conducts geospatial control by traditional land surveying method or latest remote sensing approach, from checking and preparing design information, setting out on site, and take as-built information.

3D point cloud model (by photogrammetry or laser scanning) would be a good means for as-construction checking and progress monitoring. Visualization of survey information (by animation or 3D pdf) could be displayed and understood by everyone. Dispute among working parties could be reduced, or be solved as soon as possible. Progress would then be enhanced, re-work could be eliminated. Such detail survey result would also be a good evidence for any claim procedure and could be kept for a long time.

Nowadays Hong Kong public concerns the progress of infrastructure project and relevant cost control. The mentioned visualized survey result could be shared to stakeholders enhancing transparency through online platform if necessary.

### 3.1.4 Hand over stage

Builders would report their work-done to client by transferring the physical as-constructed product (infrastructure, building, roadwork, etc.) together with huge of documents (including as-constructed CAD file, financial and/or claim record, quality report, operation manual, etc.). Representative of client (they would be Facility Manager, Operation Team, Property Management Agency, etc.) would check all the information referring to contract specification and standard.

Besides of the huge of documents to be checked within a short hand-over period, many representatives have not construction knowledge or background. In Hong Kong, contractor would follow up any defect during the maintenance period that would be normally one year after handed over. However, dispute would always be reported from operation team and contractor. They usually argue about progress of defect fixing and relevant responsibility.

By using latest remote sensing technology, all parties would conduct discussion based on the detail as-constructed surveyed record which could be presented in a 3-dimensional or graphical way (e.g. using video or animation to show the surveyed point cloud). Non-construction professionals would understand the video content easier than a traditional working 2D drawing. Hand over progress would not only be increased, but also reducing dispute.

If BIM is employed for a project from design stage to hand over stage. Government, client and operation team would check the quality of as-construction work directly by comparing the design model and 3D point cloud. If as-built BIM is generated together with operation information for operation purpose, maintenance cost would be, theoretically, reduced.

### 3.1.5 Operation stage

Construction professional as well as investor are interested if maintenance cost could be reduced by introducing BIM for operation. Repair cost and information would be retrieved from as-constructed BIM model and/or other integrated facilities management system. For instance, supplier list and latest quotation would be stored, updated and recalled whenever material is out-of-stock. 3D survey model could be used for estimate if any maintenance work is needed. As-constructed model could also be updated by replacing any modified portion.

Visualization would also help operation team in, for example, explaining situation of the building and reason of maintenance. Maintenance contractors would provide their quotations based on precise information and estimation. Property owners or investors would review cost easier. In Hong Kong, collusive tendering is a hot social issue in the past few years. Government and professional organizations are looking for a more transparent way for tendering. Visualization of survey record by remote sensing technology would be a good way out.

#### **4. SUMMARY**

Development of remote sensing generates many opportunities to land surveying professional. We have different problem and challenge in Hong Kong construction industry including lack of labor, slow progress of financial approval from Legislative Council, social argument on many development projects, etc. Construction professionals (including architect, engineer, surveyor, etc.) need to solve these problems innovatively.

Using remote sensing technology (including photogrammetry, laser scanning, etc.) in engineering surveying process would enhance our productivity and efficiency. Mass geospatial information could be collected by fewer manpower and shorter working period. Moreover, detail point cloud data has discovered new area of service since traditional point-to-point measurement could not handle.

For the benefit of our members as well as the whole society, HKIES would continuously explore new application of the technology and exchange idea with other construction professionals.

#### **CONTACTS**

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