Application of 3D Modeling in Real Estate and Land Integration Project

Qi Han 1,a, Xitun Yuan1,b, Xiongfei Yang1,c, Hang Zhang 1,d, Yongxiao Wen1,e
1Department of Surveying and Mapping Engineering, Xi'an University of Science and Technology, Xi'an City, Shaanxi Province, 710000, China
aemail:772627693@qq.com,bemail:1105231602@qq.com,cemail:346838061@qq.com,
demail:982743778@qq.com,eemail:1728061142@qq.com
*Corresponding author`s e-mail: hq1315@dingtalk.com

Abstract: With the development of science and technology, surveying and mapping technology has also advanced by leaps and bounds. More and more people in related industries have begun to pay more attention to the application of drone tilt photogrammetry to the surveying and mapping industry, which has greatly improved the progress of surveying and mapping projects. This photography technology has gradually become an indispensable part of the surveying and mapping industry due to its advantages of speed, efficiency, flexibility, and low cost. This article is aimed at the integration of premises and land project, using a drone platform equipped with 5 lens cameras and shooting from 5 directions at the same time, that is, through 1 vertical shooting lens and 4 tilting lenses to obtain ground surface images, to achieve a large overlap of multiple angles. For viewing angle, the requirement for overlap is that the heading overlap is at least 60%, and the side overlap is 30%. This article uses ContextCapture Center Master software to perform three-dimensional modeling of the acquired images and obtain orthophoto results. The three-dimensional model is loaded into the EPS software for collection. The buildings, eaves, balconies and other buildings in each parcel of land are collected, and they are finally obtained. This technology greatly improves the work efficiency of the real estate integration project.

1. UAV tilt photogrammetry technology
Tilt photogrammetry is a very mature technology that has been developed in the past ten years. It breaks through and overcomes the shortcomings of traditional orthophotogrammetry. The drone platform is equipped with 5 lens cameras and shoots from 5 directions at the same time, and expressly obtains surface images efficiently, which truly reflects the objective conditions of the ground surface and meets the various needs of the real estate and land integration project. Since in the integration of premises and land, the UAV is flying at an ultra-low altitude, the image data obtained has ultra-high resolution, which is of great value for the integration of premises and land.

Tilt photogrammetry technology is a high-tech technology that is widely used in all walks of life. Based on the basic premise of UAV aviation technology, it is equipped with a multi-lens tilt camera to conduct rapid surveying and mapping of small areas. Compared with traditional ground surveying and mapping, it has a high degree of automation and saves manpower, material resources and costs.

2. Survey area
This article uses a five-lens UAV to fly in a small area of Lianzhuang Village, Qinghua Town, Zhouzhi
County, Xi'an City, Shaanxi Province. Zhouzhi County is part of Xi'an City, Shaanxi Province. Zhouzhi is named after "mountain song is 直, water song is 厌". It borders the Qinling Mountains in the south, the Weishui River in the north, and the mountains and rivers. It is known as the "Golden Zhouzhi". It is the west gate of Xi'an. The county has a total area of 2,974 square kilometers, of which mountainous areas account for 76%.

3. **3D modeling process**

The 3D modeling process includes image control point layout, image control point measurement, UAV route planning, oblique image acquisition, internal data processing, and accuracy detection.

![](image)

**Figure 1** Office data processing flowchart

3.1. **Layout of image control points**

The image control points are arranged in the measurement area. In order to improve the accuracy, the image control points are arranged at a distance of 80 meters. According to the above requirements, a total of 44 image control points are arranged in the survey area.

3.2. **Image control point measurement**

For the image control points in the measurement area, RTK is used for measurement.
3.3. **UAV route planning and oblique photography acquisition**

This article uses DJI M600pro drone equipped with a five-lens camera. Find the survey area on the Aowei map, draw the scope of the survey area, transmit the range to the drone's tablet, automatically plan the route, set the camera interval, flight height and other parameters. The route design is laid in a straight line, parallel to the boundary of the photographing area, to ensure that the first and last route can cover the survey area. Make reasonable planning in the map software, such as the setting of the flying height, the degree of overlap and the tilt angle of the camera, to ensure that the requirements can be obtained.

3.4. **Office data processing**

3.4.1. **Data preprocessing**

First export the pos data of the DJI M600pro UAV flying in the survey area, so that the pos corresponds to the image one-to-one, and use the software to import the pos into the image until the five perspective images are written in the longitude, latitude and altitude.

3.4.2. **Data processing**

1. Taking ContextCapture Center Master as an example, the newly-built project loads the above processed images into it, and the project agent UNC path and task sequence directory of the newly-built project are changed to the location of the newly-built project. Change the task sequence directory in ContextCapture Center under Bentley. Submit the aerial triangulation in the CC software, turn on the engine and start the phase-free aerial three.

2. After the first step of the phase-free air three is over, we import 44 image control points in the CC software and perform puncture points. Each phase-controlled point punctures three orthophotos, and the point is punctured. The position is the place where the virtual and real inside the image control point is combined and the image with the image control point in the middle is selected.

3. After the puncture point is completed, return to the summary to submit the aerial triangulation, and turn on the engine to do the aerial triangulation with image control points. After the air three is over, open the 3D attempt in the CC software to check whether the image matching is qualified. If it is not, it is purposefully punctured on the unmatched images until the matching of each image is completed. Adding POS data to the image matching can assist the matching of multi-view images, roughly obtain the outer orientation elements of the original image, and perform rough matching with related algorithms, which can eliminate some mismatched points, so that accurate matching can be performed again. Figure 2.
(4) Before making a three-dimensional model, it is necessary to check the accuracy of the aerial three, and check the 3D view of the aerial three, the level and elevation accuracy of the image control points. Air triangulation accuracy inspection is carried out in accordance with the "Digital Aerial Photogrammetry Air Triangulation Specification". Generally, inspections are carried out from two aspects: the image side and the object side. The most common accuracy check of the object side is to compare the coordinate difference between the encrypted point and the check point. The accuracy indicators of the air three calculations generally include whether there is a deviation, whether the situation is reasonable; whether the connection point is correct, and whether there are delamination and fault phenomena in the air three. The statistical results show that the errors of the three-dimensional dense point relative to the actual measured coordinates and elevation of the checkpoint are less than the specified plane error and elevation error, indicating that the three-dimensional model established by this method meets the requirements in terms of geometric accuracy. As shown in Form 1.

Form 1 Image control point accuracy

| Control Points Errors |
|------------------------|
| Name | RMS of Reprojection Error [pixels] | RMS of Distances to Rays [meters] | 3D Error [meters] | Horizontal Error [meters] | Vertical Error [meters] |
|------|----------------------------------|---------------------------------|----------------|--------------------------|------------------------|
| lzxd8 | 0.8 | 0.02908 | 0.00508 | X: -0.00364; Y: -0.00311 | -0.00311 |
| lzxd6 | 1.14 | 0.02029 | 0.00824 | X: -0.00246; Y: -0.00786 | 0.00009 |
| lzxd4 | 1.42 | 0.02601 | 0.00917 | X: 0.00885; Y: 0.00074 | 0.0023 |
| lzxd2 | 0.9 | 0.02605 | 0.00694 | X: 0.00079; Y: -0.00688 | -0.00053 |
| lzxd3 | 1.95 | 0.01915 | 0.01754 | X: 0.00799; Y: 0.01553 | 0.00158 |
| lm | Value 1 | Value 2 | Value 3 | Value 4 | Value 5 | Value 6 |
|----|---------|---------|---------|---------|---------|---------|
| lzd1 | 1.25 | 0.02438 | 0.01091 | X: -0.00953; Y: -0.00433 | 0.00309 |
| lzd5 | 0.81 | 0.01375 | 0.00258 | X: -0.00039; Y: 0.0002 | 0.00254 |
| lzd7 | 1.58 | 0.02709 | 0.01659 | X: -0.00646; Y: 0.01469 | 0.00419 |
| lzd9 | 0.8 | 0.018 | 0.00384 | X: -0.00085; Y: 0.00295 | 0.00231 |
| lzc10 | 1.53 | 0.02379 | 0.01805 | X: 0.01149; Y: 0.01279 | 0.00549 |
| lzc13 | 0.8 | 0.01707 | 0.00732 | X: -0.00074; Y: 0.00666 | -0.00295 |
| lzc11 | 1.26 | 0.01822 | 0.01853 | X: 0.00057; Y: 0.00106 | 0.01849 |
| lzc14 | 1.17 | 0.01682 | 0.01463 | X: -0.00196; Y: 0.00971 | -0.01076 |
| lzc12 | 0.75 | 0.01494 | 0.00545 | X: -0.00338; Y: -0.00297 | -0.00307 |
| lzc18 | 0.88 | 0.01273 | 0.00746 | X: -0.00229; Y: -0.00086 | 0.00705 |
| lzc22 | 1.22 | 0.02382 | 0.0155 | X: 0.01027; Y: -0.00105 | -0.01156 |
| lzc16 | 1.1 | 0.01325 | 0.01199 | X: 0.00725; Y: 0.00679 | -0.0067 |
| lzc21 | 1.2 | 0.02824 | 0.0133 | X: -0.00424; Y: -0.01071 | 0.00664 |
| lzc17 | 1.04 | 0.01748 | 0.01016 | X: 0.00958; Y: -0.0033 | -0.00069 |
| lzc20 | 0.63 | 0.02346 | 0.0023 | X: -0.00107; Y: -0.00161 | 0.00125 |
| lzc15 | 0.93 | 0.01917 | 0.0082 | X: 0.00702; Y: 0.00042 | -0.00422 |
| lzc19 | 1.06 | 0.02306 | 0.01377 | X: 0.00923; Y: 0.01002 | 0.00199 |
| lxx6 | 0.96 | 0.01944 | 0.00993 | X: -0.00497; Y: -0.00816 | -0.00268 |
| lxx5 | 0.79 | 0.01937 | 0.00657 | X: -0.00523; Y: 0.00312 | 0.00246 |
| lxx2 | 1.68 | 0.02484 | 0.02092 | X: -0.00487; Y: -0.01712 | 0.01101 |
| lxx4 | 1.75 | 0.02689 | 0.01969 | X: -0.01096; Y: -0.01631 | 0.00128 |
| lxx1 | 0.94 | 0.01938 | 0.0098 | X: -0.00923; Y: -0.00287 | 0.00165 |
| lxx3 | 0.95 | 0.01414 | 0.01212 | X: 0.00161; Y: -0.00288 | -0.01166 |
| lxmjp14 | 1.72 | 0.02683 | 0.02755 | X: -0.00858; Y: 0.00795 | -0.02494 |
| lxmjp7 | 1.92 | 0.02736 | 0.03242 | X: -0.00535; Y: 0.00512 | -0.03157 |
| lxmjp9 | 1.54 | 0.02042 | 0.02284 | X: -0.01054; Y: 0.00094 | -0.02024 |
| lxmjp5 | 0.8 | 0.01719 | 0.00867 | X: 0.00038; Y: 0.00322 | -0.00804 |
| lxmjp8 | 0.68 | 0.02024 | 0.00387 | X: -0.0003; Y: -0.00386 |
| lzxmjp6  | 0.63 | 0.01835 | 0.00498 | X: 0.00235; Y: -0.00274 | 0.00344 |
| lzxmjp3  | 0.89 | 0.02031 | 0.00901 | X: 0.00706; Y: 0.00341 | -0.00444 |
| lzxmjp4  | 0.96 | 0.01443 | 0.00912 | X: -0.00293; Y: 0.00799 | 0.00327 |
| lzxmjp2  | 0.91 | 0.02564 | 0.01036 | X: -0.0006; Y: -0.00425 | -0.00943 |
| lzxmjp1  | 0.78 | 0.01866 | 0.00747 | X: 0.00416; Y: -0.00223 | 0.00578 |
| lzxmjp15 | 1.07 | 0.03578 | 0.02149 | X: 0.01542; Y: 0.01076 | 0.01039 |
| lzxmjp13 | 3.5  | 0.042  | 0.06033 | X: -0.01186; Y: -0.0027 | -0.05909 |
| lzxmjp12 | 0.88 | 0.01514 | 0.01049 | X: 0.00129; Y: -0.00097 | -0.01037 |
| lzxmjp14 | 2.53 | 0.0438  | 0.04285 | X: 0.01252; Y: -0.00113 | 0.04096 |
| lzxmjp10 | 1.84 | 0.02982 | 0.03088 | X: -0.00529; Y: -0.00681 | 0.02965 |
| lzxmjp11 | 3.87 | 0.04735 | 0.07517 | X: 0.00909; Y: -0.01177 | 0.07368 |
| Global RMS | 1.44 | 0.02408 | 0.02107 | X: 0.00687; Y: 0.00732 | 0.01852 |
| Median   | 1.06 | 0.02031 | 0.01049 | X: -0.0006; Y: -0.00086 | 0.00128 |

(5) Create a new reconstruction project in the outline, and start to make a three-dimensional model according to Kongsan. Figure 3 shows the results of the three-dimensional model of Lianzhuang.

![Figure 3 Three-dimensional model](image)

(6) Open the EPS software, load the OSGB format 3D model into the EPS software, and collect the base map of Lianzhuang Village based on the combination of the 3D model and the point cloud. As shown in Figure 4.
4. Conclusion
Research on the establishment process of the UAV 3D real scene model shows that the use of UAV oblique photography to obtain images, combined with high-precision ground control points, can fully automatically generate high-precision city 3D models under certain circumstances, and the produced models have good integrity, seamless connection of ground objects, real scenes, and realistic textures. It is a cost-effective method for producing 3D urban models. The application of drone tilt photogrammetry technology in the integrated cadastral survey of rural premises perfectly solves the shortcomings of traditional aerial surveys of low efficiency, long period, high cost, and poor authenticity. The disadvantage is that the 3D model built with 3D modeling software cannot be singularized. With the advent of the era of artificial intelligence, it is believed that drone tilt photogrammetry technology will be more accurate and smarter. To better serve the basic industries of surveying and mapping, such as highway surveying, reservoir and dam monitoring, mine surveying, and low-altitude remote sensing data acquisition.

References
[1] Zhao Wenquan. Application of UAV aerial survey in topographic surveying and mapping[J]. Real Estate, 2019(17):22.
[2] Chen Xiangnan. UAV tilt photogrammetry technology and its application[J]. Inner Mongolia Coal Economy, 2018(9):55-56.
[3] Liu Kaihong, Kang Yali. The application of oblique photogrammetry in the rural cadastral survey of real estate and land[J]. Jiangxi Coal Science and Technology, 2019 (01).
[4] Liu Zengliang. Research and practice of large-scale urban real-world 3D modeling technology based on oblique photography [J]. Surveying and Geospatial Information, 2019 (2): 42 (2).
[5] Ou Jun. Research on data processing technology of UAV aerial survey in-house industry [J]. Science and Technology Information, 2017, 15(27): 3-4.