

# LOW-ALTITUDE UNMANNED AIRSHIP PHOTOGRAMMETRY SYSTEM

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## ABSTRACT:

Constrained by the satellites orbits, Satellite Remote Sensing is difficult to achieve timeliness requirements. General aerial manned aircraft Remote Sensing is always delayed by the bad weather. Compared with Unmanned aerial vehicles, unmanned Airship can fly more lower and slower and you can get more clearer image. So it is more suitable for large scale mapping and other engineering requirements. This article mainly describes the basic components of the low-altitude unmanned airship photogrammetry systems, the process to implement the tasks of surveying and mapping and the wide applications of the system.

## 1. INTRODUCTION

Currently it is very mature for general aviation photogrammetry by satellite and manned aircraft remote sensing. However, to the constraints of the satellites orbits, it is difficult to achieve a timely demand. The loopholes obscured by cloud cover greatly reduced the ability to provide results. Due to the heavy clouds especially in the south of China, general aerial manned aircraft photogrammetry is difficult to complete tasks. Therefore, in recent years, the unmanned aerial vehicles and unmanned airship low altitude photogrammetry system have been developed rapidly. Unmanned aerial vehicles and unmanned airships can fly at low altitude under the clouds with no need of the airfields for taking-off and landing. With the merits of low cost and flexible use, they can be distributed to the nation conveniently. By contrast, airship can fly more lower and slower to obtain more clearer image. Thus it is more suitable for the scattered tasks in small towns, construction sites and the villages such as large scale mapping.

Unmanned airship can fly very low with safe flight of 100 meters high. It can also fly very slowly at a speed of 40 kilometers in an hour. Therefore, it can get high resolution images to achieve high precision photogrammetry than any other aircraft.

According to the Low-altitude unmanned airship Photogrammetry system developed by Chinese Academy of Surveying and Mapping and Beijing Ceke Spacial Info-tech Co. Ltd., the paper introduces the composition, operation and applications of the system combined with the project of "Dynamic remote monitoring use unmanned aircraft vehicles high-resolution images in 4 new town in Shenzhen City".

## 2. THE BASIC COMPONENTS OF LOW-ALTITUDE UNMANNED AIRSHIP PHOTOGRAMMETRY SYSTEM

The Low-altitude unmanned airship Photogrammetry system is composed of unmanned airship flying platform, imaging sensors and data processing systems.

Flying platform consists of an unmanned helium airship, Autopilot (flight control system), ground communications

systems, and the Global Positioning System. The first three parts are to ensure safe delivery platform, imaging sensors for impact along the air route to obtain the provisions of the mandate. The last component is used to obtain precise geodetic coordinates of photography sites to achieve high-precision

control of the goods on the ground mapping tasks. Therefore, GPS can either be the DGPS of the ground GPS base stations or be a single point positioning GPS.

The system has a special combination of wide-angle digital cameras composed of four digital cameras constitute which is very useful for low-altitude missions. Because the scope of a single camera imaging on the ground is generally not more than a high measure of freedom, while the combination of camera is imaging range can be extended four times, which not only can improve efficiency, but also can improve the three-dimensional image-based high ratio, thereby enhancing the height measurement accuracy.

Using the system to perform low-altitude unmanned airship Photogrammetric Survey typically includes three process. Firstly, making a flight plan according to mission requirements and airship conditions. Secondly, sending the airship equipment to the area for flying and imaging. Thirdly, processing the acquired image data to produce DEM and DOM and large-scale Photogrammetric Survey.

### 2.1 flying platform

The FKC-1 type manless driving helium airship, is developed by Chinese Academy of Surveying and China Special Vehicle Research Institute, specially used in low-altitude Photogrammetric. The airship has remote control platform, programmed flying controller, chain of conduction and supervisory control system on the ground, mooring tower and helium Recycling equipment adapt to fieldwork and gas cartridge.



Figure1 FKC-1 Unmanned Airship

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The stable proper soft hardware union platform, realized stable platform light Miniaturized Size , the control system of the flying platform includes ground control system , the image transfers system and charges board swiftly.

## 2.2 Imaging sensor

The combined wide-angle low altitude camera system weight 15 kilograms, To meet the light and small unmanned airships and unmanned aerial vehicles load requirements.

The airship is 18 meters long , 4.5 meters of diameter , 180 steres volume ,designed loading is 15 kilograms,the altitude capability is 2000 meters , 40-70 kilometres navigational speed, 3 hours of cruise duration , the maximum wind resistance grade-6. shows in figure1.

Verified by the practice of the projects, unmanned airships with low-altitude camera system can achieve 10 cm resolution images with the 300 meters of flying height and 5cm-resolution images with the 300 meters of flying height.

While the airship goes highly 300 meters,Each picture covers floor area are 600 \* 600 square meters . Every hour s the area will be 20 square kilometers.

Adopt combined four cameras wide-angle digital camera system. 4 shows in Figure 2.

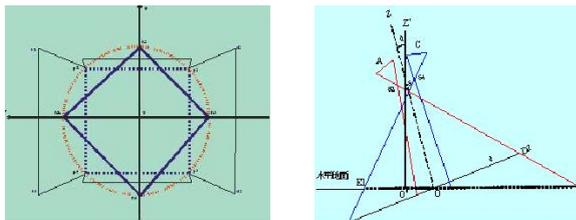


Figure 2 Combined wide-angle low altitude camera

2.2.1 **Constitutes of LAC:** 1.Combined wide-angle low altitude camera;2.Time difference control system; 3.Steady platform shows in Figure 3



Figure 3 imaging principle of LAC

2.2.2 **Combine four cameras** to achieve wide-angle for raising elevation accuracy :1.A combination of four special wide-angle cameras - increased height measurement accuracy;2.Self-calibration for combined cameras;

2.2.3 **Soft steady platform to acquire high definition images;**1.Soft steady platform to acquire high definition images;2.Comparison with single camera show the advantages:

camera type	one camera	light small combined digital camera
largest image frame	4368X2912	11750x5504
Image field angle/°	72X52 124X100	124X100
focal length/mm	24	24

Table 1 camera with a single camera comparison

## 2.3 Fly control software system

Fly control software system includes the airship part and the ground station part.Adopt to route design, autonomous navigation

## 3. PRINCIPLES OF AIRCRAFT FLIGHT PLAN

Flight plans is to solve the data acquisition to facilitate data conversion, data standardization, data visualization application problems.

### 3.1 reconnaissance

Use map or remote sensing data , location the area, get longitude and latitude use hand held GPS,. Know local landform , the climate , the weather , air humidity etc. at the same time , lay on visibility regards , air current change no intense date and time section to the full.

### 3.2 route data Visualization

For route planning as far as possible the extension of local wind direction parallel to the direction of the monsoon, or common planning course to avoid the strong winds interfere with flight airship lateral posture, affecting the quality of shooting.

After the system requirements for data conversion, in the flight control software Squadron routes generated graphical visualization, the main route-use conversion data generation graphical interface in the corresponding regions with the corresponding figures overlay maps to check whether the aerial route design requirements and, if necessary, but also in some of the key points are added to GPS points, to further check the design of routes, accuracy and security.

### 3.3 Sensor selection an Planning Altitude

Use LAC in Residential area or mountain land,the 2.0H\*2.0H range(H=300m), Interval 1.6H along the route, Overlap 20% adjacent route, exposure Interval 0.4H,can get center image resolution better than 20 cm

## 4. FLIGHT OPERATIONS AND PHOTOGRAMMETRY

Flight operations and Image Control Photogrammetry Low-altitude unmanned airship Photogrammetry system is a high-tech aerial systems, in order to ensure that the project on time and durability to complete the project, operational planning becomes particularly important. Required from the implementation of the planning, execution and inspection

### 4.1 Plan

Before the commencement of the project should take into account all relevant factors, formulate practical project implementation plan and quality assurance program, specifically including the following aspects:

1. task decomposition
2. organizational structure and human resources plan
3. the progress of implementation
4. a detailed plan for all stages of the project
5. project implementation process of the qualitative factors
6. risk factors and countermeasures
7. Quality assurance measures

## 4.2 implementation

In the implementation process, To ensure that the implementation of the following steps:

1. Equipment approach;
2. pre-flight preparations, including the inflatable airship, equipment installation and commissioning;
3. checked before the airship set off equipment, remote control equipment, sensor equipment, communications, etc.;
4. Photogrammetry operations and data collection;
5. The airship landing;
6. equipment checks and maintenance.

## 4.3 Inspection

The course of an aircraft flying at any time recording the situations encountered, monitoring the whole process, and after the implementation of technical support and provide the basis for after-sales maintenance. Of all technical documentation and implementation of the document must be the database archiving, easy to manage and query.

## 4.4 Image data processing

Modern Aerotriangulation software, MAP-AT is the Chinese Academy of Surveying and Mapping results of the latest software, MAP-AT at the break with traditional aerial photography scale, attitude angle, overlap, etc. strictly limited to deal with existing film cameras, digital cameras , LAC. By ordinary aircraft, aerial, low-altitude aerial light aircraft, unmanned aerial and no one airship vertical aerial photography acquired images, to pay to the photographic image, tilted images, and complex multi baseline photographic images route; through the multi-look image matching automatic build aerial triangulation network, can be up to 10000 images of large area beam adjustment; with low-altitude high-resolution remote sensing images, aerial precision positioning; and can be automated production of digital elevation model (DEM) and Digital orthoimage (DOM) and other products.

## 5. COMPONENTS OF MAP-AT SOFTWARE

MAP-AT software consists of:

1. MAP-AT Automatic Aerial Triangulation Module
2. MAP-DSM automatically generated DSM Modules
3. MAP-DEM automatically generate DEM module
4. MAP-DOM automatically generated DOM module



Figure 4 Automatic Aerial Triangulation

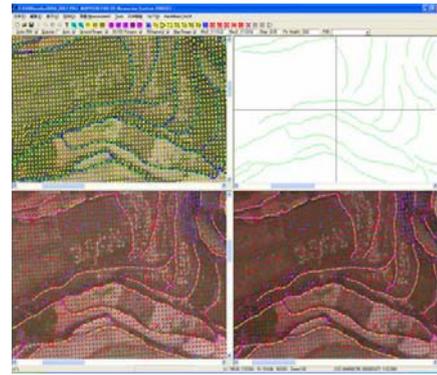


Figure 5 DEM Production

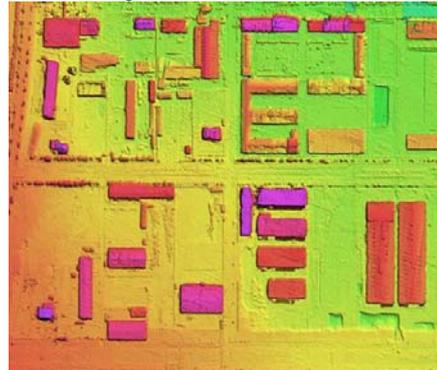


Figure 6 DSM



Figure 7 DOM



Figure 8 DLG

## 6. APPLICATIONS

Low-altitude unmanned airship Photogrammetry technology has been used in Shenzhen. Using unmanned aerial vehicles, the main tasks are scheduled to achieve the images with the resolution of 0.2 meters in four new towns.



Figure 9 Four new towns in ShenZheng City

As an important means for spatial data acquisition, Low-altitude unmanned airship Photogrammetry technology has the merits of high-risk areas detection, low cost, timely image transferring. It is a strong complementation to the satellite remote sensing and general aerial remote sensing. These can form a monitoring system to meet the rapid economic development required for time-sensitive nature of emergency monitoring.

Traditional photography technology always depends on the airport and weather conditions, and is costly with long period, which limits the application of the digital photogrammetry technology in large-scale topographic. For the smaller large-scale topographic mapping mission (usually less than 20km<sup>2</sup>), operating institution generally use the full-field data acquisition methods mapping. Low-altitude unmanned airship Photogrammetry system has the advantage of rapid reaction, and low cost. By adjusting the aperture and the shutter or the application of image-processing software, the digital camera can adjust the sensitivity ISO and improve the right color, the contrast, the brightness adjustment and anti-fogging treatment, which resulting in achieving a qualified color images in cloudy day. Therefore, a small range of large-scale topographic mapping tasks can also use full digital photogrammetry system, which reduces the labor intensity and increase work efficiency. The use of existing all-digital photogrammetric workstation can easily obtain Digital Orthophoto Map (DOM), Digital Line Graphic (DLG), digital terrain model (DEM) and other mapping products.

With the maturing of Low-altitude unmanned airship Photogrammetry system, it is widely used in surveying and mapping, land surveying of environment, the emergency response mapping, meteorological research and other fields.

## REFERENCES

- [1] Lin Zong-Jian, Sun Jie, Liu Zhao-Qin, Yong-Rong Li unmanned low-altitude remote sensing. Beijing: *The second session of the China (Beijing) Urban public safety audio-visual information seminar*, 2007
- [2] Zheng Tuan-jie, Wang Xiao-ping, Tang Jian UAV digital photogrammetry system design and application of Xian: China monitoring network <http://www.chinamca.com/>.