CALIBRATING AND USING AN OLYMPUS CAMERA FOR BALLOON PHOTOGRAMMETRY

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ABSTRACT:

An Olympus C4040 digital camera has been calibrated by using BAAP Software for taking aerial photos. This standard camera is good priced, has got a high resolution and a small weight. As a speciality, the platform was based on a Helium-Balloon of 2,5 m in diameter. The camera has been mounted under the balloon by using a gravimetric cardanian platform, which has been designed in order to hold the camera always in nadir position by its own weight, fixed on 2 independent axes. The camera has been selected because of its technical specifications such as remote controller and video output. Using the remote controller, photos are taken by an operator from the ground, which has got a video monitor showing the view of the cameras lens hanged under the balloon. The balloon has been controlled by three operator, using ropes.

The biggest problem of this application was the sensitivity of the balloon to the wind. The more intensive wind the wind blew, as more rotation and movement of the balloon and the camera took place. In such cases, angles of the photos force big efforts in the photogrammetric orientation for getting usable adjustment. Because of this, we had to use calm weather conditions for taking the photos, mostly in the morning. The study area was an amphitheatre in the antique city of Patara. Before taking the photos, a flight plan has been developed. The photos have been taken from an altitude of 30 to 40 meters. Ground resolution was fine for the photogrammetric work with an accuracy of < 5 cm. Advantage of this system is the small price, the immediate available data and the possibility to undertake daily updates to monitor the excavation process.

1. INTRODUCTION

In photogrammetric application, image acquisition is one of the most expensive steps. Especially if aerial images must be taken, the expenses are always high because of the high-cost of aircraft campaign. In some cases, other solutions for aerial imagery such as kite, balloon and remote-controlled model helicopter or aircraft can be the optimum solution (Leloglu et all). These types of solutions can be used, if the area of interest is small and non-metric cameras are enough accurate for the job.

In this study, a low-cost solution for low-altitude aerial photogrammetry is represented. The system is designed for general purposes of low-altitude aerial photogrammetry. However with some additional parts, the consisting system can be used for special purposes.

2. SYSTEM OVERVIEW

The system contains two main units. As illustrated in Figure 1, these are;

- Flight Unit
- Ground Control Unit

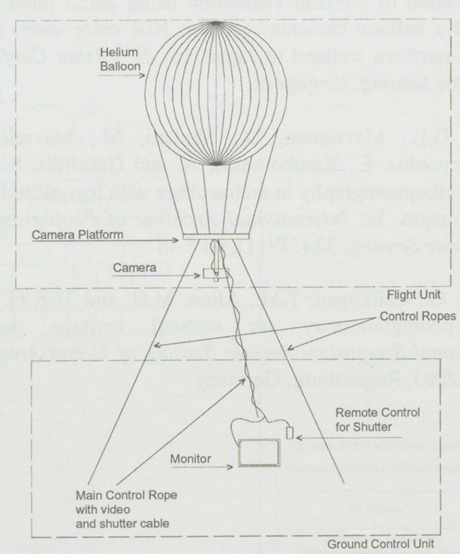

Figure 1. System overview

2.1 Flight Unit

In the flight unit, there are three main parts. These are;

- Helium Balloon
- Camera Platform
- Camera

The balloon is approx. 2.5 m. in diameter and 8 m^3 in volume. As an uplift gas, Helium (He) has been chosen because its non-dangerous properties. Such balloons are available at companies, which make professional outdoor advertisement. 8 m^3 He effect an uplift of 8 kg, so far the weight of all components had to be carefully balanced. Bigger balloons have bigger uplift, but they also need much more He. The chosen volume is just fine for 1 big bottle of gas (has 9.1 m^3). This enables to work 2-3 weeks with one filling.

The camera platform was built in the workshop of GGS in Speyer. The digital camera was fixed at a axe, which itself was connected to a triangle frame, turn able around 2 axes so that the weight of the camera forced the platform, to support always a nadir view of the camera. To reduce the swinging of the platform, a smooth-compensator was built in. Phi and Omega values should be small with this construction, Kappa had to be influenced by the rotation of the balloon.,

The triangle frame of platform was fixed with 6 ropes below the balloon. To the ground it was fixed with 3 ropes, each with 50 m length. One rope was used as carrier for a video and a remote-control wire.

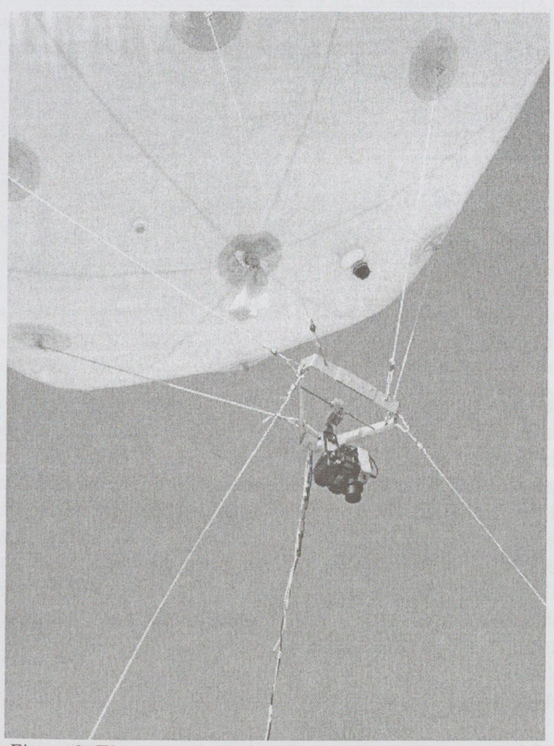

Figure 2. The camera platform below the balloon with the balanced holder of the camera and the ropes

For image acquisition, Olympus Camedia C-4040 has been selected (Figure 3). Nowadays it is very difficult to get high-resolution digital cameras with fixed focus lens. It was a must to use one of the extreme values, either the small angled or the wide angled setting of the lens. The Camedia is known for its good quality and sharpness of the images, resolution is just one aspect.

Figure 3. Olympus Camedia C-4040

The video-out port of the camera was used to transmit the cameras view to the ground. The normal PAL-signal was send through a coaxial wire.

The wireless infrared control of the camera was rebuilt and the IR LED was connected to a thin wire and fixed before the Sensor at the Camera. IR signal only bridge short distance (max 10 m) and have problems in hot air conditions.

The calibration of the camera has been done by BAAP software using the test field in ETH-Zürich. Detailed information on calibration will be given in following chapters.

2.2 Ground Control Unit

Ground control unit has parts mentioned and explained below.

- Monitor
- Remote controller for shutter and focus length
- Control ropes

A small portable TV with a video-in plug and battery power was used as a cheap monitor solution. A frame protected the screen against direct sunlight and the control worked fine (figure 4).

Other part of the ground control unit was the remote controller for shutter. Because of being out of covering distance of interior IR-LED (5 - 10 m.), remote control unit with a wire-output for an external IR-LED has been used (Figure 4).

The last part of ground control unit was the ropes. Ropes, which are light in weight but strong in stability, are selected.

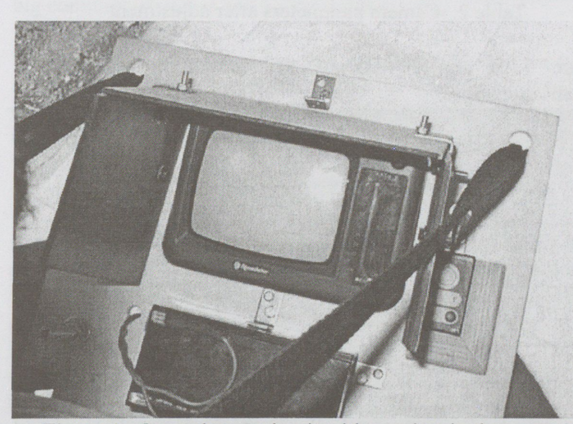

Figure 4. Ground control unit with monitor in the centre, remote controller on the right and battery for the monitor downside of the monitor

3. CAMERA CALIBRATION

The Camedia has been calibrated in ETH-Zürich using the BAAP-software. Because of being a zoom-camera, its calibration has been done both for maximum wide and maximum narrow angles.

For the calibration of the camera, 9 images of the test field from different positions have been used. For wide-angle status of the camera, 30 of 106 control points and for the narrow-angle status 4 of 90 control points have been selected as tie points.

	Narrow-angle	Wide-angle
Number of images	9	9
Number of total points	90	106
Number of tie points	4	30
Number of control points	86	76
Number of Measurements	1432	1806
UNKNOWNS		
Exterior Orientation parameters	54 (6*9)	54 (6*9)
Tie point coordinates	12 (3*4)	90 (3*30)
Additional parameters	10 (1*10)	10 (1*10)
Total	76	154
Degree of freedom	1356	1652

Table 1. Characteristics of the adjustment for the wide-angle status of Olympus Camedia C-4040

At the end of the adjustment, following additional parameters about calibration has been reached.

	Narrow-angle	Wide-angle
Focal Length	20.700859 mm	7.231573 mm.
Principal Point (x0)	0.135214 mm	0.024380 mm.
Principal Point (y0)	0.163940 mm	-0.053714 mm.
Radial Distortion (K1)	0.000210	-0.004906
Radial Distortion (K2)	0.000006	0.000080
Radial Distortion (K3)	0.000000	0.000001
Decentric Distortion (P1)	0.000116	0.000051
Decentric Distortion (P2)	0.000109	-0.000069
Affinity (B1)	0.000041	0.000160
Shear (B2)	0.000028	0.000031

Table 2. Camera parameters after adjustment

Figure 5, 6 and 7 illustrate the distortions in different visualisation types.

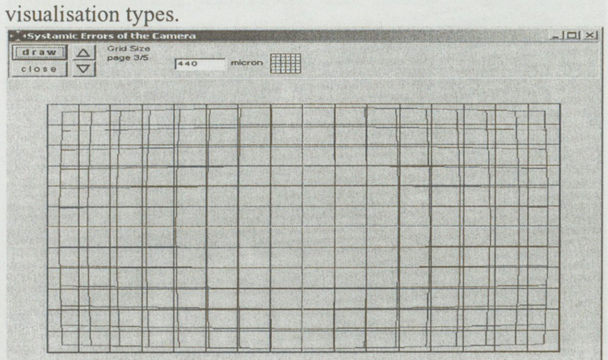

Figure 5. Distortion of wide-angle status (red: current distorted image, blue: ideal undistorted image)

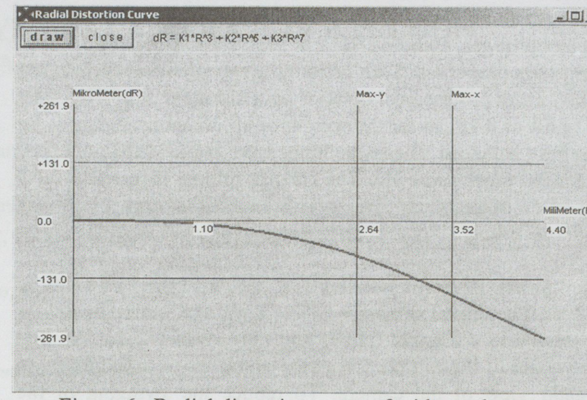

Figure 6. Radial distortion curve of wide-angle status

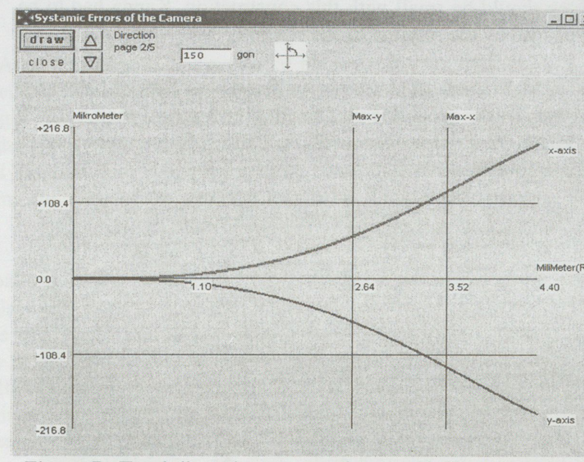

Figure 7. Total distortion curves along predefined directions (red: x-axis; green: y-axis)

4. CONCLUSION

The shown technology has benefits especially in areas, where restrictions in aerial flights exist. The fast availability of the data is also a good advantage. The construction of the platform is modified to get a better stabilization of the rotation but there will be still a big sensitivity for wind. The result is really fine but the big number of photos force big work in the data processing. On the other hand the price for the system, the balloon and the running costs are relatively small. This technology has a specific focus, which opens an interesting market.

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5. REFERENCES

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