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INVESTIGATION ON THE EXPERIMENTAL RESULTS OF PHOTOGRAMMETRIC CADASTRAL SURVEY IN TAIWAN, REPUBLIC OF CHINA

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ABSTRACT

The application of photogrammetric method for revising the old and blurred cadastral maps, we had carried out three experimental projects of photogrammetric cadastral survey in the past six years in Taiwan, Republic of China. This paper is used to investigate the accuracy, method and to find out the problems on those projects. The experimental results are quite reasonable, but considerably, new problems were raised, and should be solved carefully.

INTRODUCTION

Taiwan is a small island, the smallest province in the Republic of China, its total area is about 36,000 km^2. About 20,000 km^2 of whole island were registrated, the other part is mountainous area. Most of the registrated land are flat and located in the west territory of Taiwan. The existed cadastral maps in Taiwan were copied from the original maps, which were completed more than 70 years ago and damaged during the World War II. Since the policy of "Land Reform" was executed 25 years ago, more farmers have their own land now. The limitation of land area is three hectars for each land owner. The original landowners sold most of their lands and invested in industry. This is one of the factors to stimulate the economic situation which has grown almost 10% every year in Taiwan in the past years. Due to the reason of economic situation, changing of the ground features and the damage of nature sources, the copies of the cadastral maps became blur and incorrect now. It is in urgent need, that the old and blurred cadastral maps should be resurveyed. Before the photogrammetric method is applied for the resurvey of cadastral maps, we had carried out three significant experimental projects of photogrammetric cadastral survey in the past six years. According to the results, almost all of the land surveyors recognized the accuracy of photogrammtric cadastral survey could be compared with the ground survey, even it is better. But some new problems are raised after resurvey, it should be solved carefully.

THE EXPERIMENTAL PROJECTS

All the three experimental projects were entrusted by the Ministry of Interior and cooperated with the Cadastral Survey Team of Taipei City Government and Provincial Land Management Bureau. The first photogrammetric work was aimed to study how accurate would be the signalized photogrammetric points and how many percentages of boundary stones could be identified and measured in the pictures at suburban area mixed with rice field, fish pounds, and irregular ground features. Another two projects were executed in the flat rural area with villages of central Taiwan.

The all of three projects had been carried out like the following table:

	1st Project	2nd Project	3rd Project
Total Area:	18 ha.	500 ha.	1200 ha.
Circumstances:	Rice field fishpounds and buildings etc.	Rice field and Villages	Rice field and Villages
Number of Parcels	1,354	1,898	4,685
Boundary Corners:	2,384	2,519	13,983
Camera:	RMK 21/18	RMK 21/23	RMK 21/23
Flight Height:	640m	1050m	1050m
Flight Direction:	East-West	North-South	North-South
Photoscale:	1/3 000	1/5 000	1/5 000
Number of Strips:	6	5	10
Overlaps:	65/20	80/60	80/60
Selected Photographs:	7	14	34

SIGNALIZATION

The control points and part of the boundary corners were signalized with white or yellow colour painted on roadside or with plywood staked at field. The size and shape of signals were different for each mission, for the first one the size is 10 cm in square or 12 cm in circle; and for the second and the third mission most of them were 20 x 20 cm, but we still kept some signals with 10 x 10 cm for test.

CONTROL SURVEY

The control Survey in the first project, three triangulation points were checked by using AGA Geodimeter M6A and Zeiss Th2 at first. The minor ground control points were fully controlled by running precise traverses with DI 10 and Wild T2, and the traverses were connected with the three triangulation points. The closure errors of traverses were from 1/7 000 to 1/28 689, its accuracy was far enough for this purpose.

In the second project, Wild DI 3 and Wild T2 were used for determining 20 minor control points to connect with four triangulation points by triangulation-trilateration combined method. 681 traverse points of 55 precise traverses were controlled by those 20 minor control points, and used as check points for aero-triangulation. The results of that were quite homogeneous.

The control survey in the third project was controlled by two second order triangulation points and three third order points. 233 traverse points had been running with Wild T2 and EDM equipment, some of them were along the perimeter of the block and some were in the block used as check points.

AERO - TRIANGULATION

The point measurement was operated on Stereoplanigraph C8, Planimat D3, and Wild A8 for first and second projects. For the third project, the triangulation points were measured on PSK2, and the boundary corners were measured on Wild A8. For the block adjustment, program PRO and PAT M43 were first time used and operated with IBM 370/145 in the third project.

For the investigation of the accuracy of triangulation points, four control point distributions and weight conditions were arranged in the third one.

1. Over all control for whole area. (Equal weight)
2. Over all control for whole area. (Weight for control points equal infinite, for model points equal 1)
3. Dense perimeter control (weight condition like 2.)
4. Perimeter control, interval 2 base length. (Weight for control points = infinite, for model points =1).

RESUITS

For the first project, the standard error of transformed coordinates of signalized boundary corners was ± 4.1 cm, the standard error of distance measurement was ± 3.9 cm and for the area clculation, it was ± 0.902 m^2. The planimetric accuracy for the second project was ± 3.9 cm. The following table shows the standard error m of the unit weight of control points and check points, which were measured on PSK2.

Cases	Number of Measured Points				Standard error of the unit weight (cm)				m_{check}/m	
	Control Pt.		Check Pt.		m		m_{check}			
	H	V	H	V	H	V	H	V	H	V
1.	120	109			3.5	9.3				
2.	120	109			4.1	10.0				
3.	61	100	59	9	3.8	10.0	5.3	10.7	1.4	1.1
4.	16	25	104	84	3.5	9.9	5.8	12.1	1.7	1.2

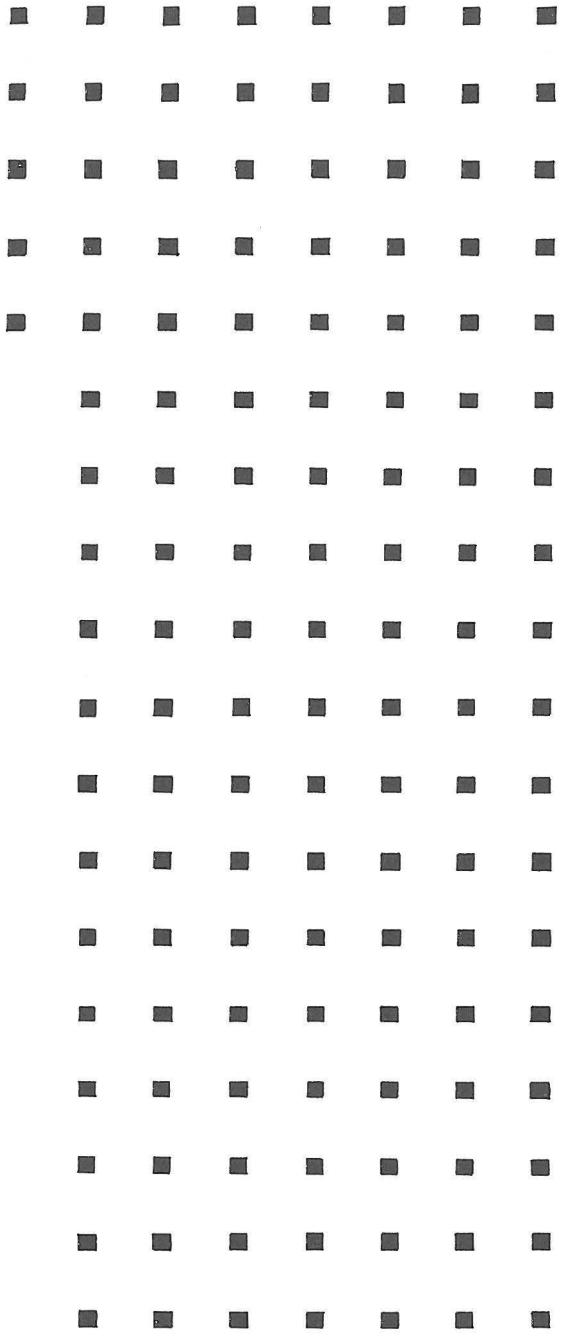
It shows, that the planimetric accuracy m_h=7.0 µm--8.2 µm, for the height m_v=18.6 µm--20.0 µm in photoscale. For the accuracy of some points, measured on the Wild A8 with independent models, mh=8.8 µm--10.6 µm.

For furthermore study on the relative accuracy of short distances, two small testblock A and B were signalized on the ground. (Fig.1 and Fig.2) The average accuracy of short distances (from 2,4 ------ 34m) in A block was ± 2.9 cm, in B block was ± 1.9 cm, which were quite satisfied.

CONCLUSION

As mentioned above, the first project was aimed to investigate the accuracy of photogrammetric points and the percentage of boundary corners could be identified and measured in the pictures at a suburban area. For the accuracy, it was quite satisfied. But for the identification of points, the percentage was too low, only 19%. The main reason was that, the landowner had their land granted by their grand parents, they did not know where was the exact location of the boundary corners now, and also due to the development of economical situation was too fast, the subdivision of the parcels of land became very often, and also the subdivision work was done with the old shrinked cadastral maps. It made the troubles to set signals correctly and to identify on the photographs. The another reason was that, the original overlaps of flight mission was 80/60, but the actual overlaps was 65/20, it lost the opportunity to identify more signals, which could be covered by trees and buildings.

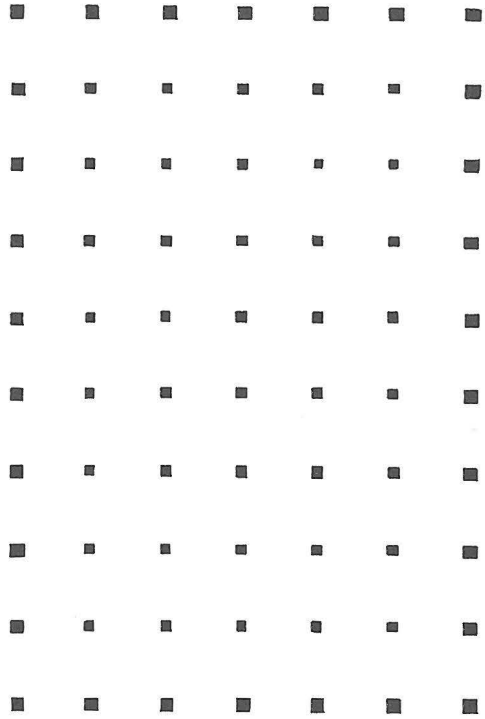
In the second project, we had developed an automatic plotting system to plot the cadastral maps, and calculate land areas with IBM 1130. We compared the new calculated areas with the registrated areas, we found out that almost more than 60% were not coincided to the original registrated areas. Inperfect restoration of the boundary stones and incorrect registrations caused the discrepency between the old and new areas existed.



Signal size: 20x20 cm

Signal interval: 2m

Fig.1 Testblock A of short distances



Signal size of perimeter control: 15x15 cm

Signal size of inner control points: 10x10 cm

Signal interval: 2m

Fig.2 Testblock B of short distances

After the third project was carried out, we found out that the most important thing was to restore the boundary stones exactly on the correct positions. Auxliary equipment like displayer and digitiser could be used for solving these problems in advance.

Second, we have learned from these experimental results, that the accuracy of photogrammetric points not only depends upon the distribution of dense perimeter control or 2 base-length perimeter control, but also depends on the colour, size, contrast and shape of the measuring mark and signals.

Third, for measuring the tremendous number of boundary points, due to the view field of instruments, precise plotters, like Planimat D2, Wild A8 etc. are much better than PSK 2.

Taiwan is an evergreen island, to avoid the signals covered by trees or buildings, the auxliary signals would be widely used. Of course, it will be increasing the working time, but it is worthy to do that and better than to make up on the ground.

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