XIX ISPRS Congress – PAPER 966 POSTER SESSION

Digital correlation experiences applied to close range photogrammetry

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ABSTRACT

It was developed a program based on correlated statistical methods dedicated to automatic detection of features on structures, facades, monuments and vehicles imagery.

When applied to close range photogrammetry, results obtained using this correlation tool reached expected results.

Applying the "moving window" procedure, displacing an user defined exploration matrix or "kernel" over a search matrix or image, the program calculates the correlation coefficient at each position. Coordinates of the point with maximum correlation are stored in an ASCII file that can be used by other photogrammetric or CAD softwares.

In order to control the application's computational efficiency, a computer-designed pattern image was used, with well-known marks coordinates and parameters. On the other hand, real images, obtained by hi-resolution analogic and digital devices were also used.

Correlation determinations in a large number were carried out to verify program results. Numeric determinations, including statistical tests, were made in order objectively quantify the change of correlation coefficient related to exploration matrix size.

Keywords: automatic detection – correlation – international co-operation.

1 INTRODUCTION

Features automatic detection (FAD) is developing with success since the beginning of the digital era. Multiple disciplines, as cartography, photogrammetry, photointerpretation, remote sensing, physics, mathematics, statistics, climatology, medicine, and other are interested in these activities. The interest in FAD is velocity and objectivity when processing tasks are done.

Images of metallic structures and vehicles, facades, community patrimony preservation and aerial photographs were tested. As programming tool to develop the activities, Visual Basic version 4 was chosen, for the advantages of the user's graphic interface (Graphic User Interface -GUI -).

The version of the developed program answers to the experimental characteristics or "beta", being possible to introduce reforms or improvements. Obtained results in program control of quality stage were acceptable according to technical patterns.

The activities were developed in Santa Catarina Federal University (UFSC), Brazil, Master degree course in Civil Engineering.

Researching in studied topics involves three universities: Universidad Federal de Santa Catarina, Brazil; Universidad Nacional del Litoral, Argentina, and Universitat Karlsruhe, Germany Working plans are oriented to inclusion of photogrammetry disciplines in South America graduation and post-graduation courses.

2 OBJECTIVE

Main objective was to program a tool for FAD in images of structures, facades and aerial photographs, using a correlated method.

3 USED MATERIAL DESCRIPTION

To develop the requested application, a language of high level was used (Visual Microsoft Basic Version 4.0 in Spanish), with user's graphic interface (Graphic User Interface -GUI -) of the system Windows 98, on 32 bits platform.

Three cameras were used, being two analogical and one digital. The used pictures were paper hardcopy for analogic case, and magnetic support, for digital. Points of taking positions were not registered, fact to contemplate in the terrestrial photogrammetry (ALBERTZ, 1980).

Two amateur analogical cameras were used to obtain pictures of interest. The devices don't present control marks and precise focal distances was ignored. A Voigtländer VSL 1 Camera

was used. It is a 35mm manual analogic camera, with Color-Ultron 1.8/50 lenses. Also, a 35mm automatic analogic Yashica T4 camera was used, with Carl Zeiss T * Tessar 3.5/35 objective.

As Digital camera, an Olympus C-820L Camera was used. Its main features are: digital registration, 2Mb of memory for storage of images. Sensitive element composed by main CCD of state solid of 8,5mm (1/3 of inch), 810000 pixels. It registers in 1024 X 768 pixels. White automatic balance. 5mm F2.8 Olympus Lens, with 5 elements in 4 groups.

4 METHOD

The program applies the "moving window" method based on iterative moving of an exploration window or "kernel" (LILLESAND & KIEFER, 1987), defined by the user. The correlation coefficient is calculated at each position.

With the largest correlation (or an interval of correlations), the central point of the window is calculated, being written the image X, Y coordinates to an ASCII file. Other applications like AutoCad or PhotoModeller can use them for more accurate tasks.

Program flow contemplates three stages: input, processing and output.

Data input can be made in three different ways: the first, by means of the routine of Digital Correlation for files. In the first one, user indicates by means of the moving window, which will be the exploration kernel, contained in a raster file. It can be supplied to the program the correlation threshold.

Second way needs numerical definition of the exploration kernel for its components or elements. The data restriction is 400 elements (20 lines X 20 columns), and entered digital values must be between 0 and 255.

Third way for input data consists in the definition of a window on the search image by means of the mouse pointer, establishing a rectangular kernel for exploration.

The calculation method was centered average (PIECHEL, 1991) to determine the variance, deviation, covariance and correlation factor. As data output, correlation results with X, Y coordinates data of the points and calculated correlations are stored in text files

5 RESULTS

In marks applied over car structure were identified 10 of the 12 marks. Other sections of the photo presented same patterns, with similar statistical conditions for digital correlation of images.

In monuments with repeated structures, the correlation method was used. It was recognized by correlation in the first execution of the program in 6 points over 8.

Used aerial photographs were taken with a Carl Zeis RMK AT 15/23 camera, 153mm focal distance. Using a window of 10 x 10 pixels as exploration kernel, the automatic recognition was tested by digital correlation for crossings of roads features. They were identified in the first execution 8 of the 12 crossings and other points with same statistical characteristics. Graphical results are shown in poster session.

6 CONSIDERATIONS

Adequate election of marks was fundamental to reach with success the recognition objectives. They were contemplated three fundamental aspects: form, size and mark contrast. Circles on square mark are appropriate when the image has form heterogeneity.

Results obtained in the digital correlation through the elaborated program were reached without inconveniences with a personal computer.

Obtained results in FAD, independently of basics photogrammetry analyzed topics, served as educational tool for photogrammetry disciplines inclusion in graduation and post-graduation courses in two South America universities: Universidad Federal de Santa Catarina, Brazil and Universidad Nacional del Litoral, Argentina.

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