EXPERIENCE OF MILITARY GEOGRAPHIC INSTITUTE (IGM) IN TECHNOLOGICAL CHANGE FOR SPATIAL TRIANGULATION PROCESS

Introduction

To understand the present study objective, it's necessary, in the first place, to know the reasons that lead Military Geographic Institute to use the technique of Spatial Triangulation in the process of elaborate the national territory cartography.

For current versions of national topographical cartography, IGM has used as main information source, air photographs. This material, in its very pure nature, only provides information referred to shape of elements that exist on terrain.

To make possible the right representation of these elements on a map, besides knowing their shape, it's imperative to know their geographical position and at least two control points are necessary in capture of georeferenced data from each of air photographs.

When land to be represented is very large and difficult to access it, for instance our country, to do measurements of terrain control points that can be identifiable on each photograph of study surface, the associated costs are very high according to human and technical resources. For this reason, Spatial Triangulation becomes the most efficient method to decrease the amount of points that must be measured on terrain.

Technique of Spatial Triangulation consists on extension of horizontal and vertical control; this is necessary to do the absolute orientation of stereoscopic models that are used in photogrammetric restitution process. The photogrammetric restitution process consists on capture information from air photographs.

For Spatial Triangulation, IGM uses a *first order* photogrammetric instrument called "Planicomp P2", which is connected to a computer and works with the software "P-CAP". The instrument provides to the software the data that allow to determinate the control points position and spatial triangulation in each one of the block models. When photogrammetric observation in all control points is done, obtained data is adjusted for obtaining the terrain coordinates of points, this is materialized through calculates develop by an adjust software called "PAT-M", which processes the points coordinates, and from these well-known points, it calculates the coordinates of spatial triangulation points, joining this way all the models to a specific reference system.

Technological advances are not been unaware of the process described previously, where have allowed to optimize and to automate the method through computer tools. For this reason, IGM in a constant of upgrade their cartographic processes, has seen the necessity of acquiring a modern computerize system that allow the Digital Spatial Triangulation process, with the premise of maintaining or improving the precision of the works executed with other digital procedures. A collective predispose and conscience of to use new tools for improve performance do exists, but anyway, all these new tools and procedures must be evaluated and demonstrated.

Objectives

General objective

- To share with scientific and academic community related to Earth Sciences, the IGM experience on evaluate a new digital spatial triangulation system.

Specific objectives

- To establish a method that allows comparing the results obtained from both digital and analytic spatial triangulation.
- To determinate the time saved in work associated to the implementation of the new spatial triangulation system.
- To decrease error possibility associate to the human factor.

Methodology

In the process of evaluation of the three spatial triangulation platforms, it's been used spatial triangulation data and adjusts from a photography block associated to a *1/10.000-scale* communal terrain study, which have been developed with traditional analytic method. The default measurement parameters in this project are 0.25 m in both 2D and 3D elements. The obtained results gave 100% of efficacy with this method. This information allows us to have as reference frame those results for future comparisons with digital procedures.
In the execution of digital spatial triangulation, the job steps are the same related to Planicomp P2 instrument.
Internal orientation: The slides with their respective pass and tie points marked are digitalized on a photogrammetric scanner, then, camera attributes data is input and finally, flight lines and photographs are created.
Relative orientation: The digital system acquired by IGM does automatically this task. The software works creating the pass points between consecutives photographs of a flight line and tie points among overlapped photographs of adjacent flight lines by pixel correlation method.
But, to be able to do the coordinate adjust, it's necessary to make the photogrammetric observation of planned control points measured on terrain. This action must be done on all photographs that are visible of control points, giving more weight to the point. Then, data obtained from previous steps are adjusted in a way that the computer system assigns to both, pass and tie points, the corresponding coordinates, according to a defined reference system (SIRGAS)
To analyze the processing results with digital spatial triangulation system, the coordinates obtained by this method were compared with those obtained by analytic method. For accomplish this, it was necessary do the photogrammetric observation of points marked on slides. Those points had been marked before scanning phase, so it's possible to identify these marks in digital process.
Once the process is finished, both project coordinates are compared to can obtain statics about existing differences.
When analyzing figure n° 1 'Analytic workflow' and figure n°2 'Digital workflow', it's possible to have a vision of main differences between old and new methods.

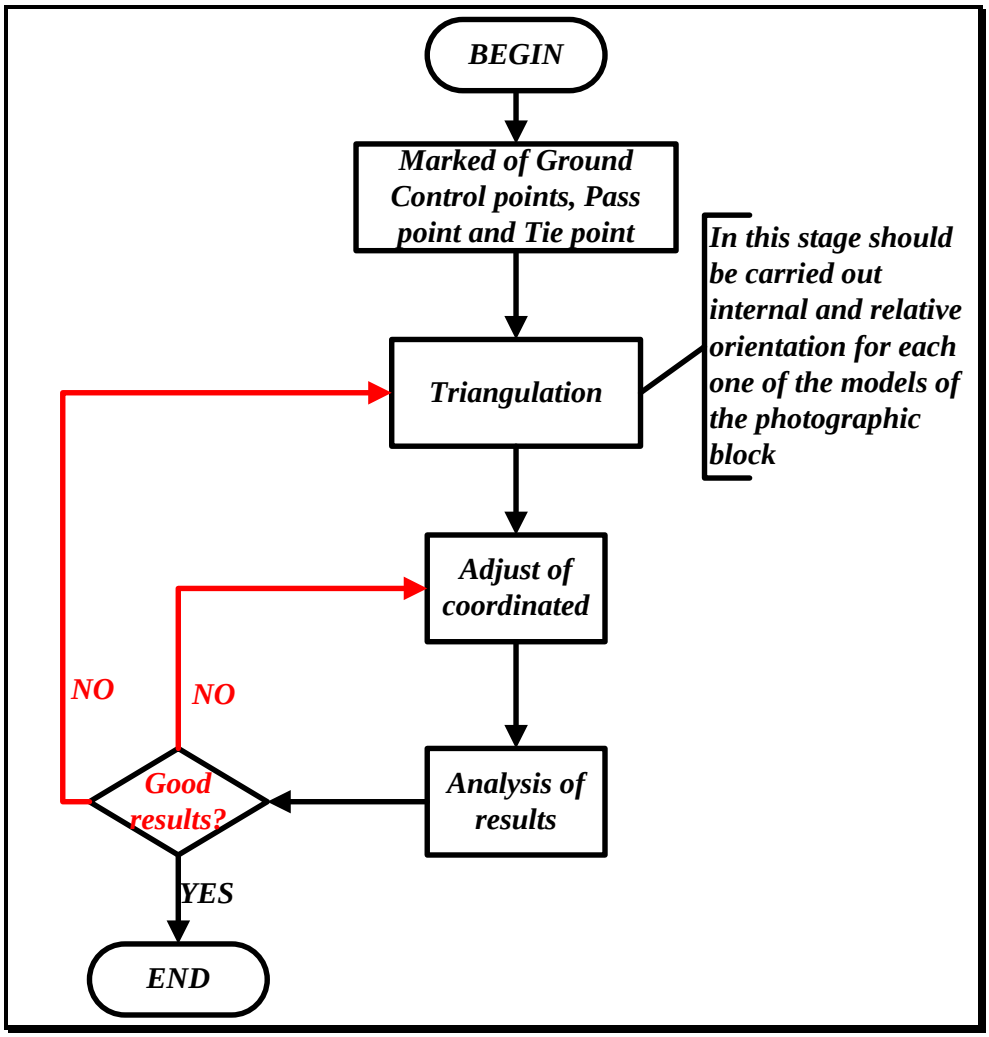

Figure n°1 'Analytic spatial triangulation workflow''

In the figure nº 1 very few steps are appreciated, what doesn't mean that these they are simple steps, it is this flow the operator should carry out in direct form with the instruments and the photographic material, it is situation it has been modified with the implementation of the system of digital spatial triangulation. In the following one imagines they appreciate but steps that in the diagram of previous flow, but it doesn't mean that the process in if it is but slows, since these steps should be defined by the operator to be executed by the application in an automatic way.

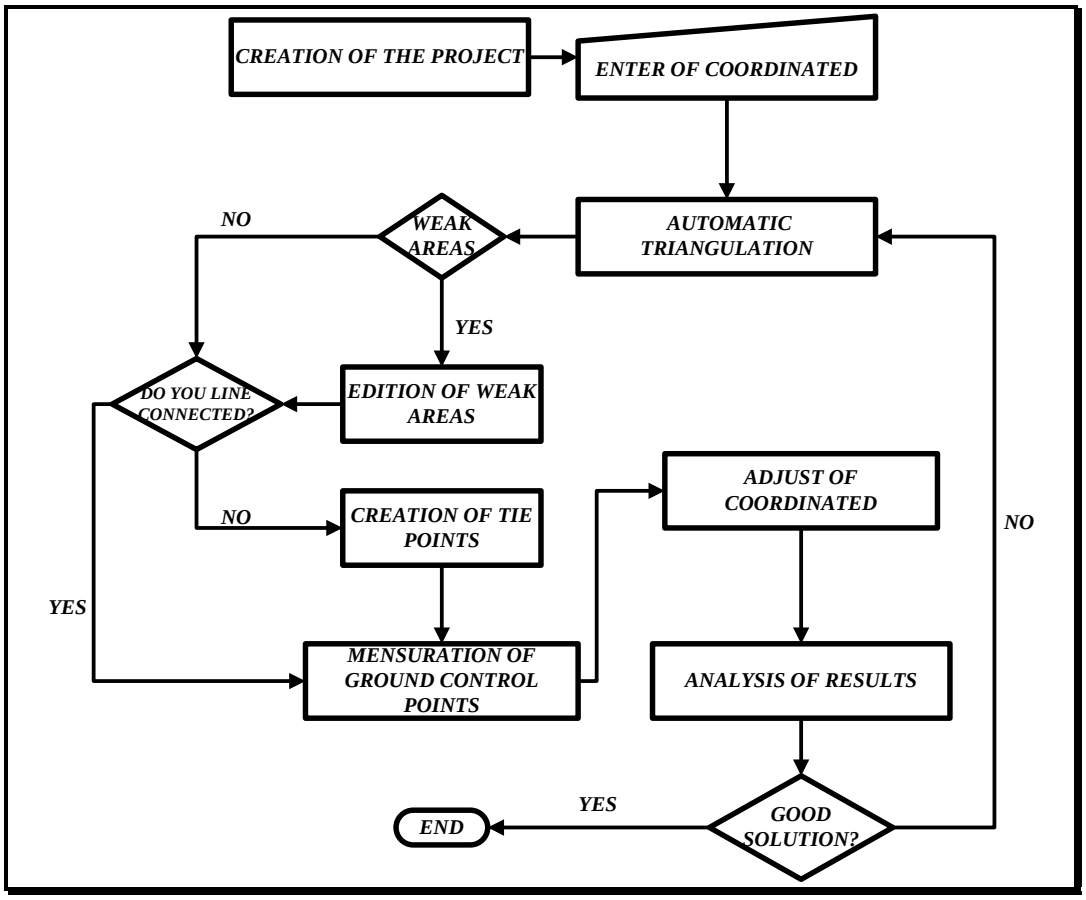

Figure n°1 ‘Digital spatial triangulation workflow’’

Conclusion

The sample used in this study is constituted by three hundred and sixty nine points with coordinates obtained by analytic spatial triangulation with accuracy of 0.25 m. In this case, the results obtained with the software under study are:

- 94.6% of criteria satisfaction for planimetry
- 93.2% of criteria satisfaction for altimetry

- From these results we can conclude the following

- The software submitted for evaluation satisfy the criteria for accuracy set by IGM
- It reduces the execution times of the process because it eliminates the step of marking the slides for the determination of the spatial triangulated points. The software determines the pixel correlation within the images.
- Reducing errors associated with the input of mistaken names of the points by the operator of the instrument in the photogrammetric observation phase of the pass and tie points.
- Given that the results accomplished by a percentage close to 100% quality criteria established in this study, it was suggested the acquisition of the digital system of spatial triangulation, which is materialized in December 2008.

Bibliography

"Carlos Sepulveda Hernández (2008), Procedure "IGM 7.5-2 REV-3 AEROTRIANGULACIÓN."

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