Construction of Georreferenced Mosaics Using Small Format Aerial Images For GIS

IX GEOINFO

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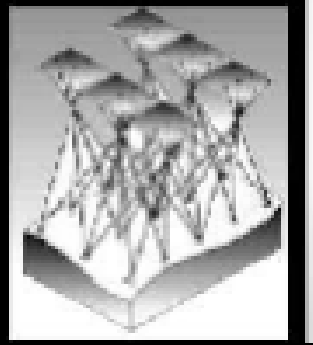
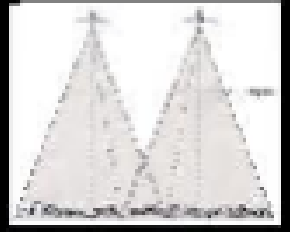
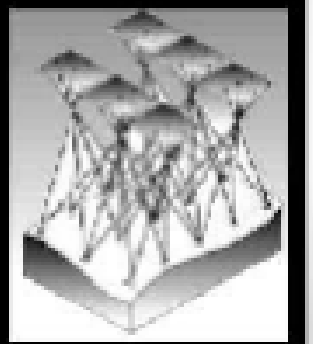


Presentation

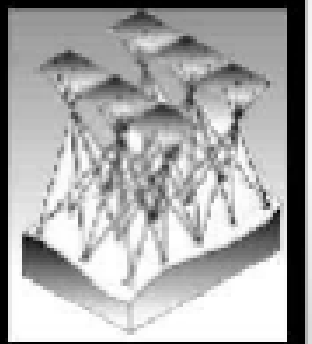
- Introduction
- State of the Art
- Construction of Georreferenced Mosaics
- Implementations
- Experiments and Partial Results
- Final Considerations





Introduction

- Mosaic is a composition of adjacent images that are put together aiming to provide a larger view of a desired scene;
- It is necessary to remove distortions and other errors caused by the acquisition process;
- Transformations are applied to reconstruct the positions and relative orientation of the images in relation the others images, and absolute orientation in relation to a scene global frame;
- Finally the definition and adoption of a scale and a system of representation;



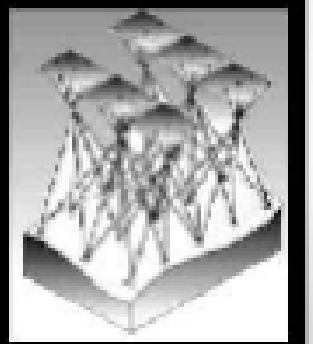
Introduction

- In the traditional cartographic process, controlled images are used. Very expensive (involves the use of special camera and plane);

- Satellite images it is an alternative, however less efficient in determination of depth and also expensive, compared to small format images;

- With the use of the small radio controlled helicopter, is possible to get images with bigger scales, closer to the surface;

- As a nice contribution, we work with monitoring in sea regions, that can be accessible many times by using the RC-helicopter.

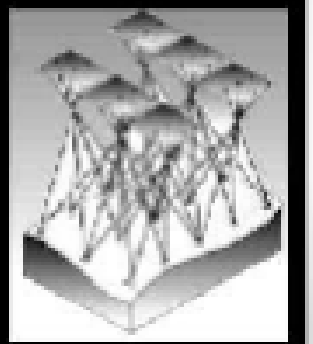


RC-Helicopter

State of the Art

- Systems as the ArcView of the ESRI, ERDAS of the Leica Geosystem, Regeemy of the INPE between others, allow to generate mosaics of quality using image registering techniques and big format aerial images (BFAI);

- Applications to monitoring in environmental protected areas are generally done using satellite images and aerial ones;

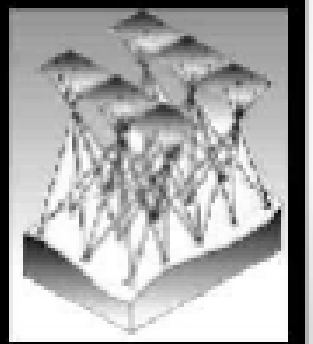


Construction of Georreferenced Mosaics Using SFAI's

- Construction of georreferenced mosaics becomes a hard task, due to lack of control in the SFAI's.

- Other errors appear due to variations of position and orientation of the helicopter during the flight.

- Procedures or techniques to be applied:
  - Camera calibration;
  - Correction of the radial and radiometric distortions;
  - Reconstruction using stereo-photogrammetry:
    - Relative and Absolute Orientation;
  - Generation of the Georreferenced Mosaics

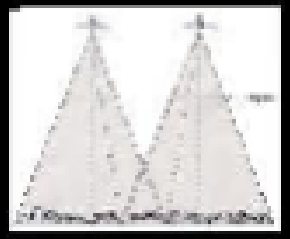


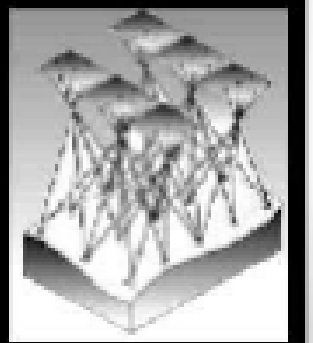
Correction of the Radial and Radiometric Distortions

- Camera calibration (TSAI and Trucco) gives coefficients for correction of the distortions (radial and radiometric);

$$x = x_d(1 + k_1 r^2 + k_2 r^4)$$
$$y = y_d(1 + k_1 r^2 + k_2 r^4)$$
$$r = \sqrt{x_d^2 + y_d^2}$$

$$E(p) = L(P)\left[\frac{\pi}{4}\left(\frac{d}{\hat{z}}\right)^2 cos^4\alpha\right]$$





Stereo-Photogrammetry

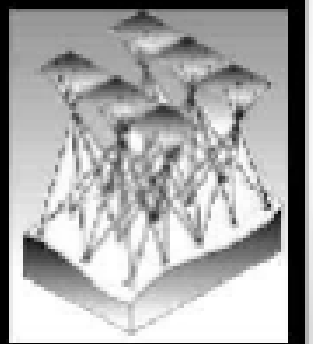
- Acquisition system guarantees longitudinal covering of about 70% and lateral covering of about 30%, between each image pair;

- It is not necessary to perform complete match, due to simplifications observed in the scene areas (area is almost a plane);

- Only 6 pairs of points known in each model (between each pair of images) are necessary for obtaining a good precision in the determination of the transformation coefficients;

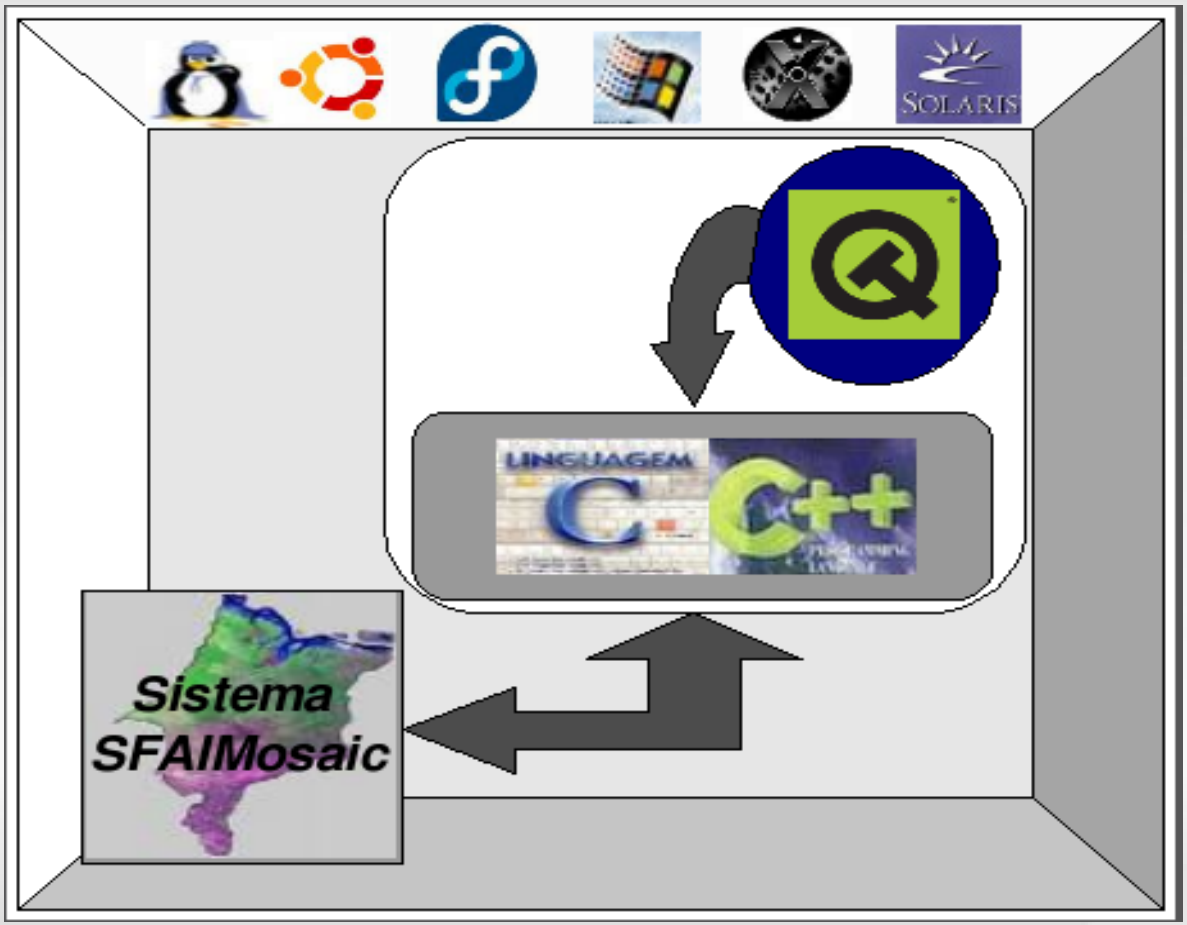
- Also, determine, approximately, spatial positioning of the helicopter at the moments of taking each image, given by the on-board GPS.

- The coefficients are then used to reconstruct the spatial positioning and orientation of the helicopter in each frame.

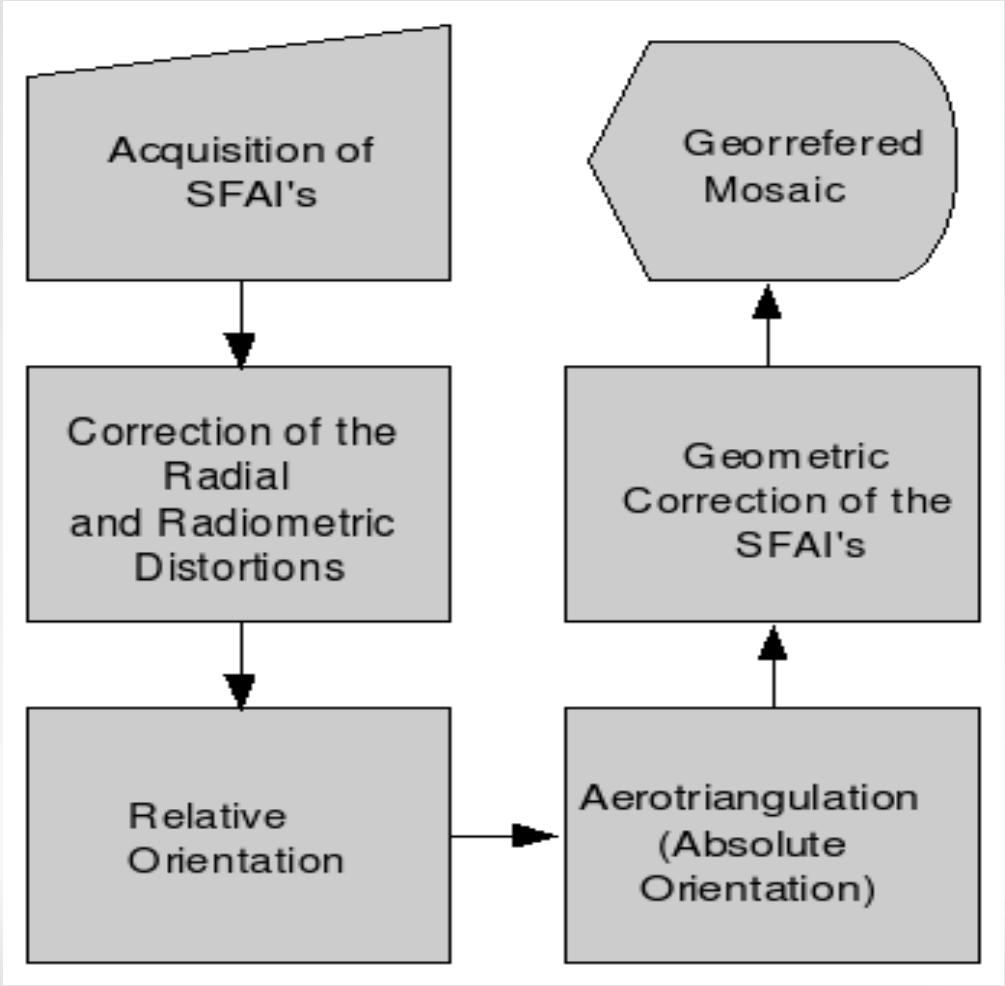


Implementations

The language used for the development this system, was C/C++, with libraries of the QT Designer.

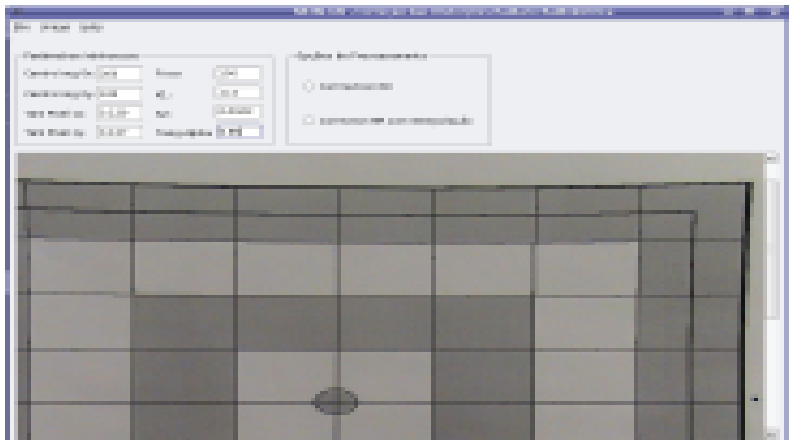


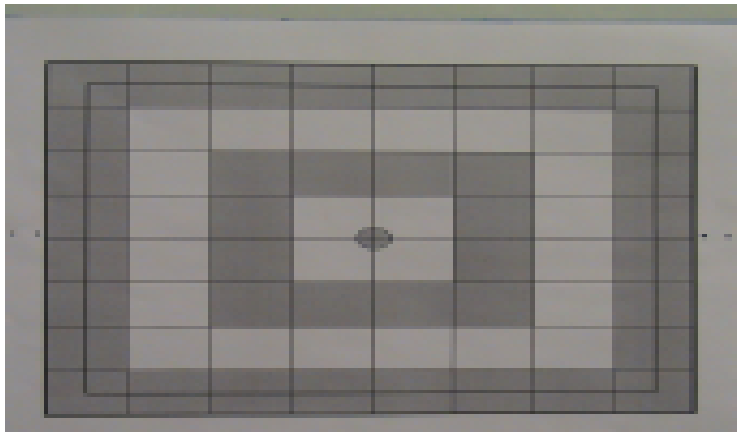
Implementations

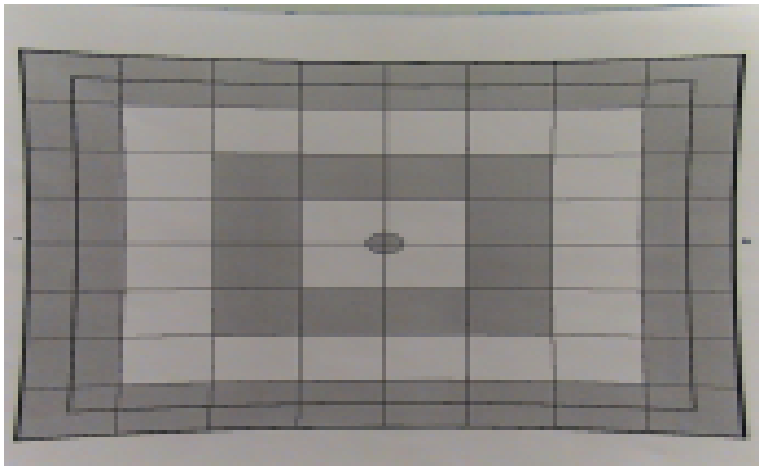


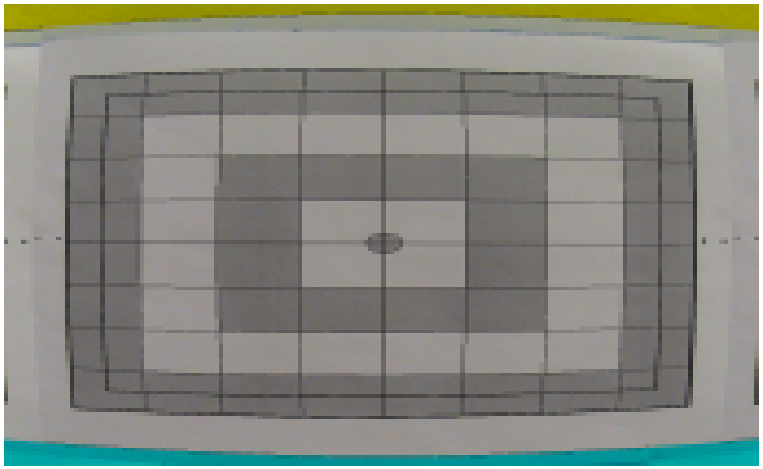
Partial Results

Correction of the radial and radiometric distortion



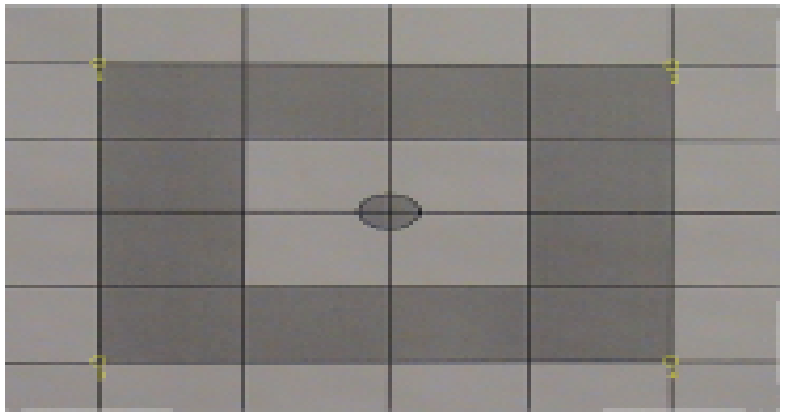


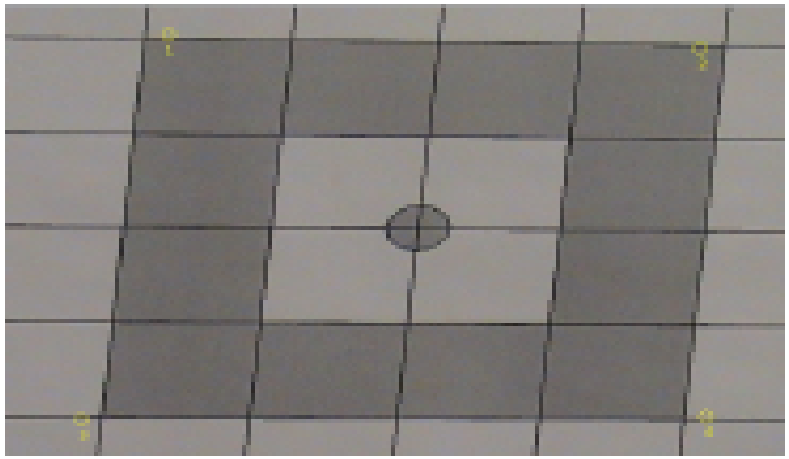


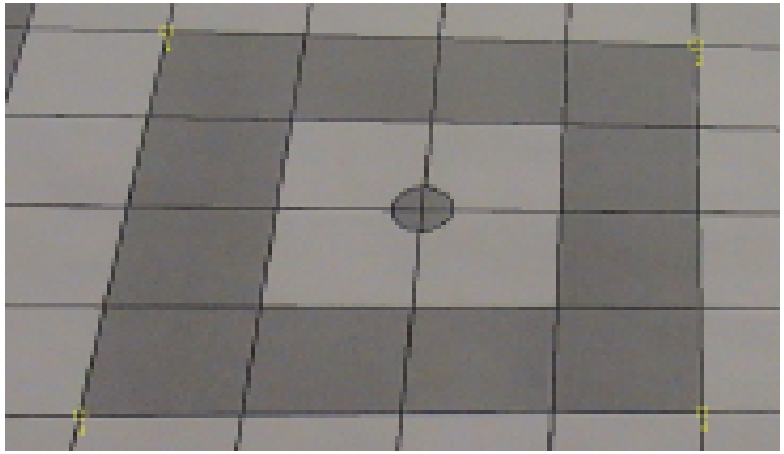


Partial Results

Affine and projective transformations applied in images;







Partial Results

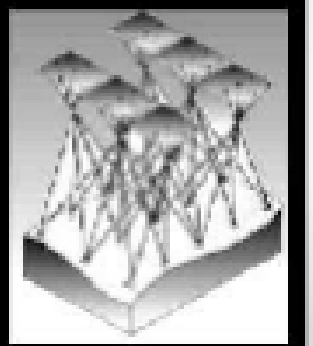
Generated mosaics without and with correction of illumination, respectively;

Conclusion

- Main contribution is the use of SFAI, that has not been, yet, widely explored in the generation of georeferenced mosaics;

- Adaptation of stereo-photogrammetry techniques allows the monitoring of environmental protected area;

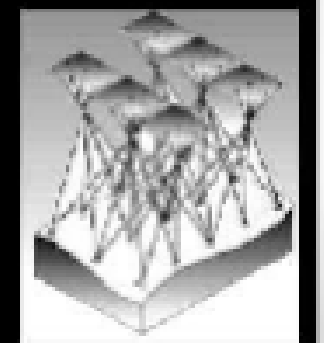
- Projects as our (NATALGIS) are essential to management of coastal regions. With the implementation of these techniques, we show to be possible to develop a low cost methodology, open source, and free code (will be available soon to all community);











References

[1] ***Albrecht, P. and Michaelis, B.*** (1998). Stereo photogrammetry with improved spatial resolution. In ICPR '98: PROC-Volume 1, page 845, Washington, DC, USA. IEEE Computer Society.

[2] ***Feldman, D. and Zomet, A.*** (2004). Generating mosaics with minimum distortions. In CVPRW '04: PROCVolume 11, page 163, Washington, DC, USA. IEEE Computer Society.

[3] ***Gonçalves, L***. Reconstruction from stereo photogrammetry - UFRJ - 1995. Rio de Janeiro - BRAZIL.

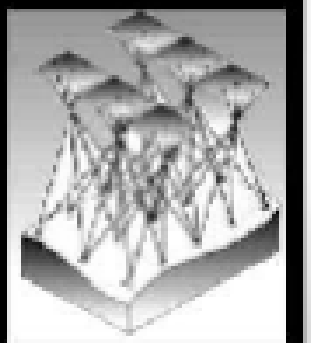
[4] ***Grandi, G., Mayaux, P., Rauste, Y., Rosenqvist, A., Simard, M., and Saatchi, S***. (2000). The global rain forest mapping project jers-1 radar mosaic of tropical africa. IEEE Transactions On Geoscience and Remote Sensing.

[5] ***Hsu, S.*** (2001). Geocoded terrestrial mosaics using pose sensors and videos registrations. In ICCV. PROC, pages 834–841. IEEE Computer Society.









References

[6] ***Lhuillier, M., Quan, L., Shum, H., and Tsui, H.*** (2001). Relief mosaics by joint view triangulation. In ICCV - PROC, pages 785–790. IEEE Computer Society, USA.

[7] ***Marr, D. and Poggio, T.*** (1979). A computational theory of human stereo vision. In PROC, volume 204, pages 301–328. Royal Society Publishing.

[8] ***Nogueira, F.*** Automatic generation of maps of disparity in stereo vision - UNICAMP - 1998. Master's thesis.

[9] ***Trucco, E. and Verri, A.*** (1998). Introductory Techniques for 3-D Computer Vision. Prentice-Hall, Upper Saddle River, New Jersey.

[10] ***Tsai, R. Y.*** (1986). An efficient and accurate camera calibration technique for 3d machine vision. In ICCCPR - PROC, Miami Beach, FL.

[11] ***Wolf, P.*** (1983). Elements of Photogrammetry. McGraw - Hill Book Company, Singapure.