3D-MODELING OF THE BRAZILIAN ANTARCTIC STATION COMANDANTE FERRAZ – A VISUALIZATION WITH ANIMATION

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ABSTRACT:

Brazil is a consultant member of the Antarctic Treaty since 1983; the construction of the Brazilian Scientific Station "Estação Antártica Comandante Ferraz – EACF" began during Operation n^0 II in January 1984.
Starting with the assembling of only 8 steel modules, the EACF is today a complex composed of more than 60 modules.
In accordance with the "Protocol of Madrid of 1991", which regulates the protection of the environment, the members of Antarctic Treaty are required to document their activities in their occupied areas of the Antarctic Territories by maps, charts, etc.
During Operation n^0 XXIV (Nov 2005 – Feb 2006) the area of EACF was surveyed. The result is a topographic plan in 1 : 500 scale – about 7.5 ha.
A photogrammetric documentation by orthophotomaps with a scale 1 : 50 of the EACF building's façades has to be performed also.
About 83 horizontal and 25 low altitude oblique (close to vertical) images were taken with a digital camera Sony 5.6 mega pixels from a helicopter.
The spatial coordinates of 21 targets, well distributed over the many façades of the building, were determined by a Total Station Leica TC 805, based on several traverse stations.
Later, the camera was calibrated according to the instructions of the PhotoModeler user manual. Processing of the images by PhotoModeler 4.0 Software, orthophoto-mosaicking, 3D- modeling, visualization and animation were performed.

1. INTRODUCTION

1.1 History

Brazil is a consultant member of the Antarctic Treaty since 1983. The construction of the Brazilian Scientific Station "Estação Comandante Ferraz - EACF " began in January 1984 during Operation No. II (November 1983-March 1984) of the Brazilian Navy, executed by " Diretoria de Hidrografia e Navegação - DHN " at the location: Admiral Bay, King George Island, South Shetland Archipelago, with Latitude 62^0 05´ South and Longitude 58^0 23´ West.
Starting with the assembling of only 8 modules(steel containers), the EACF is today a complex composed of more than 60 modules, which, at the time the photographs were taken, were under reconstruction, as shown in Figure 2.
During the same operation, the "**Brazilian Horizontal Datum 1984**" in WGS 72 was established by use of Transit - technologies with a Magnavox Receiver MX 1502. A reference azimuth was determined by astronomical observations (Wild T2 with Roelofs Solar Prism) completed by gyroscope measurements (Wild GAK 1)
A so-called "**Provisional Vertical Datum 1984**" was also fixed through tide observations by a level during a relative short period of time, compared with the Transit ellipsoidal heights corrected for geoid undulations.
Control points for hydrographic surveys were determined by traverses with use of electronic distancers (Wild Theodolite T2 / Distomat DI 20). Monitoring of the positions of bathymetry were obtained by continuous electronic distance measurement equipment: the Transponders of Motorola.

As a result of operation n^0 II the Nautical Chart n^0 25 121 "Baía de Almirantado" in 1: 40 000 scale with its derivatives
- Plano A in 1:20 000 scale
- Plano B in 1: 5 000 scale

could be published, in 1984. This was considered one of the most modern nautical charts of that epoch by the international hydrographic community, thanks to the high quality field equipment employed.

1.2 Operation n^0 XXIV

In accordance with the "Protocol of Madrid of 1991" , which regulates the protection of the environment, the members of the Antarctic Treaty are required to document their activities in their occupied areas of the Antarctic Territories by photos, maps, charts, etc.
In compliance with the above requirements, the area of EACF was surveyed during Operation n^0 XXIV in January-February 2006, which resulted in a topographic plan, shown later.
A photogrammetric documentation by orthophotos in a scale of 1:50 (or smaller) of the many façades of the EACF-building has to be performed also, which will be treated in the following chapters.

2. GROUND CONTROL

As common to all projects of IME, great care was taken :
- to guarantee an efficient ground control with necessary precision.
- to choose an adequate coordinate system for the projection of orthophotos.

Figure 1

Figure 2

2.1 GPS- Measurements

Two stations - Comandante Ferraz and Alice - of Operation n^0 II in 1984 were determined now again by GPS technologies in WGS 84 –System (**Brazilian Horizontal Datum 2006**) by use of 2 Trimble Double Frequency Receivers, model 4000 SSI, based on the permanent reference GPS antennas FERR and EACF of former GPS campaigns in that region of Antarctica. The latter is a station of continuous GPS - monitoring, integrated into the so-called " RBMC- Rede Brasileira de Monitoramento Contínuo do Sistema GPS " operated by IGBE- Instituto Brasileiro de Geografia e Estatística - (Brazilian National Institute for Carthography and Geoinformations)(see Figure.3) .

2.2 Electronic Traverses

Based on the already mentioned GPS stations- with coordinates in UTM - 2 traverses were planned, their 4 stations well marked at the existing rocks and then measured by use of a Total Station Leica TC 805 .
Later, the coordinates of the traverse stations were confirmed by GPS measurements with satisfactory results. (see Figure 3)

Here are shown some characteristics of the traverses:

Table n^0 1

Traverse No.1	Traverse No. 2
3 stations	5 stations
Extension : 788,90 m	Extension : 504,95 m
Closing errors :	Closing errors :
f E = - 2 mm	f E = -18 mm
f N = - 3 mm	f N = -12 mm
f s = 3,6 mm	f s = 21,6 mm
f h = 0 mm	f h = + 4 mm

2.3 Topographic Survey

Referenced to the traverse stations , the area of EACF was surveyed by use of the already mentioned Total Station TC 805 with 528 detail points. The result is a topographic plan in 1:500 scale- about 7,5 ha, as shown in Figure 4.

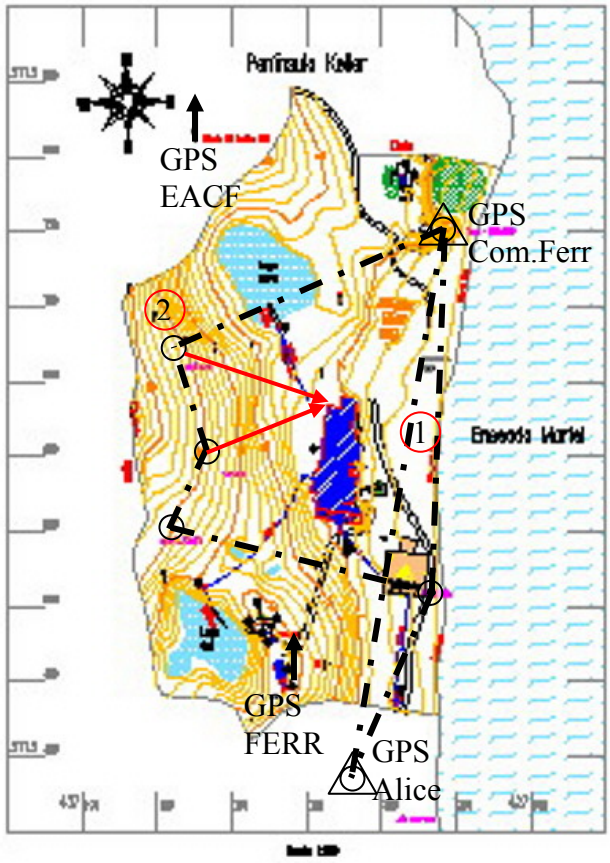

Figure 3

2.4 Control Points for Photogrammetric Operations

2.4.1 Targets

23 targets- with a size appropriate to orthophotos in a 1:50 scale and already numbered - were fixed on the walls of all façades around the building. The targets were protected with transparent PVC foils (see Figure 6).

2.4.2 Coordinate System

An adequate coordinate system- the so-called "Object System"- was chosen according to the experiences of former projects of IME as shown in Figures 5 and 6 (see Prado et al.: 2003 and 2005)

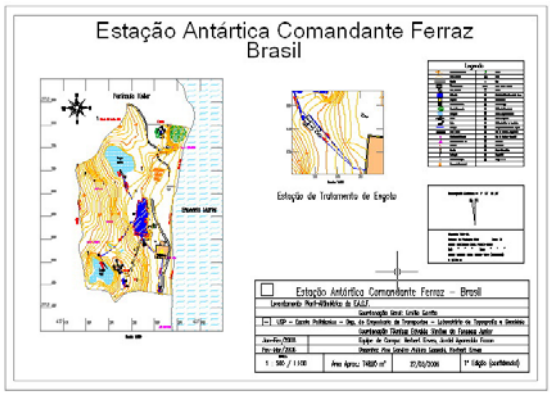

Figure 4

Figure 5

2.4.3 Measurements

The spatial coordinates of the 22 remaining targets (1 destroyed) were determined from the traverse stations by the TC 805, however, the distances were measured by the reflector in eccentric position. The determination of targets was made twice - from different traverse stations for control, in most cases (see Figure 3). This proved to be very helpful, because some errors occurred.
It should be mentioned that control point measurements were executed during the topographic survey, without loosing additional time.

2.4.4. Transformation of Coordinates

The target's plane coordinates in UTM - System were transformed into the Object Coordinate System through a so-called " Helmert- Transformation " by use of 5 identical points (see Prado et al. 2003 and 2005).
Later, the distances between targets, calculated from coordinates, were checked by tape measurements.

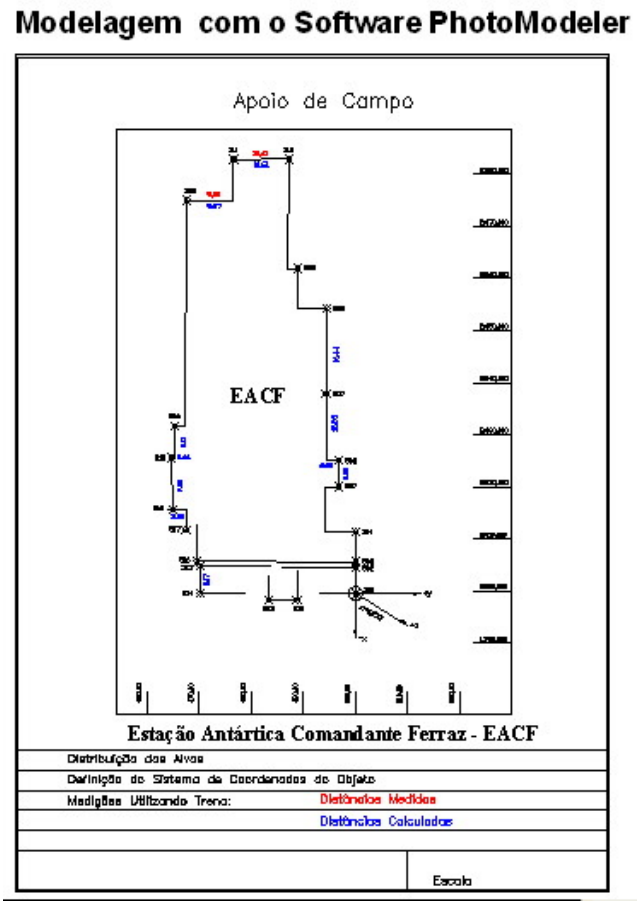

Figure 6

3. TAKING OF DIGITAL IMAGES AND CALIBRATION OF CAMERA

3.1 Images

About 83 horizontal images of the building's many façades were taken in several campaigns, due to bad weather conditions.
However, on a sunny day, it was possible, to take about 24 low altitude oblique (close to vertical) images of the building and surroundings of the station from a helicopter, operated from "NApOc Ary Rongel" - Navio de Apoio Oceanográfico (Support Ship for Oceanography and Antarctic Operations) thanks to the kind cooperation of the Brazilian Navy.

3.2 Calibration

Before starting the image processing, the used camera Sony 5.6 mega pixels was calibrated in accordance with the procedures prescribed in the PhotoModeler user manual (see PhotoModeler Pro. User Manual).

4. PROCESSING OF IMAGES WITH PHOTOMODELER SOFTWARE

Some of the taken images could already be processed by PhotoModeler 4.0 software.

5. RESULTS

After processing the images by the PhotoModeler software, some results could be obtained, as shown by the following examples:

- Orthophoto of a part of the main façade. (Figure 6)

Figure 6

- A rectified image of the roof. (Figure 7)

Figure 7

At the moment – June 06th 2007 – the assembling of orthophotos and the 3D-Modeling are still in progress.

6. CONCLUSIONS

The PhotoModeler Software proved to be very useful in the generation of the orthophotos for the assembling of the orthophotomosaic.

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