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Sistema para perfilagem de fundo na zona de arrebentação utilizando sensor de pressão

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Abstract - On this work, a successful device, fully developed at the Marine Physics Lab of the Center for Marine Studies of the Federal University of Paraná, Brazil is presented. Beside the working principles, the bottom profile methodology, also developed for this particular instrument, is described. Some examples, showing results obtained by the use of such instrumented sleigh are also depicted here. The system consists in an aluminum base, in a form of a snow sledge, equipped with a mini-STD, which is capable to measure at time rate of up to 1 measure each 1 or 5 seconds, water temperature and salinity, as well as the water column height. The pressure sensor has an accuracy of up to 1 cm. The device is deployed behind the breaking zone using a fisherman or small rubber boat, capable to depart from the beach. The device, measuring at its maximum rate, is then recovered using a long graduated and weighted rope. The recovering is performed, in a straight line, with intervals of 9 meters, stopping for a short period to obtain enough data in fixed points. When the device is still underwater, but near the beach, a leveling rod is located at the pressure sensor in order to reference the vertical profiles to a fixed land benchmark by using a precision topographic level. The topographic leveling is also performed over the beach. Pressure data are then filtered from wave action at lab, resulting in a full and complete topographic profile, from behind the breaking zone up to any reference point at the back of the sandy beach. The sledge format, the weighted rope and the filtering procedures ensured straight line profiling and an adequate elimination of the surface waves signal. The topographic profiles obtained and presented as examples, shown enough accuracy in depicting the effect of meteorological fronts over the sampled beaches.

Keywords - beach profiles, bottom profiler, beach dynamic.

INTRODUÇÃO

O levantamento topográfico das feições de fundo, presentes na zona de arrebentação de uma praia, através dos métodos convencionais de nivelamento topográfico, é de difícil realização devido às condições turbulentas, típicas da zona de arrebentação. Métodos alternativos de nivelamento topográfico para registro de feições de fundo, bem como o monitoramento de suas migrações, foram propostos inicialmente por Isaacs (1945, In: Reimnitz & Ross, 1971). Estudos alternativos da morfologia da zona de arrebentação foram iniciados no Brasil por Muehe & Souza (1997), seguidos por Martins *et al.* (1998), que desenvolveram trenós para a sustentação da mira topográfica, em porções da praia onde é difícil a operação da mesma na maneira convencional.

No presente trabalho apresentamos um sistema alternativo para o levantamento topográfico de perfis de praias incluindo sua parte submersa. Este sistema difere dos propostos por Muehe & Souza (1997) e Martins *et al.* (1998) pois utiliza medidas de profundidade, obtidas através de sensores de pressão, para

identificar os desníveis nas porções submersas do perfil, substituindo a mira topográfica.

DESCRIÇÃO DO SISTEMA

O referido sistema consiste em um trenó para medidas de fundo, construído em alumínio e equipado com um Mini STD Sordata SD200, que possui sensores tais como: profundímetro, termômetro e salinômetro.

A estrutura deste trenó apresenta dois esquis feitos de barras de alumínio com comprimento de 1,2 m, largura de 0,1 m e espessura de 0,01 m. Os esquis estão conectados por duas barras do mesmo material com comprimento de 0,65 m, largura de 0,05 m e espessura de 0,01 m. Montado, o trenó possui uma altura de 0,15 m. As barras transversais não possuem emendas, sendo suas extremidades dobradas e parafusadas nos esquis que estão separados lateralmente por uma distância de 0,55 m. Furos nas barras transversais foram utilizados para fixação do Mini-STD, dos cabos de resgate através de manilhas e de bóia de localização visual e/ou segurança (Fig. 1).

Figura 1 - Sistema de trenó equipado com STD SD 200. Possui como dimensões nominais 120 cm de comprimento por 75 cm de largura.

MÉTODO DE OPERAÇÃO

Utilizando-se uma embarcação capaz de transpor a zona de arrebentação das ondas em condições de mar calmo, o sistema é lançado ao fundo além da arrebentação e resgatado pela praia através de um cabo. Este cabo é chumbado a cada três m para evitar o arrasto lateral devido à deriva litorânea, servindo também para o controle das distâncias percorridas pelo trenó num alinhamento fixo.

Uma estação amostral é realizada a cada nove metros de percurso marcados através da graduação feita no cabo de resgate. O registro de dados no STD é pro-

gramado para ocorrer a cada cinco segundos. Em cada estação amostral o sistema permanece parado durante um minuto. Com o sincronismo de horários no aparelho e no relógio do operador, estas estações podem ser identificadas nos registros dos dados. A profundidade em cada estação amostral é definida pela média calculada para cada minuto de dados coletados, garantindo a filtragem do efeito das ondas de superfície com períodos não superiores a 15 s.

A transição entre o levantamento feito na parte submersa e o efetuado na parte emersa, através dos métodos convencionais de nivelamento topográfico, é feita utilizando-se a linha d'água como referência de nível em comum. Para tanto é medido o desnível entre o trenó, quando o mesmo atinge uma profundidade de cerca de 1 m, e da linha d'água, considerada como sendo a linha de areia saturada na face da praia.

RESULTADOS

Este sistema foi testado em praias do litoral paranaense que são predominantemente dissipativas, com baixa declividade e formadas em geral por areia fina à média. Como exemplo dos resultados gerados por essa nova técnica apresenta-se uma comparação das mudanças morfológicas sofridas por duas praias, Balneário Atami (Fig. 2) e Balneário Caravellas (Fig. 3), após a passagem de um sistema frontal ocorrido entre 25/05/2000 e 07/06/2000.

Figura 2 - Comparação das mudanças morfológicas sofridas pelo perfil da praia do Balneário Atami, após a passagem de uma frente meteorológica.

Figura 3 - Comparação das mudanças morfológicas sofridas pelo perfil da praia do Balneário Caravellas, após a passagem de uma frente meteorológica.

CONSIDERAÇÕES FINAIS

Os resultados do emprego dessa técnica têm sido satisfatórios para a utilização do sistema em praias dissipativas, com declividade suave e durante condições de mar calmo. O sistema proposto neste trabalho é de fácil operação e sua construção é de baixo custo. O elemento mais oneroso do sistema é representado pelo Mini-STD.

Como desvantagens dessa técnica podem ser citadas as seguintes:

- a) Necessidade de utilização de uma embarcação;
- b) Medidas de distâncias na porção submersas são imprecisas, porém aceitáveis devido às grandes dimensões e suavidade das feições alvo.

Como vantagens na utilização dessa técnica podem ser citadas as seguintes:

- a) Grande abrangência do levantamento em termos de extensão do perfil investigado;
- b) Possibilidade de medição de outros parâmetros físicos como salinidade e temperatura ao longo do perfil.

Vale realçar que as condições do mar têm um importante papel, pois o tamanho das ondas pode impedir a operação de embarcações e correntes de deriva muito intensas podem aumentar a imprecisão das medidas de distâncias na porção submersa do perfil.

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Capture Small Format Aerial Digital Images Using the Airborne Data Acquisition System (ADAR-1000) from Positive System Company (USA)

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Abstract - That work is about the experience of FURG (Fundação Universidade Federal de Rio Grande), RS, in capture little size (35 mm) and low altitude digital images using a Cessna 182 "Skylane" airplane, like flight platform, and the Airborne Data Acquisition System (ADAR-1000) supplied by Positive System Co., USA. Several images were acquired in RGB and infrared band covering different areas (rural, urban and coastal zone) and flying in different levels (from 500 to 7000 ft). Airborne Data Acquisition System (ADAR-1000) and Cessna 182 "Skylane" characteristics are presented, likewise, are commented necessities modifications in airplane to receive the "ADAR-1000". The importance of navigation GPS for correct fly over flight lines and individual activities of crew are reported. One flight operation with "ADAR-1000" system is described in details. At the end, problems and solutions are subject of discussion and analysis concluding from the advantages and disadvantages in use the "ADAR-1000" system.

Keywords - Aerial Digital Images, Geographical Information System, Small Format Aerial Photographs.

INTRODUCTION

Activities using aerial images acquired by digital cameras in small format and low altitude has been made in United States and Canada since earlier of eighties, both for environmental and urban mapping (Disperati, 1991).

Digital images with 35mm has been used for many different applications, mainly in Geographical Information Systems (GIS). Many researchers are working in to compare results between both digital and conventional cameras, for every situations. Klödtz & Geerders (1998) used aerial digital images to study costal zones and the principal advantage found was the prompt processing and evaluation of photos conditions through classification and enhance computation technique.

Hardy & Burgan (1999) presented results got with the first generation of multi-spectral (4 channels) "ADAR-5000" in acquisition of *Normalized Difference Vegetation Index* (NDVI), using seasonal monitoring of natural vegetation wet. Phinn *et al.* (1999) used high resolution digital images acquired by infrared band of "ADAR-5500" system to determine vegetation structural parameters as indicator of salt marsh vegetal kinds in the south of California. Coulter *et al.* (2000)

studied the utility of high resolution infrared digital images (1 m) from "ADAR-5500" to get vegetation mapping for use in GIS and the results showed witch this images are sufficient to mapping in detail most parts of vegetation classes.

Aerial digital cameras are still in the beginning of life as compared as with conventional cameras, meanwhile, air-photogrammetric digital cameras like "ADS40" from LH System already can be found.

Small format systems present low operational cost and can be used by medium and little counties, as the case of Rio Grande County, RS, Brazil. Then, to make rural and urban aerial mapping of Rio Grande County, FURG (Fundação Universidade Federal de Rio Grande) acquired from Positive Systems Co.-USA, the Airborne Data Acquisition System (ADAR-1000).

The 'ADAR-1000' is the first of a series ('ADAR-3000', 'ADAR-5000' and 'ADAR-5500') being the last two multi-spectral systems. Originally, this equipment was designed to mapping and monitoring secret plantations of '*cannabis sativa*', but with the time showed good performance in other jobs.

This work presents the experience of FURG in acquisition of small format and low altitude digital images, using a Cessna 182 'Skylane' airplane and the 'ADAR-1000' system, over the Rio Grande city.

METHODOLOGY

The Airborne Data Acquisition System (ADAR-1000)

The 'ADAR-1000' is a set of digital images capture devices, supported by a GPS, managed by a PC through of several specific software and supplied by a proper power unit (Fig. 1) (Positive Systems, 1998).

The principal part of the system is the digital camera 'DCS 460 CIR' with body and lenses by Nikon and hardware/software by Kodak. The 2036 x 3060 pixels of resolution build images with 6.230.160 pixels, which are stored in 6 Mb row format file. Capture images could be possible in either RGB or infrared (IVP) format.

To operate the system in RGB or IVP mode is necessary to use correct lens and specific camera configuration. The image device is constituted by CCD (Charged Coupled Device).

One video camera 'Pulnix TMC-7' makes permanent images of the ground below the airplane which are showed in a 'Marshall V-LCD4-PRO' video monitor, giving a view of ground to operator.

One PC 'Field WorkStation 7000', designed to field works, with GPS into, manage all system and store into HD 1.7 Gb of acquired images (Fig.1).

Two software are used by the system: 'ADARFM 57' and 'ADAR IMAGE VIEWER'.

The 'ADARFM 57' is used for:

- To control camera system during the images capture.
- Together with GPS system to control flight conditions (airplane actual position, altitude above the ground, ground velocity and airplane head direction).
- To build an airplane trajectory coordinates file (will be used in post-processing work to identify image central point).

The 'ADAR IMAGE VIEWER' is used for:

- To access captured images and look at it in real time, it's important to control images quality during acquisition process.
- To change image file from acquisition mode (6 Mb) to full resolution mode (18 Mb) for a correct post-processing job.

Figure 1 - ADAR 1000 System.

The power device is a unit composed by transformer and rectifier supplied by 300 W from either CA 127/220 V or CC 12 V sources.

The Airplane

The used framework was a Cessna 182 'Skylane', a single-engine and high-wing plane adapted to receive the 'ADAR 1000' (Fig. 2).

An annular 12 inches diameter window was open in the airplane floor, over which was installed a 'camera housing' contends the 'DCS 460 CIR' camera and the auxiliary video camera 'Pulnix TMC-7'. For equipments installation was necessary release space in back part of airplane, this was made removing the back bench.

In the same space was also installed a chair for the operator of the system and a table to support computer and video camera monitor. The power control unit was placed in the load compartment and the antenna GPS of 'ADAR 1000' was fixed in the external part of the plane.

The power control unit of 'ADAR 1000' is fed by CC/12 Volts and 300 Watts of airship power system.

Some difficulty was found in opening the 12 inches diameter airship floor window by the structural parts of the cabin and also because there are the command cables of rudder and rudder elevator which pass into the inner space of cabin floor.

This airplane type can operate so much in paved airfields as in earth runways, what favors operations in areas that don't have close airports, alternative runways can be used at farms. The maximum speed of the airship is 240 mph and its autonomy 4 hours.

The Flight Plan and the Navigation GPS

To capture quality images represents the most important stage of process because bad data or not registered data are lost information.

In that context, the flight plan acquires great importance and it should be planned by professionals which domain each stage of whole process. For larger details about the creation of a flight plan, are suggested

Figure 2 - Airplane Cessna 'Skylane' 182.

Marchetti & Garcia (1986); Lillesand & Kiefer (1987); Disperati (1991) and Dalmolin (1999).

The objective of flight should be established with clarity because flight parameters and acquisition patterns are defined in that stage. Images can be used for several purposes and to each application are associated particularities of acquisition. Details neglected in this stage are responsible by future difficulties in the processing and interpretation.

To know work area in detail is also an important factor: geography, topography, weather, intensity and direction of the winds. Lateral winds can be associated with strong drifts or high angles 'K' ('crab'- angular displacement of airship around vertical axis), head or tail winds, when well used, can help in low altitude flights.

It is important to know the available airports and possible alternatives, far airfields and unstable weather diminish useful work time in the air. At same time, alternative airfields can be used for local fuel supply or maintenance providing gain in time and safety flight.

The base map is a important instrument on which the flight lines are traced. In Brazil is common to use for it maps made by Brazilian Army. During flight is possible to happen route deviations, which are caused by insert wrong coordinates in GPS, the best way to identify them is comparing important features over the ground with base map registration.

Experience has showing importance of a entrance and exit points coordinates file (UTM or LAT/LONG) for each flight line. This file also should contain the sequential number of entrances and exits point and each corresponding flight line number which will facilitate insert and conference data in GPS, along the flight.

Special care is necessary with the side overlap, which in generally is about of 40%. To get a good side overlap is necessary a correct navigation over the flight lines.

Drift, tilt, crab, altitude variation and ground reference loss are very common during the flight.

Whole work quality can be lost, if airship presents quick position's change over the flight line, escaping from the parameters established in flight plan.

For this reason, visual flights are exposed to strong quality loss, although they have some success chance in low altitudes, well-known and well demarcated land, specific and very defined targets, with individual and short flight lines.

The better way in get parallel and even lines during the acquisition images flight, is use an aeronautical sailing GPS or similar, a light-bar device and one automatic pilot. However, due to the high cost of these equipments a minimum configuration demanded for a professional quality work is use an aeronautical sailing GPS or similar, to visualize on screen the flight lines and the current position of airplane.

In that project was used a Garmim-95 navigation GPS. That is a low cost equipment and presented all functions demanded for a quality flight. This equipment allows to insert entrance and exit points coordinates each flight line; it allows to define way-points in agreement with the plan flight; it allows to generate routes coincident with the planed flight lines and to establish the azimuthal direction of each route.

Garmin-95 allows to activate one route each time. The active route appears in an outstanding way in the GPS screen, while a mobile icon with airplane format, shows in screen the current position of the airplane over the flight line. It will also permit create a file with positions of airfields cooperating with flight safety.

The GPS screen visualization scale should be chosen in function of both work area size and flight lines lengths. For flight lines length of 4 km was used one approaching scale of 1:5 and one entrance flight line scale of 1:2, that scales allows a good visualization of flight lines in GPS screen. This choice should be made together by the navigator and by the pilot in function of the available GPS. Only six routes at each time must be used in GPS memory, so that, there isn't a saturation of GPS screen with points of disabled routes that only difficult the visualization of active route.

The training, ability and experience of the crew are responsible for a good approaching and correct entrance in flight line and stable airship flight over the traced route.

The Crew

A good number of members of the crew, is three: a pilot, a navigator and a operator of 'ADAR-1000'. In full automated flight conditions as the system known as 'ENZO Mosaic' (1997), it is necessary only to involve the airship pilot which decreases operational costs.

In case of 'ADAR 1000' could be possible to use only two members: the pilot and the system operator, but the difficulties increases very much and it can growth final cost face possibility largest operational mistakes and time losses.

Each member of the crew should know own yourself importance in the context, to be able to solve problems which involving own yourself specialty, to know his colleagues specific activities and to be clear general objectives of flight. In that way, the crew can to give solutions for unexpected problems along the flight.

The flight plan should be elaborated by the crew's members or at least with their direct participation. The pilot must to take knowledge about atmospheric conditions, operational and normative demands for the flight area, permanent contact with traffic controllers and with other airships flying into the aerial zone, to care flight safety, to configure and to drive airship into plain parameters.

The navigator must to use the navigation GPS and sailing charts, to establish and to control the accuracy of routes and help pilot during the approaching, entrance and sailing over flight line.

The operator must to configure and to operate the digital camera, video system and GPS of 'ADAR 1000' using the airborne computer. He must also to observe land features in real time, to decide to start and to finish images acquisition, to monitor flight altitude, crab angle, tilt angle, ground speed and together with pilot to make flight corrections. At same time the operator must check the quality of the images and to decide about new acquisition when problems are detected.

For a team to reach good results with professional quality are necessary at least 50 hours of effective flight and a strong theoretical base.

RESULTS

Flight Procedures

Before and during the airship taxiing, onboard equipments should be started and tested in one full checkup. A fast review of flight plan should be made avoiding setbacks during the work. It is more easy, cheap and safe to stop flight in this moment than after take off.

The take off must be authorized only when 'ADAR-1000' and navigation system are ready and working. Checkup airplane equipments is a pilot responsibility.

GPS system should be placed in navigation mode after take off with active route going to entrance point of first flight line. One scale which can to facilitate the pilot in visualization and maintenance of course must be chosen. This scale should be defined in function of the distance between airfield and work area.

When airship is closing to entrance point of first flight line, the route corresponding that line must be activated (usually denoted by Lv1) and must be used one approaching compatible scale, generally function of line's length. In this phase is suggested a full visualization of all lines inserted in GPS and the use of all inserted way-points together active route in outstanding mode.

Pilot musts to drive airship to entrance point and at the same time should to execute necessary airship configurations to get stabilization in altitude and ground speed. When airship gets near of entrance point scale should be altered for a larger value, liberating screen exclusively for use of active route, this will allow a final approach with great precision, avoiding abrupt direction changes. Abrupt changes are important factor of quality fall off in first images of line.

During approaching the operator should prepare acquisition system to start. The 'ADAR 1000' GPS system must be registering airplane flight positions coordinates second by second; the flight parameters should be monitored and showed to the pilot, so that his can execute necessary flight corrections; the camera should be ready to start; the computer file that will receive acquired images should be opened and activate; the capture mode (singular or continuous) must be defined and started; and the operator should be looking land features to decide moment capture start.

The first raid should be not used to capture images but only to carry out some adjustments that can only be done during flight, such as the fine adjust of ground speed, the camera level and crab angle 'K'. After corrections above should be re-started the flight over first line from the entrance point starting finally the acquisition images. Full flight and acquisition parameters should be monitored along all line and reviewed on each new line.

Eventually, problems can happen, and the most common are: wrong entrance over the flight line; loss route with lateral deviations; over-run problems, with data transfer time from camera to computer larger than images acquisition time; image loss due to internal conflict of the system; loss GPS satellite sign; loss data from GPS

coordinates file; cloud presence between camera lens and ground, and shades covering target by presence of clouds above airship. Problems such as wrong routes and mistakes in input of waypoints, can also happen.

The crew should be always alert because the problems above can mean need re-start work and is always easier and cheap to solve problems during flight.

Final Products

Up to now, some important works were made with ADAR-1000 system and they will be presented with details in further and specific reports. In this paper only a few words will be said about it, because it's no principal subject that work.

Among several applications is important to refer especially:

1. Elaboration of ground digital model of 'Saco da Mangueira' edges (internal shallow water body), Rio Grande city.
2. Location of fine mesh nets used to capture shrimps into Patos Lagoon estuary.
3. Geographical referred images mosaic of 'Porto Velho'

(ancient part of Rio Grande docks), Rio Grande city.

4. Geographical referred images mosaic of 'Super Porto' (Fig. 5) (modern and large segment of Rio Grande docks), Rio Grande city.

5. Geographical referred images mosaic of 'Ilha dos Marinheiros' (Fig. 4) (important estuarine island near Rio Grande city).

6. Sequential aerial images along Rio Grande do Sul State coastal line from Chui to Torres (south of Brazil).

7. Geographical referred images mosaic of urban zone of Rio Grande, RS (Fig. 3) (belong to the Rio Grande city-GIS).

DISCUSSION

Operational Particularities of the System

In one flight operation, as above described, can happen several operational problems, linked to the system or to the crew, which must be solved in local.

When the airship is moving aerodynamic speed is measured through one 'Pitot Tube', this is a relative speed between the airship speed and the external air

Figure 3 - Urban image of Rio Grande city, RS, acquired by ADAR 1000 System. Flight level: 2500 ft. Pixel resolution: 0.37 mpp.

speed, however, to get aerial sequential images is necessary to use the absolute speed between airplane and the ground and called here as 'ground speed'. The 'ADAR 1000' allows to measure ground speed through GPS system.

The minimum speed of Cessna 182 'Skylane', for an even flight, is 90 mph. In fitting ground speed it's possible to appear a tilt (angular displacement of airship around cross axis) when actual airship speed is below the minimum airship speed for even flight, however, when there is a small angle (until $\pm 5^\circ$) it can be compensated by changing in camera housing position.

The smallest acquisition time interval of 'ADAR 1000' is 12.5s (time interval between two consecutives images when in continuous mode). By Positive System Co. this is the minimum time that the system needs to transfer the last captured image from camera to computer. When is used time values smallest of 12.5s is possible to appear some over-run problems,

this happen when the new image is acquired before previous image is full transferred from camera to computer, this provokes conflict and locks the system.

During low altitude flights at 60% longitudinal overlap to stereoscopic images with acquisition time interval below the minimum time allowed by the system (12.5 s), there is need to use a very low ground speed, and it, provokes an accentuated tilt impossible to compensate moving camera housing.

Operations in very low ground speeds only are possible with total use of flaps and partial cut of motor power, but it, provokes a partial lose of airship sustentation which migrates from wings to propeller. With it, airplane hang in propeller taking an inclined position with longitudinal axis, with prow higher than tail. In cases of tilt higher than 5° is impossible to compensate it only changing camera housing positions.

Experiences using wind as aerodynamic brake present good results. The airship must be driven over flight line and against the main component of wind,

Figure 4 - Image of Rio Grande coastal plain showing pine tree plantations, vegetable plantations, land road and coastal line of Ilha dos Marinheiros, Rio Grande, RS. Flight level: 2500 ft. Pixel resolution: 0.37 mpp.

Figure 5 - Mosaic of Rio Grande Super Port, Rio Grande, RS, done with Arc View software. Flight level: 7300 ft. Pixel resolution: 1.08 mpp.

this can cause high crab, but crab can be easily compensated by $\pm 45^\circ$ move around of camera housing. In this case all flight lines should be traveled using same sense (Fontoura, 1999).

The adjust of crab is made rotating the camera housing around an angular ring. The value used is the difference between prow angle, given by GPS of ADAR-1000 and the route azimuthal angle, given by sailing GPS of airship.

In most operations the time that airship spend moving on flight line is equivalent at time spent in approach, is important to use this time to check quality of acquired images and to prepare system to next images.

Important system limitation is the capacity of images storage (1.7 Gb), that corresponds 280 images in acquisition mode (6 Mb). That can seem a sufficient space, but in extensive works where the number of images is larger than this is necessary return to land to discharge computer and it is very onerous, mainly, when work area is far of airfield. A possible solution is to expand the storage capacity changing the Hard Disc or introducing one Zip Drive device.

Special attention should be given to the target type that wants record. Alterations in vegetable base are easily interpreted when used infrared images, meanwhile, images of water bodies should be made distant of middle day, avoiding sun-spots. Sun-spots are important light marks, superimposed on the images, which provokes permanent damages.

Urban zones demand differentiated treatments between no densely built areas and densely built areas. Target definition in no densely built areas is easier. For densely built areas solution can be make images in lower levels.

In rural and coastal areas sandy grounds present high reflection facilitating to look trails, however targets into fields of dunes present difficult identification. Metallic, clears or strong color roofs are highly identifiable in images captured above 7000 feet.

However, dark colors and colors without shine are practically invisible even for low levels.

Others two important system limitation are: the low definition of camera video (Pulnix TMC-7) in flights above 3000 feet and value of minimum acquisition time interval (below 12.5 s). This small value impede sequential acquisitions in altitudes below 500 feet (important in acquisition of details) and put great difficulty in to use maximum airship speed above 7000 feet (important in reduction of final product cost). A possible solution for camera video limitation is to change that one by other with higher definition.

CONCLUSIONS

Many flights made over Rio Grande, RS, allows to conclude that ADAR-1000 system offer great operational versatility, easy installation and handle and functional safety.

The final product presented good quality in urban works as well as in environmental studies with excellent results in Geographical Information Systems (GIS) (Hartmann, 1999).

By its simple operation and good results, the ADAR-1000 system is a fit equipment to mapping studies and environmental resources. Actually, images made by this system are being analyzing to photogrammetric application, with goods results.

Finally, concludes that non expensive airships conjugated with 35 mm digital acquisition systems, are most economic way to obtain aerial images for several applications.

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