APIAS – AIRBORNE PHOTOS AND IMAGES ATTAINMENT SYSTEM

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Abstract
The attainment of photographs and images through photogrammetric flights and space sensors is not cost-effective, if the purpose is just to carry on a thematic analysis of a small isolated area. An alternative to this application is the use of a radio-controlled aircraft, equipped with a conventional camera with a wireless shooting device. Starting with the construction of such aircraft, and the execution of a testing flight in a limited area, images were obtained, evaluated about their quality, and then digitalized and photo-interpreted, with mostly of the available information being retrieved. Thus, it became possible a more comprehensive evaluation about the feasibility of such technique and its application in several fields of knowledge.

INTRODUCTION
Conventional photogrammetry is a widely spread technique, applied in mapping. Its utility is beyond any discussion, and its methods are often in progress. Its quality is due to the use of high precision cameras and sophisticated electronic and computing devices, operating along with precise set of lens. These equipment bear fiducial marks (that allow models orientation), constant focal distance, and 23cm x 23cm size negative, which allows better trade between covered area and flight scale.

These cameras are generally positioned in aircraft and helicopters, and the taking of images of an area depends upon a set of factors, that must be considered in the phase of planning that precedes the flight. All these previous proceedings, plus the after-flight proceedings turn airphotogrammetric setting up a very expensive technique, narrowing its application to large area projects. This kind of flight depends also upon climate factors and authorizations from the Civil Aeronautics Department (DAC).

When one is willing to analyse the characteristics of an isolated small area, one alternative is the use of an old flight images. However, depending upon the region, those images can be out of date, and maybe mismatching the needs of the users.

Another possibility is the use of orbital sensors digital images. The use of this kind of images is widespread, and its application, that until the last decade was limited to large areas of Earth surface, due to the little space resolution, is becoming more accurate and specialized due to improvements in satellite sensors, with high resolution capabilities.
IKONOS and QUICKBIRD images can lay detailed informations about Earth surface targets, with space resolutions close to 1 meter and in short time periods, which allows constant up to date. This resolution allows several kinds of analysis in a given area, such as: rural planning, precision agriculture, and rural monitoring. The disadvantages of this kind of technique are its high cost, around US$ 25,00 per square kilometer, and the need to employ modern and sophisticated processing techniques and equipment.

Research developed since the 70ies, shows that to analyse the characteristics of surface areas, the photointerpretation of images obtained through small frame conventional cameras (focal distance ranging from 35 to 80 mm) is enough and offers excellent results, thus dispensing the use of complex photogrammetry set of instruments, and turning the process financially attractive, as long as the topographic detailing is not a target.

There are small frame cameras specific to airlifting that can be also used in mapping. To allow that, the big distortions inherent to this system had to be offset. This was reached in the decades of 70 and 80 through the development of new computing models and analytical methods. Karara (1980) came up with a model called DLT (Direct Linear Transformation), an analytical solution that relates the comparing coordinates straight to the space-object coordinates, thus dispensing the use of fiducial marks. This transformation allows the camera’s self calibration and the dismissing of many instrumental, financial and human resources. However, the forthcoming development of digital products restrained those researches before the technique could be more widely studied and used.

So, the use of small frame pictures was limited to obtain a sinoptical vision of the area to be analyzed, what anyway, helps a lot the task of mapping, considerably reducing time and cost in the construction of the desired map by suppressing many field analysis. This allows the use of common small frame cameras, smaller and lighter than those specifically employed in airlifting, thus dispensing the use of conventional aircraft.

A practical, cheap and fast way of obtaining aerial pictures of a small area with common cameras is installing them in a radio-controlled aircraft (airmodel), then setting flight altitude, speed, exposure time, and kind of film to be used, according the field of interest, in order to achieve the best use of the final product. If properly taken, these pictures will bear quality enough to allow a proper photointerpretation, from where interesting information can be obtained.

CONSTRUCTION

Prototype
The assembling of a small radio-controlled aircraft, able to bear a camera and overfly an area, started with the adapting of a standard model, that can be found in the airmodel market, originally used to prepare beginners in the art of airmodeling, and able to perform a stable, low speed flight, with good altitude control, thus allowing clean, uniform and overmatchsing pictures to be taken (so that those pictures can be used in the future in topographic purposes). The standard model, with small wing range, performed a flight turbulent enough to interfere in picture quality, so harming the photo interpretation. To tackle that problem, a new aircraft was built, keeping almost the same features of the precedent, except wing range (2,2 m). This new model, besides greater load capacity, enough to bear even a video camera, has excellent quality. The model can be seen in Figure 1 and flying in Figure 2.
A standard camera was chosen to take the pictures, due to its low cost, but any other device can be used (digital cameras, movie cameras, compact cameras). The camera was easily installed due to the wide enough aircraft body.

As far as the shooting mechanism is concerned, although electronic systems were available, a servo mechanism was rather used, able to be mechanically operated by the emission of radio signals, so that the aircraft flyer could be also the camera shooter.

**Cost**

Table 1 below presents how much which the financial expense with the project.

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model (material)</td>
<td>150</td>
</tr>
<tr>
<td>Model (assembly)</td>
<td>65</td>
</tr>
<tr>
<td>Engine</td>
<td>75</td>
</tr>
<tr>
<td>Radio – control</td>
<td>240</td>
</tr>
<tr>
<td>Camera</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>550</strong></td>
</tr>
</tbody>
</table>
AIRLIFTING SCHEME

The airlifting scheme is described in Figure 3:

Figure 3: Main Phases of airlifting (Gonçalves et al., 2003).

FLIGHT

Testing area

The area chosen to be overflown belongs to the Portuguese-Brazilian Society of Presidente Prudente, and is located in the municipality of Alvares Machado, SP, where there is leisure club with an paved airmodeling runway, what allows the aircraft operation. The club borders with producing rural properties, and reaches the edge of an intermunicipal road, thus offering a good base of aircraft operations and interesting elements to photointerpretations.

To built a case study, the premises along the airmodel runaway were selected as photointerpretation targets.

Flight cover

To secure total runaway cover, the aircraft flew approximately 70 m high and at 10 m/s speed.

The utilized camera has a 35 mm focus range, and the shooting was made randomly, while the craft was overflying the targets. The model bears a 250 ml fuel tank, with a 25 minutes flight autonomy, what allows the target region pictures to be taken in a single flight.
INTERPRETATION

Image selection
The processed pictures were analyzed, to determine which of them were appropriate to the project and which had to be put away. A set of intuitive criteria were employed in this task, using elements as scale, brightness, color range, contrast and resolution.

Although showing good stability and control, the aircraft, influenced by climate elements, changed its altitude while taking some of the pictures, which were put aside due to its not compatible scale. Pictures that were not accurate enough to allow the identification of the photographed targets, or exhibited scrolled images, were put aside.

To improve image quality, some of the camera parameters were modified, such as the time of exposure. In this case, this problem was solved by changing the flash system position, because this, when out of use, extends the time of exposure, causing image scrolling. As the available light was enough, and the camera had good features, the flash was set in the position “automatic”, where the light amount is measured by a sensor device installed in the own camera, thus controlling the exposure time. So, after that, the pictures dramatically improved, allowing a good photointerpretation.

Information retrieval
The visual interpretation of images was originally conceived to retrieve data from air photographs, the process being called photointerpretation. The photointerpretation is directly related to the visual accuracy of the interpreter, along with his or her scientific knowledge, activity and degree of mastering of the image acquisition system. Thus, no matter what the photointerpretation purpose should be, a good conceptual background, application experiences and related areas knowledge are required, so that the aimed that should be criterionly retrieved.

The visual interpretation of image can be ordered into three related phases: photoreading, photoanalysis, and photointerpretation itself. Photoreading consists mainly in identifying, or recognizing, the objects (faces) in the images. The photoanalysis deals with examining the objects, trying to establish the relations, associations and orders among them; and the photointerpretation deals with the definition of the objects and faces present in the scene, using inductive, deductive and comparative methods.

Visual interpretation requires training and the use of logic criteria to develop the process with the employment of visual data retrieval method.

Interpretation elements
The images represent the recording of the energy coming from the surface objects. Those images can be of several resolutions and scales, but beyond that, show some basic elements that allow the retrieval of information from the terrain. There is no consensus about which elements should be considered in the visual analysis of images, however the most widely accepted are: colour, texture, shape, standard, shadow, localization, convergency of evidences, size and resolution (often considered as image characterizing element).

Photointerpretation of the object of study
Pictures were taken from several points within the club, but just were selected those that targeted the object of study, that is the flight runaway.
With the chosen images, an uncontrolled mosaic was set, because in that starting phase of the project, neither the aircraft altitude control mechanism, nor the spatial coordinates of the region were available.

The image were digitalized by the use of a scanner (...) with 150 dpi resolution, and manipulated with a Corel Draw 9 software to built the mosaic.

**RESULTS**

**Immediate**

In the mosaic, can be identified since the constructions and runway infrastructure details to the people and cars present in the scene (Figure 4).

![Mosaic of the flight track](image)

Existing trees around the runaway, and the variations of the green cover of the soil opposed to the constructions in the runway, are other samples of interpretation obtained with the use of APIAS.

With the help of the topographic lifting, the region’s space coordinates can be determined and even use the images to sponsor mapping field visits.

**Future expectations**

Digital cameras are to be used in future liftings, so that the steps of revealing and digitalizing the images can be kept.

Should a GPS receiver be installed in the aircraft, and the positions of the images taking should be known, as well as the aircraft altitude and speed, allowing both the control in the build of the mosaic and the measuring with topographic purposes with APIAS.

Agriculture should also benefits from the system, which retrieved data should be used to optimize production.

The Figures 5, 6 and 7 had been gotten with a digital camera in an experimental flight on the campus of the Unesp, in Presidente Prudente, Brazil. As if it can see other collectors of data can also be part of the system, showing its versatility.
Figure 5: Digital Image of Unesp University Campus.

Figure 6: Digital Image of Unesp University Campus.

Figure 7: Digital Image of Unesp University Campus.
CONCLUSION

APIAS has proven to be efficient and versatile to take air pictures, and can be used to photointerpretation as described in this paper. In the future, other kind of lifting should be available, increasing the options of cartographic products or data for mapping purposes.

The low cost of the project, compared with the standard airphotogrammetry, is the main attraction of the AIPAS. The reduced employment of labor – only one or two persons are needed to execute the lifting – allows economy, besides the equipment saved costs.

REFERENCES
