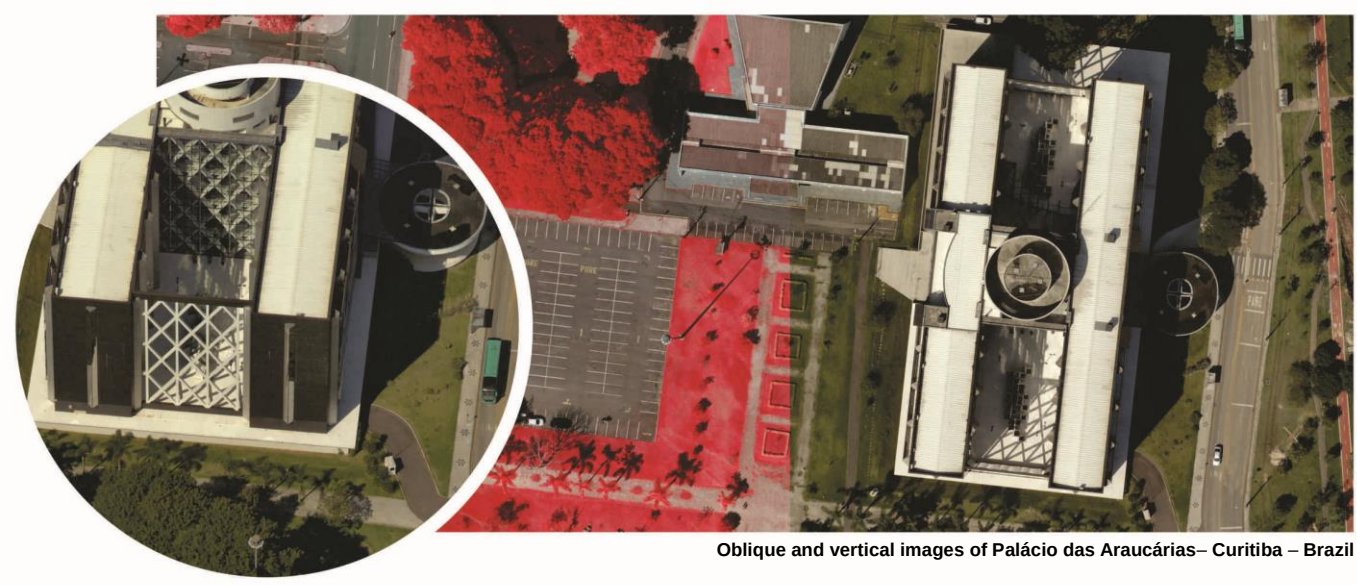
# Oblique Images

**Valther Xavier Aguiar**



**Oblique and vertical images of Palácio das Araucárias– Curitiba – Brazil**

In my journeys and contacts with customers, the question about how will the future of aerial photography be, or simply, what is coming ahead is frequent and common. I have learned from one of Esteio's founders that to be technologically updated is a *sine qua non* condition for not dying on the market – this pursuit must be constant. Even though we are going through a period of crisis, it will not last forever, and we need to be prepared for the end of this situation.

**Oblique Aerial Images!** I believe this is what will guide the work of many cartographers and photogrammetrists in a near future.

It is true this is not a new subject, as it has been present since ever in photogrammetry history. It is very likely that an oblique image taken from a balloon was the first aerial photography. Shortly after, due to less complexity in the mathematical treatment, nadir or vertical aerial images were adopted, which were of full knowledge and use of cartographers, other professionals and non-experts. In the 1930s the American (US Army and USGS) captured and used even more the oblique images; however, during the days of analog photography, the use of those resources was almost technically and economically unworkable. With the imaging development to the digital world, oblique airborne images returned intensively and now have great potential and benefits in its use.

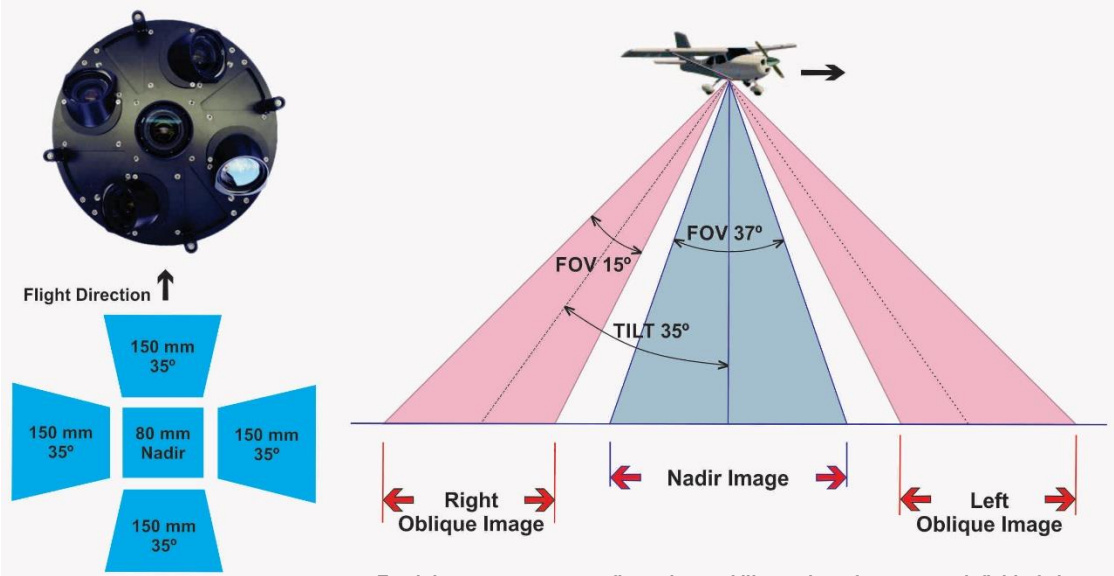
**Zeiss CameraRMK C1 - 1930**

Several manufacturers have already provided oblique camera systems into the market. Some of them are: Leica, with RCD30 Oblique Penta System; Vexcel, with Osprey 2; IGI,with Penta DigiCAM; Dimac–Oblique; VisionMap – A3; Trimble – Optron; among others, and a some more yet to be created or improved.


RCD30 Penta in the aircraft

Leica RCD30, a medium-format single head camera started to be sold in 2011/2012, it is a sensor established by the industry as it quickly gained numerous followers – over 100 sensors around the globe. This camera's main features are: geometry and radiometry of very high quality; single and interchangeable lenses with 50, 80 and 150 mm of focal length; multispectral resolution in RGB and NIR (Near Infrared) co-registered; bidirectional mechanical, full, motion compensation; possibility of use with gyro-stabilized mount; integrated GNSS (Global Navigation Satellite Systems) and IMU (Inertial Measurement Unit); besides being lightweight and compact.

Leica RCD30 Oblique Penta is the multi-camera system which ESTEIO is innovatively introducing in Brazil. There are five RCD30 cameras arranged in a pod in order to, simultaneously, take a vertical aerial image and four more oblique images, all with 80-megapixel resolution sensors. The oblique takes are in forward, backward, left and right directions, with 35 degrees of sight inclination. The nadir image



Esteio's Penta system configuration and illustration of across track field of view

is collected in the RGB and NIR bands with focal length lens of 80 mm and field of view (FOV) of 37 degrees, oblique images are collected in RGB with 150 mm focal and 15 degrees of FOV. This configuration was brought to market in 2015. The entire Penta system weights about a hundred kilos or 220 pounds; it is a modular and configurable system, and with various peripherals, common to other Leica sensors like ADS and ALS, for example, mass memory unit, controllers and gyro-stabilized mount from PAV series.

There is a long time 2D mapping is part of our lives. More recently 2.5D mapping was introduced and now the 3D mapping begins to gain more and more users. The demand for 3D mapping is in full ascension and acceptance in Asia, USA and Europe, mainly.

This wide acceptance has been motivated by the advantages of oblique aerial imagery when compared

to the only nadir imagery. The EuroSDR- European Spatial Data Research has an important research project on the potential of oblique airborne imagery, and presents its main advantages and characteristics: three-dimensional view very close to the way we see; As the vertical features are imaged, due that, many new applications arise; great ease in obtaining the height of features; greater ease in the identification and characterization of imaged elements, mainly due the visualization of vertical features; dense point cloud generation with detailed digital surface model; greater ease in identifying and mapping vegetation; greater ease in generating true orthophotos; and many others.

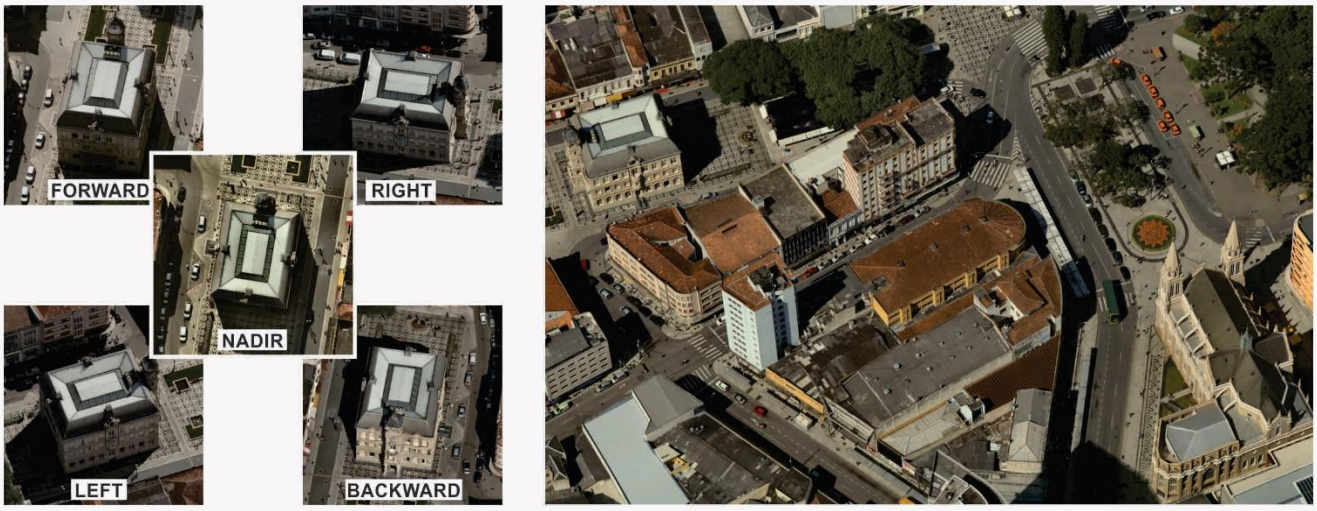



**Illustration of RCD30 Oblique Penta image acquisition and generated 3D model of the downtown region in Curitiba city**

As not all is a bed of roses, some challenges and difficulties also exist. Whereas it is, almost always, imaging with medium format sensors and various photographic takes, the number of images is extremely large; the mathematical modeling and the subsequent merging of several images is complex and dense, which requires greater need of processing, memory and sophisticated software; yet there are major variations in oblique images scale and radiometric quality.

As the cost of an oblique system is similar to one of nadir large-format sensor, or in some cases even more expensive, and still due to the need for greater overlapping and number of flight lanes, the cost of oblique imagery and mapping can be superior to the conventional. However, the additional value can be compensated by the large increase in benefits. The fullness of images is almost always considered as advantage, but it can also be a disadvantage, since, in some cases, the required volume of memory can be twenty times larger, or more.

The percentage of lateral and longitudinal overlap needed for the perfect covering of an urban area is larger and now depends, besides the sensor characteristics and terrain relief, on the width of streets and the height and density of the buildings as well, which requires the performer better planning, knowledge and expertise. Another important fact is that there are only few oblique camera systems comprising infrared band.

Such difficulties and challenges will be minimized in the future and with the increasing adoption of this new tool. Oblique airborne imagery has generated a huge research demand for academia and software developers. The Institute for Photogrammetry at the University of Stuttgart has been systematically researching this topic for more than ten years. There are several research areas, among them: oblique mapping integration with mobile mapping, with aerial and ground LiDAR surveys, with drones imaging, and with common photography; generation and integration of digital surface models; texture generation;

finder for features; and several other applications.

A three-dimensional model generated from the oblique aerial Imagery today is the dream mapping of many professionals in urban environment. This is a product with an array of additional information compared to traditional mapping. “All” of horizontal and vertical elements in a region can be mapped and displayed in a virtual tour, for example: the façades of a building and all its windows, with great ease to know the number of floors and its constructive pattern; vertical signaling boards can be easily identified and visualized; communication panels (like billboards) can be easily identified and scaled; heights of buildings, bridges, posts, trees, urban equipment and many other features can be obtained; ultimately, the 3D City Model is a tool for many and many applications.

Video game lovers know these three-dimensional models very well. The difference is that from now on it is going to be possible to play in an environment created with real data and not fictitious ones, as it is the case of GTA for Sony PS4. This evidences the trend that the photogrammetric technique will be used


**3D city model of fictitious “Los Santos” city in GTA game and the real Curitiba 3Dcity model from Leica RCD30 Penta Imagery**

more and more in different areas like computer vision, artificial intelligence, autonomous driving, virtual reality, robotics, etc.

Because the great cartographic need in Brazil, where many places still do not even have 2D mapping in appropriate scale, it remains the question of what is going to be the market speed to absorb this new and very interesting alternative of aerial photogrammetric mapping. However, it is certain that this technology will be part of our lives sooner or later.

**Valther Xavier Aguiar** is cartographer engineer and the technical director of the company **Esteio Engenharia e Aerolevantamentos S.A.**

**www.csteio.com.br,** valther@esteio.com.br (April, 2016)