Oblique Aerial Photography: A Status Review

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ABSTRACT

Recent developments in digital photography and accurate navigation equipment have brought a new lease of life to oblique imagery to create a unique complimentary dataset to conventional aerial imagery. For many surveying and mapping companies, oblique imagery has traditionally been a sideline business to the acquisition of vertical photography, providing site views of a location with little potential for measurement or real integration with GIS data. Traditional oblique photography has been either "artistic" showing a landscape or location specific to support a particular application.
The idea of complete coverage as a GIS layer is a relatively new concept which opens up new market opportunities in and outside the traditional market for aerial images.
Blom has built a database of oblique images covering more than 1,000 cities in Western Europe. Through Blom's unique geodatabase BlomURBEX® images are available online to a multitude of platforms.

1. INTRODUCTION

With the evolution from aerial film-based cameras to digital frame cameras a multitude of different combinations of CCD and CMOS area arrays, multi-lens systems and multi-camera heads have been developed to cover larger areas at the ground (see e.g. Schroth, 2007).
Oblique frame images in different configurations are more or less a standard now. First introduced to achieve at least the same coverage as of the typical 23x23 film-based cameras later on extended to high-angle oblique frame images for reconnaissance, geospatial intelligence and GIS applications. Based on the idea of the old Fairchild T-A3 film-based five camera system with its "Maltese Cross" configuration the company Pictometry® developed the first digital five camera system for high-angle oblique frame images. An actual overview of the different technical approaches is given by G. Petrie, 2009. Also the 3-line scanner technology, e.g. used in ADS technologies from LEICA (see Sandau, 2000), are delivering oblique views cross track wise.
Pictometry® started in 2000 to produce and sell their services based on their own camera system development. They were not aiming at the standard traditional aerial survey and mapping market with their near vertical imaging approaches. New applications, like for the emergencies led to an early success at least in the US. But a real step forward came following the cooperation with Microsoft and their integration into Virtual Earth. On the other side Google started out of its Google Earth success story also the possibility to integrate oblique imagery. Both corporations pushed the idea of high-angle oblique frame images into the consumer market as Google Earth were doing with the vertical aerial and satellite images.
Already in 2005 the Blom Group came to an exclusive license agreement with Pictometry® for the European territory. The Blom Group comprising subsidiaries in 12 European countries have since completed an ambitious project to acquire geo-referenced oblique imagery of every major town and city in Western Europe with a population greater than 50,000 inhabitants, covering 80 % of the population, approximately 1,000 cities and a total of almost 100,000 sq km.
This database provides a standardised image product across Europe, which will be updated every 2 years. Microsoft has been one of the key customers to this database aiming to populate their Virtual Earth database with high quality, high resolution aerial "Birds Eye" imagery.

The following gives an overview about the applied technology and its application. A special emphasize is given to the handling and distribution of the information by the BlomURBEX® system.

2. TECHNOLOGY

Already in 1993 Pictometry® was awarded an US patent for a new technology that captured direct geo-referenced oblique images based on the “Maltese Cross” configuration. In 1998 the system came to production. Other suppliers followed the idea of establishing 4 oblique digital medium format frame cameras and one nadir digital medium format frame camera on a mount for aerial surveys. The integration of inertial measurement units including differential GPS for direct geo-referencing is a standard nowadays. So most of the systems are using off the shelf products for the camera mount, medium format cameras and the IMU (see e.g. www.aerial-survey-base.com, www.igi-systems.de).
Lohmann, 2008, gave an overview about the different approaches of the Pictometry® and the MIDAS systems.

2.1. Pictometry® System

The Pictometry® system consists of a cluster of five cameras pointing North, South, East, West and vertically down to acquire multiple images. These combined with GPS/INS positioning and a DTM enables the images to be geo-referenced and to be integrated in to a geo-spatial environment.
Geo-referenced oblique imagery extends the benefits of traditional vertical photography providing a unique perspective view of a locality, allowing users:

- To see each side of a building, structure or feature, exposing blind spots, exits and entrances previously impossible to locate on vertical photography.
- The ability to measure the height, length & area of features directly from photography.
- Improve the identification of hard to see assets and facilities (e.g. lamp-posts, telegraph poles, etc) which can be difficult to distinguish on traditional ortho images.
- Improving the “readability” of geographical information for non-cartographic skilled people.
- View GIS data in “3D” by draping it on oblique imagery, extending the traditional and more familiar 2D view afforded by most GIS applications.

2.2. Image Acquisition and Processing

The Pictometry® Europe project involves 15 aircraft located around the continent, acquiring imagery of each urban area according to the flight plans. Each aircraft contains 5 cameras, 400 GB of disk storage and collects approximately 1.1 GB of imagery per sq km, creating over 100 TB of raw data.
Image resolution is typically between 10 – 12 cm, with a positional accuracy of approximately 0.5 metres. To achieve this, two types of camera lenses are used depending upon local flying restrictions, permitting acquisition at altitudes of 3,000 and 6,000 feet.
Aerial platforms currently being used are a combination of Partenavia, Piper Aztec and Seneca twin-engine aircraft. Each of these uses a standard aerial survey camera hole into which the Pictometry® camera system is mounted. An example of the five views are shown in figure 1.

3. APPLICATIONS

Pictometry® supports applications in:

- Planning
- Property
- 3D modelling
- Change intelligence
- Emergency response
- Environment
- Insurance
- Security
- Navigation
- Mobile phones

and a variety of possible uses.

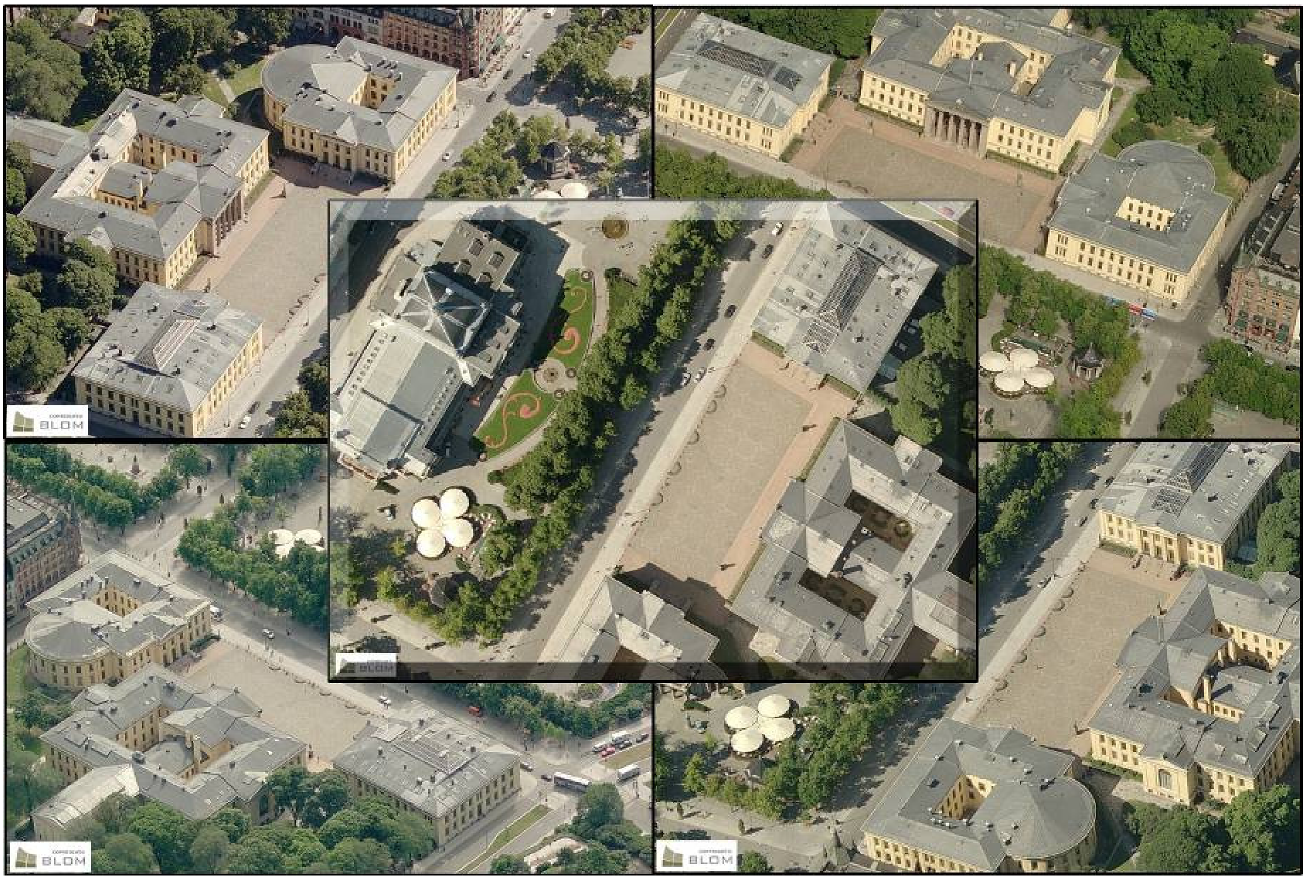

Fig. 1: Example of the 5 views with the Pictometry® system showing the University of Oslo, Norway.

3.1. Image Viewing and Measurement

Due to the unique geometry of oblique images and their inherent nature, plug-ins are available to enable GIS software to be able to view the images and integrate them with other geospatial data.

Many of these operate within an Active-X environment and support the use of measuring activities within the imagery, e.g.

- Angles & bearings
- Area
- Building height
- Length / distance

In addition to measurement, the plug-ins are able to import almost any geo-referenced data for display, analysis and interrogation within the GIS software, broadening the use and the applications for the imagery.

3.2. 3D Modelling

3D modelling activities based upon photogrammetric technology have traditionally used the stereo vertical imagery to extract building outlines, paste imagery to the roof structure and ground surface and extract what visible building façade imagery is available (see Schroth, 2008). Unless in-filled with ground-based photography, the resultant façade is not usually complete and can vary in quality depending upon the scale of the original photography.
The use of ground-based photography is also complex as numerous images may be required and the recording of location etc is important, which makes it a very time consuming exercise.
Blom's oblique images are all geo-referenced and can be extracted directly from the image database to the building frameworks captured using photogrammetric techniques or from LiDAR DSM. Blom has developed automatic routines to select the most appropriate image from amongst the 18 views available and apply it to the facades. Blom has recently announced a significant partnership contract with Tele Atlas to produce a comprehensive 3D library (Blom3D®) for navigation using Blom's unique existing database. For this contract Blom will in 2009 produce and deliver more than 200 cities and has already completed the first 40 Blom3D®s of European cities. Tele Atlas, the leading global provider of digital maps and dynamic content for navigation and location based solutions, has already announced that they have launched the photo realistic buildings and blocks created by Blom, as part of their navigation solutions. Their solution, named Advanced City Models, will enhance the user-experience of any personal navigation device (PND) integrating the solution (see www.blomasa.com).
This will be the industry's most detailed, realistic 3D views and provide a superior experience for the end user in more cities than ever before.
Blom3D® is produced in four different definition levels; 3D blocks, 3D blocks including roof details, pattern-texturized 3D blocks with roof details and full real image-view texturized 3D buildings (see figure 2). The "real image view texturized buildings" are created by combining oblique aerial images based on Pictometry® technology with the 3D blocks. Blom3D® provides three-dimensional representations of major city centres, including buildings and city blocks. The Advanced City Models by Tele Atlas, based on Blom3D®, are designed for use in navigation systems and location-based applications. Advanced City Models dramatically improve the clarity and reality of screen images within in-car and portable navigation systems and mobile devices. With the 3D models users are able to see the actual surroundings, helping them more easily find locations and points of interest.
By the end of third quarter 2009 Blom3D® models of 100 cities throughout Europe and North America will be completed. Blom3D® will be available for online streaming through Blom's geo server BlomURBEX®. In addition to Tele Atlas' focus on navigation, location based services and internet portals, Blom3D® are useful in a number of industries and applications such as government

and municipalities for rural and urban planning, security services, geo-referenced search and emergency services.
Blom has established a production process for high quality, detailed Blom3D® models allowing for production of five to ten cities a week. This is a record-high speed taken into account the quality and detail level of the models, and it demonstrates Blom's ability to establish itself as market leader within this industry.

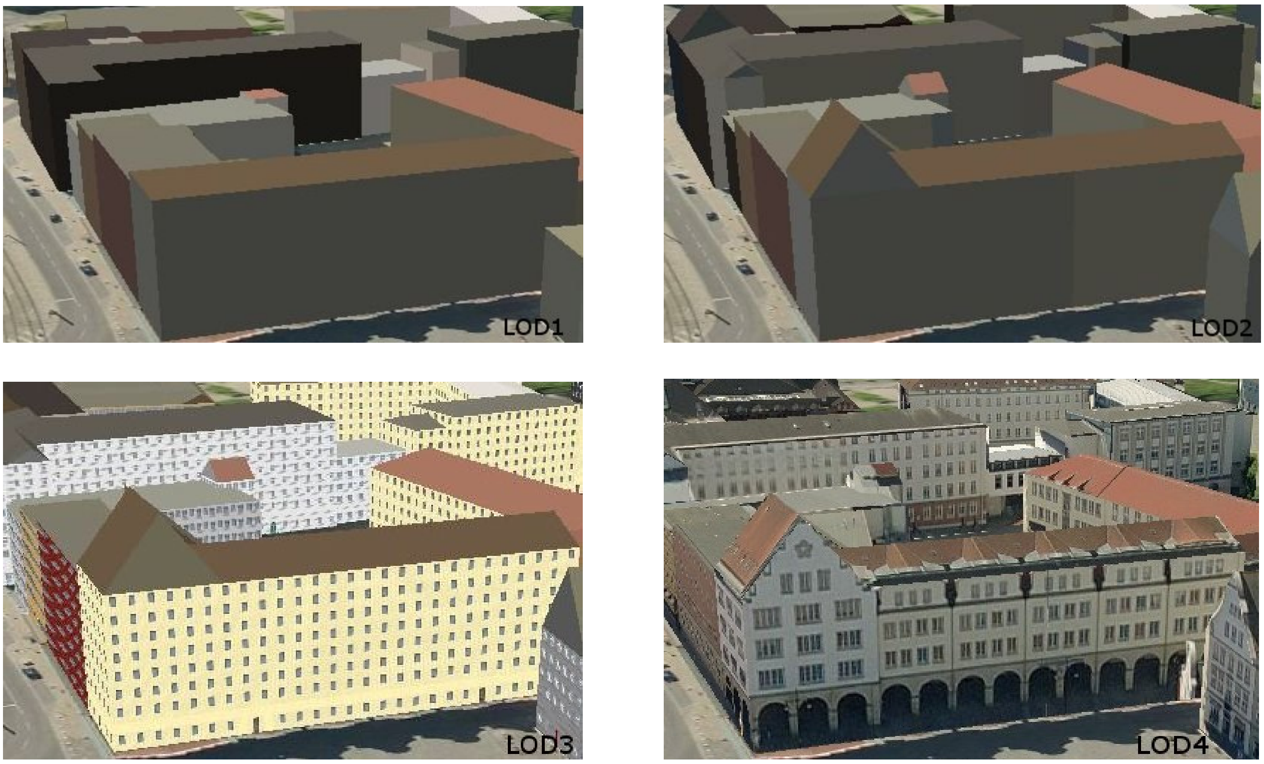

Fig. 2: Example of Blom3D® with four different levels of detail.

4. BLOMURBEX®

4.1. BlomURBEX® Web Services

Technically speaking, BlomURBEX® is an online service provided by Blom from several computing centers world wide, offering a revolutionary collection of geographical datasets showing urban environments with high-definition real images and 3D textured models, extracted from at least five different views and accurately geo-referenced to fulfill both, end-consumer expectations and professional/engineering requirements.
BlomURBEX® data models include:

- Orthogonal images: continuous projected mosaic of vertical views.
- Oblique images: set of fully geo-referenced pictures provided with true orientation and scale.
- Orthorectified-oblique: continuous projected mosaic of oblique views.
- Textured 3D: Full 3D modeled cities with textured buildings and ground. All surfaces (ground, buildings' roofs and facades) are covered with real images.

All datasets are available on line, and easily accessible from a wide range of platforms and technologies via an HTTP interface – from desktop to mobile: JavaScript, J2ME, Symbian, iPhone, Windows embedded platforms, Play Station, and Android. Proper Software Development Kits (SDKs) are provided for each technology allowing the developers to immediately put hands on and obtain impressive results without the need to take care of protocol details. Mobile platform SDKs provide data caching in order to minimize response time and network use. There is also a set of plug-ins available for connecting to the BlomURBEX® service from the major GIS Desktops on the market (see figure 3).

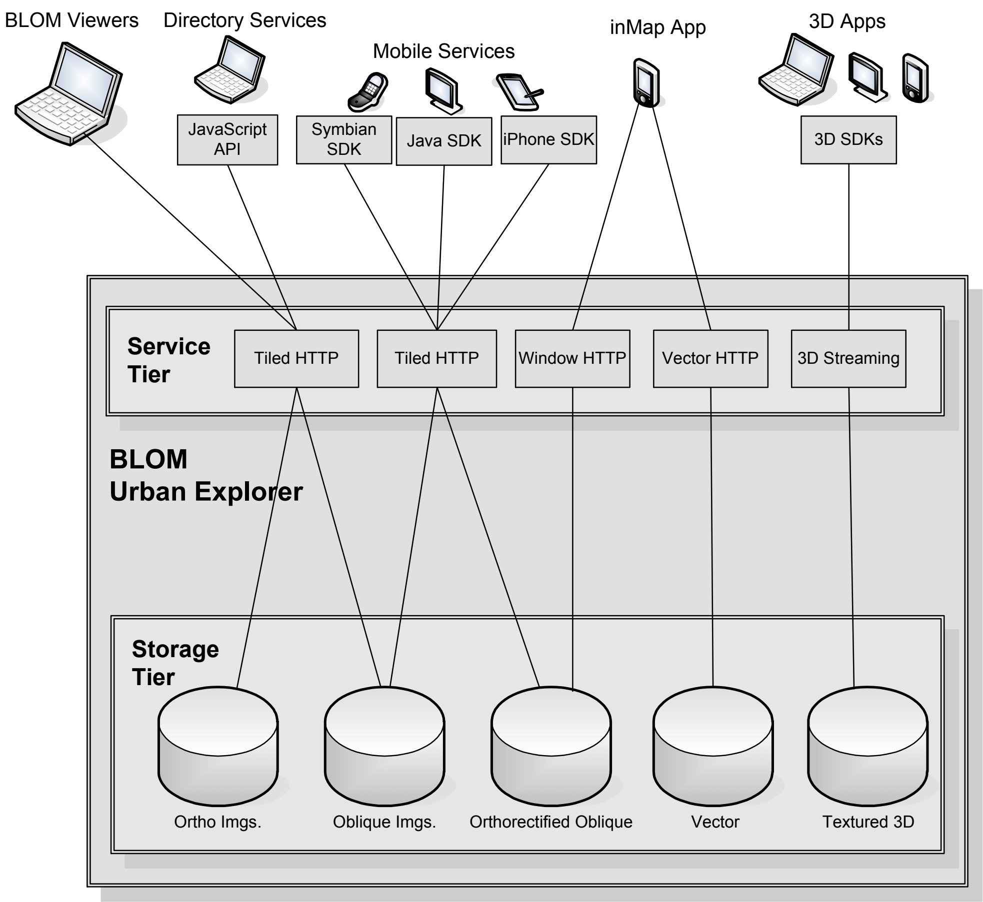

Fig. 3: BlomUrbex® offers a variety of databases to a multitude of platforms.

4.2. Market

The market opportunities for BlomURBEX® are very exciting. The Pictometry® Imagery is well under way to become the European standard for oblique photography as it has become in the US. This is due to the product's unique user interface, European coverage, newly captured images combined with the data resolution, the applications and interfaces developed or under development using Pictometry® data. This range includes Location Based Services, integration in emergency response applications, applications for municipalities, graphical applications using data, and web services such as Microsoft's Virtual Earth, newly renamed as Bing Maps. Blom is currently working in many ways to address these diverse market segments. For a traditional photogrammetry mapping company, this has been and continues to be an exiting journey in a strong technology-driven market.

5. OUTLOOK

With the recent technological developments and increased use of Geographic Information on a variety of platforms and for a multitude of uses, we believe that images, it be satellite, aerial or street imagery, and three dimensional "virtual reality" models will be increasingly demanded. Storage capacity, wireless transmitting capacity and computing power on handheld devices such as mobile phones and personal navigation devices (PND's) has been a challenge, but we believe that it has now reached a level where high resolution images and 3D-models can be made accessible for all people on all platforms everywhere! Oblique images offer an ease of use which will attract new users not familiar with using maps and accelerate the use of Geographic Information in general.

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