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PICTOMETRY® – A NEW PERSPECTIVE ON AERIAL IMAGE PRODUCTS

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Introduction

Pictometry® is a revolutionary aerial imaging system which combines oblique and orthogonal images for stand alone use or integration within GIS. The important for Pictometry® is quickly available image library that allows analysis of features, detail and environment. Pictometry® system enriches traditional method of photogrammetry, what provides the user with the ability to orientate, measure, see and plan. Three years ago Pictometry® was introduced to Europe by BLOMAerofilms, one of the UK's leading providers of aerial photography and digital map solutions for civil engineering design, environmental assessment and land information management. The system, developed and patented by Pictometry® International, has been used to acquire high resolution geo-referenced oblique images of about 50 degree declination and orthoimagery. This is achieved by mounting five digital cameras in the aircraft which capture five different views in a single pass. At the moment the system is used in 18 European countries. Images are captured around urban areas with population over 50,000 inhabitants.

Pictometry process

Flight planning

The starting point for any new flight plan is a coverage shape file. The shape file limits are determined on urban areas with population above 50,000 inhabitants. To complete the flight plan the Pictometry Flight planner need to obtain:

- elevation data,
- information about the local flight restrictions,
- permitting acquisition at an altitude of 3000 or 6000 feet.

During flight planning the coverage by oblique and orthogonal images is considered. It is important to remember about 1.5 km buffer outside the area and the economic efficiency. The economic quantity of images to capture and minimum number of flight lines must be taken into account including flight line direction influenced by Airspace and Runways. On Figure 1 an example of flight plan for Cardiff, UK is presented.

Image Acquisition

The full equipment for image acquisition includes an aircraft with standard aerial survey camera hole, the camera equipment and a GPS navigation system. The camera system is fully automated and can be operated by the pilot. The cameras, specifically designed for this purpose, are to capture images from five different directions. The image acquisition according to a flight plan has been supported with GPS *(Global Positioning System)*, mounted on the aircraft. The additional GPS equipment is integrated with an IMU *(Inertial Measurement Unit)* system to directly geo-reference the imagery. Captured images have been saved on a disk in an airplane and after that it has been developed in office by using proper software. This software also ensures the control of copying and checking if the process has been completed. Captured Images are saved in RAW format and then developed into PSI *(Pictometry Shot Image)*. This format allows further work on photographs in pictometry system.

Quality control

Digital photography gives us a good quality of imagery but a visual inspection is still needed. Our goal is to eliminate images with clouds, color saturation, flares, and excessive shadows and an adjustment can be made to reduce atmospheric haze, excess solar reflections.

The captured data is automatically rejected and recommended for re-fly if:

- there is missing or no GPS/IMU data available,
- the cameras were outside the position tolerance at the time of capture,
- data is positioned outside the flight plan (gross errors).

Post processing and GPS&IMU data

We get the GPS information about position and camera calibration at the moment of image acquisition by using base station data. One second GPS data will be requested from one of three stations nearest to the area of interest and processed. The GPS information is being combined with IMU data and as the results we get an exterior orientation for every captured image.

Camera calibration

Accurate geo-referencing of imagery is dependent on DTM quality and also on the correct determination of the look angles of the cameras in aircraft. The values of camera calibration have been established on the Control Field. The digital camera calibration method has been established for pictometry purpose. The Ground Control Points located on Control Field have been captured. The measurements made on images give us a possibility of camera calibration parameters being computed. Final values are monitored over the time to ensure that the camera mount configuration remains the same. The control field is flown routinely each month for every aircraft and every time maintenance work is completed on the camera rig.

Positional accuracy check

Accuracy of dataset is checked by measuring the Tie Points. Buildmode software which is a part of Pictometry system has a possibility to check the quality of placing the Tie Points. Accuracy of the test points has been checked by measuring the same position on available images – 2 nadirs and 3 oblique. Also this accuracy is determined by the quality of DTM used in processing. A further independent check of image positional accuracy will be made by checking the imagery against independently collected data for example vector data or GPS points.

Quality control ensures also that the full coverage is available, images are fully geo-referenced and desired accuracy has then been achieved. If the positional accuracy exceeds the accepted tolerance the work will be review to determine the source of error.

Ortho-rectifycation and tessellation

Due to ortho-rectifycation nadir images are converted into geographically-accurate forms. The process of tessellation has to assign to every part of an oblique image a value of terrain elevation. The results of the processing on images are fully geo-referenced and can be accurately integrated with other spatial data. They can be directly applied in GIS or mapping applications. Without this process, you wouldn't be able to do such functions as make direct and accurate measurements of distances, angles, positions, and areas.

The processed orthoimages (PMI – Pictometry Map Image) have been checked for any image errors caused by an inaccurate DTM. Particular attention will be paid to bridges and other structures with a big difference in terrain.

Results

The results of the pictometry processare as follows (Fig. 4, 5):

- pictometry mosaics,
- high-resolution images with a pixel size of 12–15cm,
- geo-referenced images,
- accuracy information about the captured images and measured structures.

EFS – Electronic Field Study

For viewing and analyzing geo-spatial imagery, Pictometry®'s Electronic Field Study (EFS), a proprietary geospatial imagery application is used. The application can be used to view the imagery, make measurements, navigate around images as well as add annotation and other geographic data. Loaded GIS layers may be overlaid on oblique images (Fig. 2).

The data can be either viewed through freely available software EFS or through software such as ESRI, MapInfo, CadCorp, Geomedia, using established plug ins (Fig. 3). Development of the software allows users to upload independent data such as raster and vector maps. Address or postcode can be overlaid in the images as information data and used with info tools.

Benefits

The benefits offered are numerous:

- pictometry is the “complete” system providing cameras for acquisition, image development, viewing and analysis,
- the results are available within 8–10 weeks after data has been captured,
- library’s update every 2 years,
- automated processing with manual quality control,
- high resolution data,
- good accuracy of data which depends on the digital terrain model used during processing,
- multiple views of the features – up to 12 different view points of properties, buildings, landmarks, and other structures,
- view of the structure from four different directions and vertically downwards (Fig. 6, 7 and 8, 9)
- valuable measurements to obtain on images by using provided software:
  - distance, taking into consideration terrain traversed
  - elevation of ground surface
  - building height
  - height of any other structure in image
  - area
  - angles & bearing
  - co-ordinates x, y, z,
- images may be used/edited without knowledge of coordination system, datum, projection
- easy to use, doesn’t need photo-interpretation skills to recognize the feature
- oblique images give additional perspective next to orthophotomap,
- recognition of elements on images and area is easier and quicker (see compare images 8&7)
- allows users greater appreciation of the features in the build environment: how many floors; where the entrances and exits to buildings are,
- easiest to interpret the elements of infrastructure like street light, telephone boxes,
- saves time and costs of site visit by showing the complete view of features,
- pictometry images can be used and viewed through some of GIS software next to a freely available pictometry program – EFS(Electronic Field Study) ,
- plug ins to load an pictometry images are available to most of GIS software packages,

BLOM are currently developing an online web based system where every commercial library is included and allows users to access the libraries over the internet. BLOM has developed a web hosting package which will allow users to access their data live from our hosting site and then use our specially designed web viewer.

Usage

Using of oblique aerial photography and measuring system in public safety applications is now more established. Compared to traditional, straight-down images many public agencies are finding the at-an-angle images more intuitive and easier to use. Public administration using new, more flexible applications find Pictometry useful in many situations that's why Pictometry has still growing customer base. The scope of users and uses includes:

- public administration and security
  - helps identify true location in difficult weather conditions, at night, in winter,
  - support searching,
  - allows planning the rescue,
  - help to choose the alternative way in case of traffic,
  - alternative route in case of problems on the way,
  - analyze of the area including other data,
  - planning using the available data such as GIS data,
- fire brigades
  - preplan responses for major structures and facilities,
  - zoom on the structure and analyze of: height, numbers of floors, the roof layout, access points,
  - inspection of the area of danger,
  - analyze of wind and danger in the area,
  - helps to locate and establish field command centers,
  - enable measure the distance between the structures, hydrants,
- hydrology system
  - analyze of flood risk,
  - simulations of the danger,
  - analyze of coastal line,
- emergency response
  - analyze the range of danger,
  - planning the rescue on the area,
  - analyze the effect: compare and contrast new and older aerial imagery pre- and post-disaster; identification of destroyed structures,
  - measure distance from water sources, hydrants,
  - helps identify true location of the object due to clods obscure,
  - helps navigate in getting the destination,
- law enforcement
  - identify area for planning and developments,
  - planning,
  - photo documentation for search variant,
- coordination in search and rescue efforts,
- planning and development
  - architects for 3D modeling to help clients visualize their new environment,
  - motorway: noise barrier assessment,
- vehicle and personal tracking,
- possibility to create high-resolution, realistic urban models to meet the needs of planners and developers alike.

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Streszczenie

W artykule przedstawiono nowy system informatyczny – Pictometry® – oparty na wykorzystaniu kolorowych zdjęć lotniczych wraz ze specjalistycznym oprogramowaniem dla wizualizacji terenu.
W systemie wykorzystuje się dwa rodzaje zdjęć lotniczych o wysokiej rozdzielczości, a mianowicie zdjęcia ukośne oraz ortogonalne, dające możliwość obserwacji obiektu z rożnych kierunków. Dzięki wbudowanej w systemie bazy danych o lokalizacji obiektu, istnieje możliwość wykonywania pomiarów na obiekcie za pomocą specjalistycznego oprogramowania pomiarowego.
System Pictometry® składa się z biblioteki zdjęć lotniczych wraz z oprogramowaniem do ich oglądania. Dane pomiarowe mogą być przeglądane za pomocą darmowego oprogramowania zwanego EFS lub dowolnego oprogramowania GIS, takich firm jak: ESRI, MapInfo, CadCorp, Geomedia itp. używając standardowych procedur. Produkt umożliwia także wprowadzenie dodatkowych danych, takich jak mapy sytuacyjne, mapy wysokościowe oraz nakładki GIS.
Biblioteka zdjęć piktometrycznych stanowi olbrzymi zasób informacji do opracowywania i analizy danych, a zdjęcia georeferencyjne wzbogacają zasób tradycyjnych ortofotomap, dając możliwość perspektywicznego oglądania obiektu, a także:

m *inspekcje fasad budynków łącznie z analizą ich struktury, lokalizacją wejść i wyjść, poprzednio niemożliwe w tradycyjnej fotogrametrii lotniczej,*
- *pomiar wysokości, długości, powierzchni obiektu bezpośrednio z fotografii; pomiary mogą być robione także na modelach 3D,*
- *poprawę jakości analizy w terenach niedostępnych, a także poprawną identyfikację takich obiektów jak słupy oświetleniowe, telegraficzne itp. co jest trudne do przeprowadzanie w tradycyjnej fotografii lotniczej,*
- *możliwość nałożenia nakładek GIS także na zdjęcia ukośne.*

Powyżej opisany system bazujący na danych przestrzennych i danych geograficznych GIS jest łatwy w użyciu i dostarcza wiele więcej informacji. Szczególne zastosowanie system znajduje w obrocie nieruchomościami, planowaniu, inżynierii. Używany jest przez policję, służby bezpieczeństwa, zakłady ubezpieczeniowe, agencje nieruchomości. Zdjęcia piktometrycze mogą być wykorzystane do tworzenia nowych projektów, analizy i weryfikacji posiadanych danych na mapach ze stanem obiektów na zdjęciach. System piktometryczny oferuje użytkownikowi dużą oszczędność czasu i kosztów przez „przeniesienie obiektów z terenu bezpośrednio do biura", gdzie istnieje także możliwość wykonania pomiarów.

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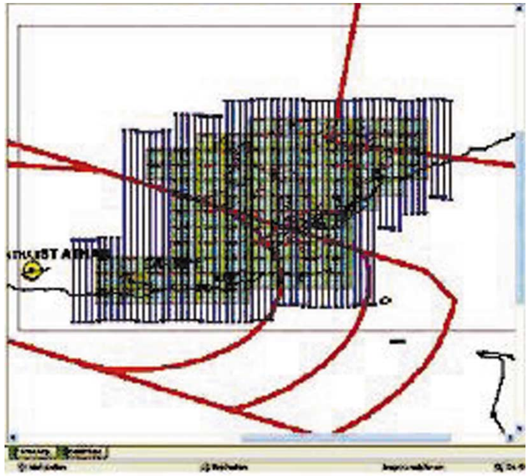

Fig. 1. Flight plan ©blomaerofilm
Rys. 1. Plan lotów ©blomaerofilm

Fig. 2. Vector data ©Ordnance Survey, Image ©blom
Rys. 2. Dane wektorowe ©Ordnance Survey, Image ©blom

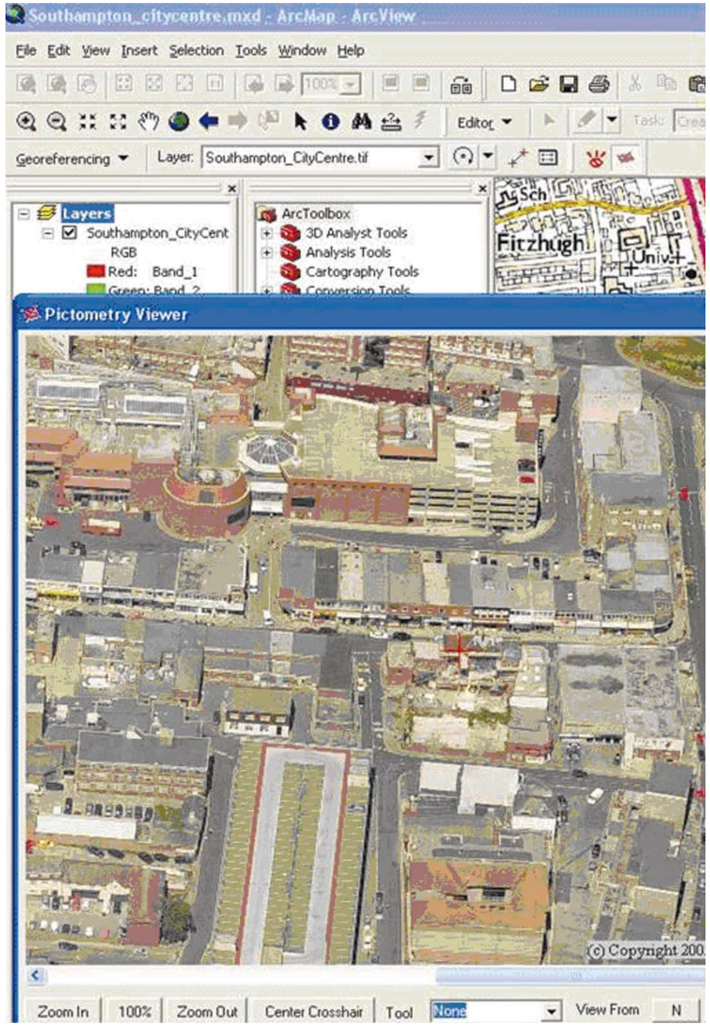

Fig. 3. Example of use ArcMap with pictometry imagery ©blom
Rys. 3. Przykład użycia ArcMap ze zdjęciami piktometrycznymi ©blom

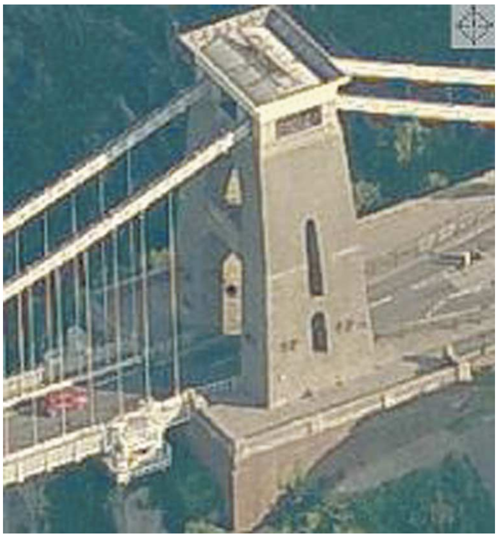

Fig. 4 and **5**. Suspension Bridge, Bristol, UK ©blom
Rys. 4 i **5**. Most Suspension, Bristol, UK ©blom

Fig. 6. Ultrecht, Netherlands – orthogonal view ©blom
Rys. 6. Ultrecht, Holandia – widok (ortogonalny) z góry ©blom

Fig. 7. Ultrecht, Netherlands – west view ©blom
Rys. 7. Ultrecht, Holandia – widok z zachodu ©blom

Fig. 8. Tower Bridge, London, UK – orthogonal view ©blom
Rys. 8. Most Tower, Londyn, UK – widok (ortogonalny) z góry ©blom

Fig. 9. Tower Bridge, London, UK – west view ©blom
Rys. 9. Most Tower, Londyn, UK – widok z zachodu ©blom