POLISH ASSOCIATION FOR SPATIAL INFORMATION
ANNALS OF GEOMATICS 2009 ❍ VOLUME VII ❍ NUMBER 2(32)

APPLICATION OF UAV IN POLISH FORESTRY TO ACQUIRE IMAGE DATA

ZASTOSOWANIE UAV W POLSKIM LEŚNICTWIE CELEM POZYSKANIA DANYCH OBRAZOWYCH

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Keywords: UAV, forestry, photogrammetry
Słowa kluczowe: UAV, leśnictwo, fotogrametria

Introduction

In recent years the technological process of acquiring numeric data has developed rapidly. This has been influenced by the miniaturization of processing systems and the development of advanced technologies for the rapid acquisition of data.

The application of UAVs (Unmanned Aerial Vehicle) and digital (non metric) cameras to register the condition of a forest in small and medium areas seems to be achievable because these instruments are being tested for civilian use (Grenzdörffer et al., 2008; Eisenbeiss, 2008; Merino, Caballero et al., 2006). Apart from research, into creating orthomosaics, there are also projects concerned with evaluating the generation of a precise Digital Surface Model (DSM) (Haarbrink et al., 2008).

Digital cameras ounted on unmanned vehicles enable capture of high resolution data in a short period of time, so they are competitive to traditionally obtained photogrammetric images (using a plane) for small forestry areas (~1000 ha). The use of planes leads to lengthening the period of time from ordering the photogrammetric service to receiving the final data and may be unprofitable because of the small operational areas. The application of UAVs in forestry in order to achieve orthomosaics may become a competitive enterprise because of:

- arbitrary frequency of repeating the flights,
- mobility,
- improvement of the process for acquiring spatial information,
- short period of time to process images into orthomosaics,
- possibility of high resolution (below 10 cm),
- much lower costs of deriving orthomosaics for small areas.

In Polish forestry, the use of UAVs is an innovative operation. Testing this methodology for forest management will not only introduce a new alternative means of measuring the changes in the forest, but also will enable the definition of the chosen features of a forest stand. The specific characteristics of forest stands introduces a number of difficulties to obtaining precise orthomosaics. The particular issue is the vertical structure of the area, with gaps, individual trees projecting above the surface, and surface variations caused by different species, maturity, etc. As a result, the application of the method to selected forest areas will be carried out over a short period of time and also use FNM (Forestry Numeric Maps) as vector data in association with the latest raster data.

Unmanned Aerial Vehicle (UAV)

In these tests, a UAV with a gross vehicle weight (GVW) of 5 kilograms and equipped with electric drive was used. The sensor platform, weighing 1.25 kg, comprises a calibrated digital camera with a permanent focal length recording the image in a range of natural colors. The UAV is equipped with GPS and autonomous mission capability – Autopilot, with the possibility of correcting the route during flight. Thus, after the flight mission, we are in possession of the recorded flight parameters, which are used when converting the images into orthomosaics. The area covered by a single flight may cover several square kilometers (Fig. 1) with an operational flight time of 30–40 minutes.

Methodology connected with taking images

The project is divided into phases – field measurements and image processing:

Phase I – field measurements

- Planning the flight over study areas with different forest stand characteristics and specifying optimal conditions for the UAV flight.
- Collecting data (geometrical and semantic) from the chosen reference objects (researchable). They will be used to specify the accuracy of raster data.
- Carrying out the UAV flight missions.

Phase II – image processing

- Generating orthomosaics with ground sampling distance below 100 mm.
- Generating DSM models.
- Defining accuracy on the basis of the reference data.
- Defining conditions to apply the suggested method in forestry practice.
- Verifying the photogrammetric and remote sensing quality of collected data and their usefulness for solving forestry issues.

The work was performed in Rogów and Głuchów, which belong to the Forest Experimental Station in Rogów. These areas differ from each other in forest stand characteristics – Rogów is characterized by parkland features; whereas, the area in Głuchów is a forest stand, but which has a remarkably large number of species.

Before the flight the parameters of the interior orientation are defined and the camera is calibrated for focal length, image centre and radial distortion. Field measurements, on the other hand, are determinations of photogrammetric control and ground control points (GCP) for image registration.

Another task in preparing for the flight is to set the appropriate forward lap (80%) and side lap (60%) for the images and to obtain the target resolution of below 10 cm.

For the tests, a Sigma DP2 digital camera with a focal length of 41 mm and CMOS matrix of 3 layers, 14.06 Mpix, or a Canon 400D with focal length 24 mm and CMOS matrix 10.5 Mpix were used.

The flight takes place several hundred meters above the ground level (Fig. 2) After takeoff, the control is taken by the Autopilot which automatically executes the flight program. When the flight is completed, data are copied to the computer and later the mosaics are prepared. The final stage concerns processing the images automatically, in order to remove distortions caused by the differences in height, terrain surface and image distortion.

Theoretical calculations show that there is a possibility of obtaining orthomosaics with a pixel size below 10 cm (with position error for X and Y limited to several pixels). These calculations are verified at the end of the tests. Finally, the orthomosaics may be generated either entirely automatically or with manual control.

Conclusions and future work

Geographical information systems and remote sensing are currently among the most dynamically developing informational fields in Polish forestry. Together they support spatial management through the use of digital data.

The UAV is a device which improves the process of gathering geographical information and will enable collecting data in short cyclic periods of time. This is beneficial for those people using such imagery for forest stand health monitoring and for registering change, especially following disaster.

The results of this project may influence further UAV development through applying different types of vehicles, with more advanced steering systems, and through applying better, high resolution digital cameras for collecting data.

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Streszczenie

Konieczność ciągłego aktualizowania zmian gospodarczych w drzewostanach wymusza stosowanie nowoczesnych metod monitorowania tych zmian. Prowadzone testy z użyciem nowoczesnego modelu latającego UAV (Unmanned Aerial Vehicle) przedstawiają nową alternatywę do pozyskiwania danych obrazowych o lesie.

Opracowanie optymalnego procesu pozyskania obrazów ortorektyfikowanych (przetworzone obrazy lotnicze poprzez usunięcie zniekształceń powodowanych różnicami wysokości powierzchni terenowej oraz nachyleniem zdjęcia) dla małych obszarów leśnych przy użyciu kamery niemetrycznej i UAV może stać się przydatnym rozwiązaniem w praktyce leśnej.

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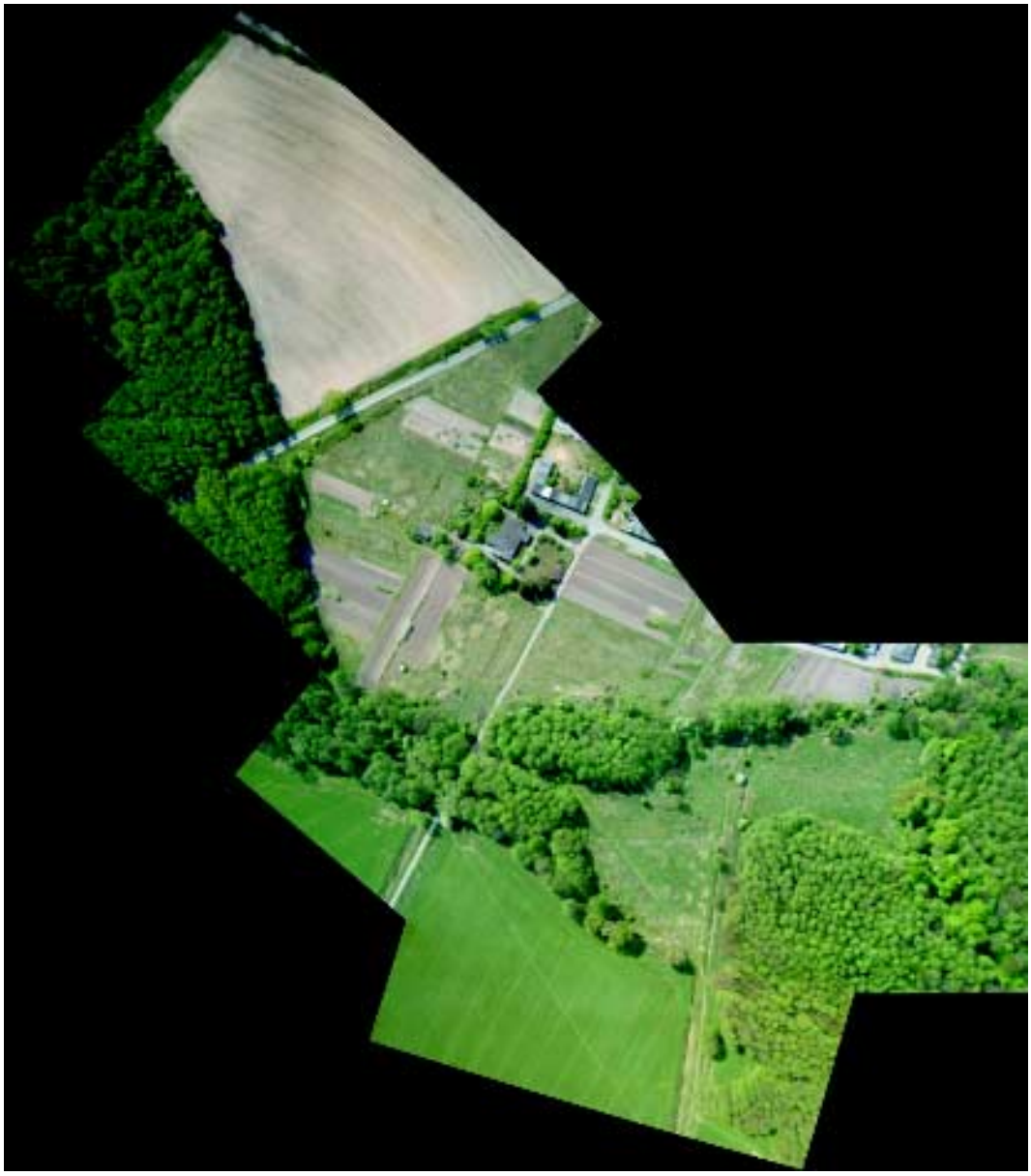

Figure 1. Flight altitude of 300 m Above Ground Level (AGL). Images taken using the Sigma DP2

Figure 2. Flight altitude of 200 m AGL. Images taken using the Canon 400D