Extended Abstract

URBAN GREEN SPACE MANAGEMENT INFORMATION

Processing and use of remote sensing images and scanner data

Christine RIES[1], Werner PILLMANN[2], Klaus KELLNER[2], Philipp STADLER[1]

Draft Summary

Almost in all Cities accurate and detailed maps of streets and the built environment are available. Seldom overall information on urban greenery exists and only in single cities information on green areas with data on species, state, distribution and development of vegetation are accessible for the public administration.

This paper describes the strategy of monitoring phytotopes for the management of urban greenery using remote sensing methods. Differences between aerial images and digital scannerdata for monitoring of biotopes are outlined and compared. The main part of this paper deals with the preprocessing of air-borne, multispectral scanner data records, their present use and their potential for inventories of whole city areas. Using a model for *Management of green urban areas* the overall process of communication and use of green area information will be demonstrated on the example of the work program BIOTOPMONITORING VIENNA.

1. Information regarding Green Urban Areas

The importance of green areas and free spaces in urban surrounding is often outweighed by that placed upon streets, residential- and work areas. The work program BIOTOPMONITORING VIENNA was launched in 1991 with the specific goal of creating an information system designed to provide in depth information on Vienna's green spaces and urban forest based on remotes sensing methods supported through ground truth inventories. On the basis for three aerial surveillances of the whole city, results of BIOTOPMONITORING provide an overview of changes and the present state of 35.400 vegetation areas between 1991, 1997 and 2000 in the city of Vienna.

2. Monitoring methodology using aerial images

In the surveying flights over Vienna, aerial color images and air-borne multi-spectral scanner data were taken simultaneously over the whole city area (413 km^2). During each flight the entire city area was depicted on 650 color infrared 23x23 cm aerial pictures with a scale of 1:7.800 and with 1:25.000 on 100 pictures from altitudes of 2.000 and 3.700 m respectively. These infrared photos were used as the information source for monitoring green urban areas. The visual image interpretations, database and GIS application resulted in an integrated information system on green areas and free space.

[1] Vienna University of Technology, Institute of Photogrammetry and Remote Sensing (I.P.F.). Gusshausstrasse 27-29, A-1040 Vienna, Austria. E-mail: chr@ipf.tuwien.ac.at

[2] ÖBIG - Österreichisches Bundesinstitut für Gesundheitswesen (Austrian Health Institute). Stubenring 6, A 1010 Vienna, Austria. E-mail: pillmann@oebig.at

In comparison to ground-truth inventories, the infrared image resolution (0,2 m) permits a precise observation, classification and measurement of green areas in a very efficient, repeatable manner. The stereoscopic visual interpretation enables us to identify and describe manifold object characteristics e.g. the biotope type, the vegetation stock, number and crown condition of trees and the surface type (vegetation covered, sealed, built-up area etc.). In the non-densely, peri-urban city area a simplified interpretation concept is used.

BiotopMonitoring includes the attributes of the investigation areas, units with respect to their geometric form, function and environmental surrounding. The data were compressed in a matrix 51 x 21.100 for the densely built-up area and in a 10 x 14.300 matrix for the peri-urban region. These two main matrices provide the database for the Geographic Information System (GIS), where the geometric data were handled together with the object data. Up to now the results of the work Program BiotopMonitoring information is used in the intranet of the municipal government. The reports about Viennas green areas can be found on http://www.magwien.gv.at/ma22/pool/biomon.htm.

3. Multispectral Scanner data application

Feasibility studies showed, that image processing of scanner data were suitable for identification and classification of urban biotopes, especially for change detection. Prerequisites for this tasks were sufficient computer capacity (speed, memory) and georeferenced pixel data. Scanner data were recorded in the foresight of future developments of BiotopMonitoring in which one major goal is the improvement of the cost efficiency through automatic identification of green urban areas.

The multispectral air-borne scanner data of Daedalus AADS 1268 with a ground pixel size of about 2,5m and 11 spectral bands provide an excellent basis for the evaluation of these new techniques. But as a prerequisite for further use the scanner data have to be rectified with respect to a map projection system, this process is called geometric rectification, geo-referencing or also geo-coding. This task is usually solved with a so-called parametric approach: the scans of the scanner image are (mathematically) re-projected onto the surface of the earth, which is represented by a digital terrain model, thus generating the rectified image. This approach assumes that the exterior orientation (i.e. position and attitude) of the scanner is known and mathematically modelled along the whole flight path.

Due to the airborne - and consequently very dynamic - scanner data acquisition the usage of powerful sensor technologies (like GPS - Global Positioning System - and IMU - Inertial Measurement Unit) during the surveying flight is highly recommended. So-called integrated GPS/IMU-systems were developed and brought to a high maturity in recent years. These systems enable the direct observation of the six parameters of the exterior orientation of the sensor with a high frequency (50Hz and higher) along the whole flight path. This new technology is a significant improvement for the rectification task. During the “historical” surveying flights of the BiotopMonitoring in 1991 and 1997 such a GPS/IMU-integrated system was not yet available, whereas during the recent flight in 2000 an integrated GPS/IMU-system was already in operation.

The rectification of the scanner data of the flight 2000 as well as of parts of the scanner data of the flight 1997 was carried out by the Institute of Photogrammetry and Remote Sensing (I.P.F.) of the Vienna University of the Technology. At the I.P.F. an algorithm was developed which enables the mathematical modelling of the exterior orientation along the flight path (theoretical) independently of direct observations of the exterior orientation with an integrated GPS/IMU-system. This algorithm uses a six-dimensional vector of spline functions (called

"orientation spline" in the following) for modelling the six parameters of the exterior orientation along the flight path. The orientation spline can be determined by direct observations of the exterior orientation by GPS/IMU and/or by ground control information. The ground control information may include points as well as linear features which can be mathematically modelled as straight lines, polynomials or three-dimensional spline-curves.

We would like to point out, that without any direct observations of the exterior orientation the determination of the orientation spline is in principle feasible but very labour intensive as plenty of ground control information has to be provided. Therefore and as financial and time resources were limited only a part (about 50 km^2) of the scanner data of 1997 was rectified.

During the rectification process for the scanner data of 2000 we observed that in spite of the availability of GPS/IMU-observations (which are an enormous improvement anyway) a certain amount of ground control information is still necessary for correcting or at least dampening some remaining systematic erroneous effects in the GPS/IMU-observations.

In this paper we present the experience and the results gained during the geometric rectification process of these airborne scanner data.

4. Further perspective

Scanner data and image processing methods can be used for change detection purposes. The goal in the further development of BiotopMonitoring will be an improvement of the cost efficiency using image processing methods. High resolution satellite images promise to be an additional source of data. The data basis presently available to us through BiotopMonitoring could provide an excellent basis for the evaluation of such new techniques. Since March 2002 a geo referenced multispectral scanner image is available with a resolution of 2,5 m in 11 spectral bands for further use for change detection with image processing methods.

5. References

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