FLI-MAP APPLICATIONS, THE EXECUTION TECHNOLOGY, THE CHARACTERISTICS AND UTILITY OF ORTOPHOTOMAPS IN LAND SURVEY WORKS

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***Abstract**: The acquisition of the necessary data for efficient topographic and/or photogrammetry studies is difficult, time consuming and insufficient and, in some cases, it does not ensure the demanded precision due to the interpolarity between two measurements. Practically, it does not matter how the land looks like between two profiles. With the help of the system described here, the information is complete and rigorous; moreover, the productivity is of about 100 km/day. The great density of laser points offers us all the necessary information for identifying and classifying all the physical elements.*

***Keywords:** The FLI-MAP System, photogrammetry, ortophotomaps*

1. Introduction

The airborne LiDAR technology of great density is an innovation of the techniques of depicting through sensors, from a distance that exceeded all the barriers of the traditional flying techniques. Especially for long corridors, such as streets, terraces, railroads, high pressure lines and hydrographic basins, the laser altimetry offers a new flying method for collecting the sensor detected data fast. The LiDAR technologies that operate at a low altitude (50-450 m) and at a low speed (50 km/hour) specially represent a professional overfly instrument that can compete with the traditional overflying methods as it is clear (3-8 cm absolute precision in X, Y, H – the altitude), safe, fast (100-150 km/day) and very efficient.

Fig. 1 Zones for using LiDAR technology

The FLI-MAP System (Fast Laser Imaging and Mapping Airborne Platform) can supply enough precision in the overflying related to topography and engineering. The great density of points (10-30 points/m^2), the extremely clear data of the FLI-MAP system, together with the image covering of the overflown corridor, allow the cartography of all the data related to every existing or theoretical corridor. The cartography of an existing street, for instance, can be done in the smallest detail, including the traffic signs, marking, barriers, terraces, high voltage power lines above the streets, etc. It can also take data under the trees due to the two vertically and sidelong placed video cameras. Practically, each point from the ground is an intersection of three lines.

A special processing package supplies CAD filtration and functioning algorithms, besides laser data and synchronized photo and video imagesș all these offer the operator the extra possibility to obtain valuable information regarding the LiDAR data.

This information can be easily incorporated into specific GIS or CAD software packages. The recent software developments focus on the automatic filtration programmes and on the possibility to produce orthorectified and georeferenced images.

2. The description of the system

The FLI-MAP system has high-tech components in an extremely efficient overflying instrument. All the components of the system are of the highest quality and are regularly modernized in order to maintain the highest standards.

The two components can be differentiated: the airborne component and the land component. Both of them are extremely important for the FLI-MAP operations.

The airborne component

The airborne component of the FLI-MAP system is made of a part attached to a helicopter, a computerized unit and an interface for the pilot. This part has sensors. These sensors are connected to the computerized unit in the helicopter through an “umbilical cord”. The computerizing unit contains more computers interconnected in a network. These computers have the task of charging the obtained data, of computerizing the information in real time and of offering feed-back to the pilot regarding the flight using a special interface. The whole system is controlled and monitored by an operator who uses a portable computer connected to the network of the computerizing unit.

As all the sensors are positioned in one frame, all the positions between sensors are fixed. These positions are carefully calibrated, with additional control measuring after the assembly of all the equipments.

Fig. 2 Computerizing unit inside the helicopte

The land component

The land component of the FLI-MAP system implies more basic stations and processing computers. The basic stations contain an antenna and a GPS receiver, supply energy and allow the data uploading. While overflying, these stations upload the GPS data into reference points with known coordinates.

The processing components will be used in order to check and ensure all the data taken from the basic stations and the airborne system in order to calculate the GPS and the INS/GPS and in order to analyse the quality of the obtained data.

3. The sensors

The airborne component of the FLI-MAP system is equipped with the following sensors: GPS, INS, The Laser Scanner.

Video

Two well fixed video digital cameras are used in the system in order to identify objects along the overflown corridor. The video is included in the GPS time and converted into a MPEG1 digital video flux, which is registered on hard disks. The bites speed can be configured between 1.2 – 3 Mbites/second. A camera is placed in the front in a sidelong angle. The other one is placed downward and generally shows the area covered by the two lasers.

Using the synchronizing and the known positions between sensors, the video can be combined with laser data in order to offer georeferential images, pixel corrected ones for the local height differences.

Fig. 3Video

Photo cameras

Two ½" CCD high resolution digital photo cameras are placed near the video cameras, front side down. Both cameras incorporate an IEEE 1394 Fireware interface and are configured to capture an image at regular intervals. Normally, this can happen once every second, but it can be configured for each image every two seconds or less. The resolution of the obtained image in a typical mission is of 3-5 cm/pixel and it depends on the altitude of the overflight.

The images are stored in an unprocessed data format on hard disks and they can be orthorectified at the office. Using an improved characteristic for capturing the images, these orthorectified images can be used for building mosaics in Fugro’s FLIP7 Processing Software. These images can also be used by other software packages that build mosaics.

Fig. 4 Photo cameras

LiDAR coordinates

The calculated coordinates (WGS84) or the airway (50 times a second) are transformed in the local system of coordinates on the ground, applying corresponding data exchanging and map projecting. The laser point coordinates are in their turn calculated by combining the coordinates of the airways with the configuration parameters of the system and the laser rays measured by the laser scanner.

The visual presentation and acquisition system

Intel processor PCs, which allows flight data management, sensor control and surfing processing. The measurements, just like the GPS action rays during the flight, the laser scanner recordings, the INS solutions and the real time differentiated solutions are stored on memory cards that can be moved.

4. The helicopter

FLI-MAP is fully certified for operations with the following types of helicopters: Bell 206 L (LongRanger), Bell 206 A/B (JetRanger), MD 500, Eurocopter AS350 (A-star) and AS355 (Twinstar). Installing the airborne component in the FLI-MAP system in each of these helicopters lasts for about four hours. No calibre flight is necessary as all the sensors installed in FLI-MAP have known positions that had been measured with e millimetre precision.

5. Data processing

Data processing is divided in two: pre-processing and post-processing. Data pre-processing is done on the spot, while overflying. This allows a full control of the quality of the land data. If there are any missing data, extra flights can be planned in order to ensure the quality of the final data.

- **Pre-processing**

Pre-processing starts with calculating the references between the basic stations and the antennas in the airborne system. These multiple references are combined in order to have a clear position of the helicopter at any moment. The solution for GPS positioning is integrated with the INS data in order to clearly calculate the flight direction of the system. Meanwhile, the data covering and the point density are checked. Finally, the absolute precision of the laser data is checked regarding the location and height of the reference points.

Post-processing is the combination of all the efforts for getting the final information out of the FLI-MAP data, according to the clients' needs.

- **Post-processing**

The main software for data processing is the FLI-MAO processing package called FLIP7, specially developed for seeing, manipulating and analysing the FLI-MAP laser data and the video images. Being a multi-media package, with numerous characteristics specially created for flying, FLIP7 facilitates the processing, applying and communication operation for the FLI-MAP flying data.

The software will help the user with special filters in order to classify the laser data, in order to get specific information regarding points and lines, in order to combine the video images with the laser data in order to obtain orthorectified video mosaics. The results of FLIP7 processing can be exported in different CAD, GIS and DTM packages.

FLIP7 fully controls the coordinate transformations (data exchanging, map projections, geosis separations) in order to guarantee that the exported data can be integrated with data coming from other sources using the same reference system of coordinates.

6. The FLIP7 components

- **FLIP7**

The main component of the software package combines the information regarding the position of the helicopter and the LiDAR data about the sensors. FLIP7 supplies full CAD (Computer Aided Drafting) capacities of the LiDAR data, supplying the operator extra possibilities in order to extract valuable information of the FLI-MAP data.

- **Video Digital Controller**

This FLIP7 component controls the coded digital video images in special time, allowing the user to coordinate the video with processed LiDAR data in order to get a multimedia presentation of the overflown area. FLIP7 also offers the possibility to see and orthorectify the video images in order to get extra visual information.

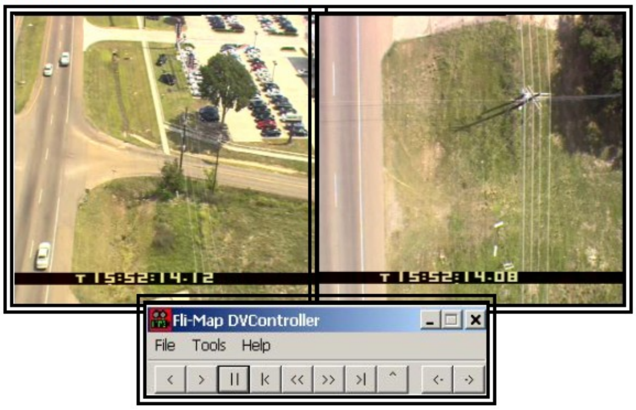

Fig. 5 Video Digital Controller

- **Image slides**

This FLIP7 component, just like the Digital Video Controller, controls the integration of the digital static images with the processed LiDAR data in order to improve the information that can be extracted from the overflown area. FLIP7 also offers a way of uniting the static images in order to get extra visual information.

Fig. 6 Image slides

- **Configuring filters**

FLIP7 is equipped with a variety of filters that can be used individually or together. These filters allow the user to automatically extract specific interesting information out of the LiDAR data of FLI-MAP. These filters can extract a series of characteristics regarding the ground, the high pressure lines, the railroads and others. The filters classify the LiDAR data in subassemblies of the original data and allow the visualization and exportation of each subassembly.

Other FLIP7 characteristics

- **Projections and data**

FLIP7 has the ability to work in a series of horizontal and vertical reference data. FLIP7 admits Transverse Mercator and Lambert Conformal map projections (FLIP7 can also admit local projections if necessary).

- **Visualising the LiDAR data**

FLIP7 introduces the LiDAR data in more ways. It is not at all an easy task using more than 1,000,000 data points/km. FLIP7 presents the LiDAR data to the user in ways that allow him to make a quick and exact interpretation. The LiDAR points can be visualised in “Colour through Hight” or in “Colour through Intensity”. Besides these two methods of visualising the data, the data can also be visualised in a vertical presentation (longitudinal and crossed profiles).

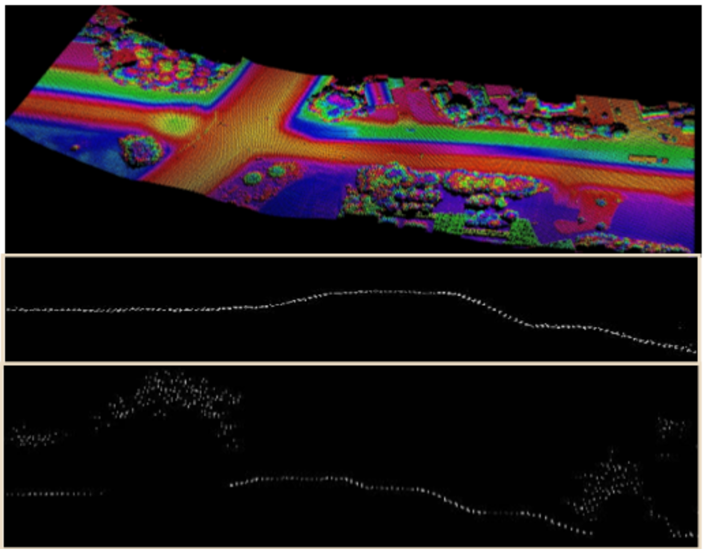

Fig. 7 Visualising the LiDAR data

- **Reducing the LiDAR data**

Delivering the data under a 100% percentage to the client is not often one of the final products as it is about too much information that could be controlled. FLIP7 uses more JCLS filters in order to reduce the ensemble of original data in a collection of easy to use and control data.

- **Computer sketches**

After the user had extracted the data, the processor can use the LiDAR base information (digitalizing).

FLIP7 allows simple points and multi-segment polilines that can be defined as “drawing-objects”.

By exporting at more levels CAD packages such as MicroStation or AutoCad, the client can import the final product in his own structure.

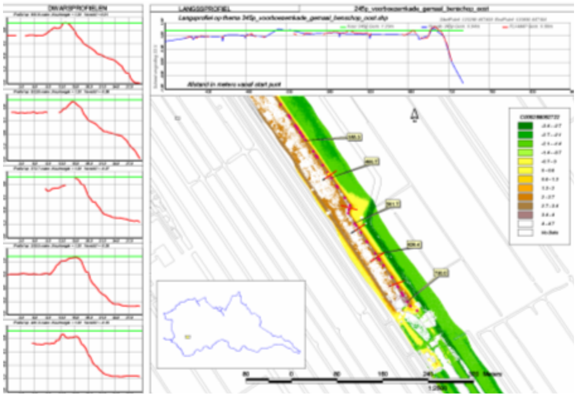

Fig. 8 Computer sketches

- **The export-import of drawn-objects**

The drawing-objects can be imported in FLIP7 using the AutoCad DXF standard file format or an ASCII simple text file format. The drawing-objects can also be exported from FLIP7 using the DXF and ASCII file formats.

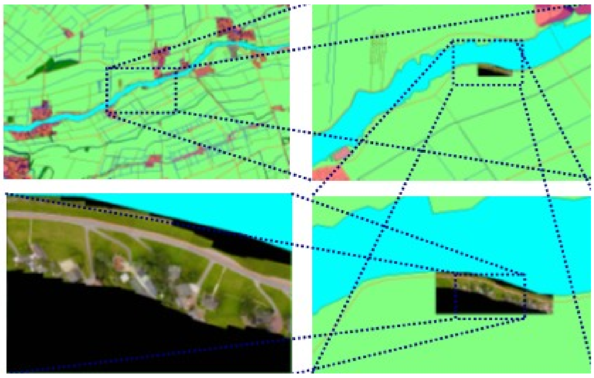

Fig. 9 The export-import of drawn-objects

7. Conclusions

This presentation clearly shows that for many typical engineering activities, exact and modernized geographical and topographical information are extremely important.

The capacity to collect these data fast, safely and efficiently is the essence of any practical use of the information. The capacity of the FLI-MAP system of clearly collecting the necessary data in a fast and efficient way makes the FLI-MAP system an excellent flying system that allows different engineering applications.

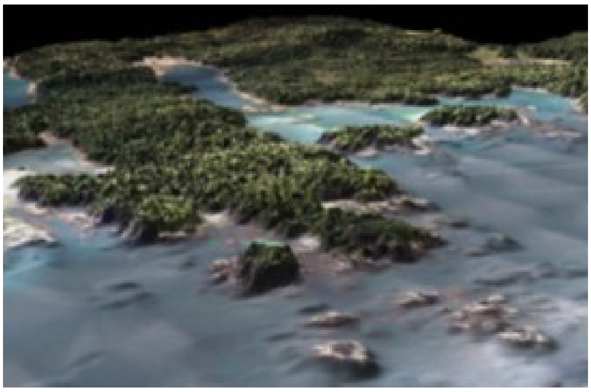

Fig. 10 Using the FLI-MAP data with the SIG package

The easy integration and the reuse of the data grants a value to the FLI-MAP data, being able to be used with different GIS packages. (as it is shown in the image below.)

The advantages of the FLI-MAP system compared to the traditional techniques can be summarized as it follows:

- Low costs.
- Very short execution time till the final product.
- Compared to the conventional flying measures, there are no blockages necessary to interrupt the traffic.
- Compared to photogrammetry, the FLI-MAP system is less depending on the weather forecast and has a greater H precision due to the low flying altitude.
- Offering static or video geo-referenced, orthorectified images 9up to pixels of 4-5 cm) can be considered an extra product that can be used for 3-D visualising studies, engineering studies and very clear DTM for projection studies.

8. Bibliography

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