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IGI Ltd. – Serving the Aerial Survey Industry for more than 20 Years

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ABSTRACT

Since 1982 IGI has specialized in the development of guidance and management systems for aerial survey flight missions. The first systems were based on portable Precision-DMEs, Loran-C and DME-Tacan networks, since 1990 GPS is used. In 1996 IGI introduced the GPS/INS system *AEROcontrol* as an option for the *CCNS4*.
After the introduction of the *AEROcontrol-IId* GPS/IMU system for the precise determination of the position and attitude of an airborne sensor in 2000, IGI started to integrate digital airborne sensors to develop complete airborne sensor systems. This paper describes the *LiteMapper 5600*, an airborne LIDAR System with full waveform digitizing, and the *DigiCAM-H*, a medium format digital camera for airborne applications.

1. INTRODUCTION

The increasing number and complexity of the sensor systems used simultaneously in one aircraft, combined with an increasing demand in quality and productivity lead to the need of simple tools for the airborne crew to operate the sensor systems efficient and error free. The basic idea of all IGI products is, to optimize the workflows in the aircraft and to minimize the error sources to ensure the most efficient use of the expensive flying time and sensors.

Since 1982 IGI is specialized in the development of guidance and management systems for aerial survey flight missions [Ackermann 2003, Grimm 2003].
After the introduction of the *AEROcontrol-IId* GPS/IMU system for the precise determination of the position and attitude of an airborne sensor in 2000 [Kremer 2001], IGI started to integrate digital airborne sensors to develop complete airborne sensor systems. The *LiteMapper 2800*, a combination of an airborne LIDAR system together with a 16 Megapixel digital camera was introduced during the Photogrammetric Week 2003. In 2004, the first results of the *LiteMapper 5600*, an airborne LIDAR System with full waveform digitizing were published [Hug et al. 2004]. As an additional sensor for the LIDAR systems, but also as an alternative for small area mapping projects and for infrastructure maintenance, IGI provides the *DigiCAM-H*, a medium format professional digital camera modified and extended for airborne use.

2. GUIDANCE, SENSOR MANAGEMENT AND GPS/IMU

The *CCNS* is a GPS based guidance, positioning and sensor management system for aerial survey flight missions. The basic system consists of the Central Computer Unit (CCU), at least one Command and Display Unit (CDU) and the mission planning software package *WinMP*. The system can operate two airborne sensors of different kind and make at once, most currently available airborne sensor systems are supported by the *CCNS*.
For the precise determination of position and attitude of the airborne sensor, the *CCNS* can be operated with the GPS/IMU system *AEROcontrol*. Both systems are described in [Kremer 2001].

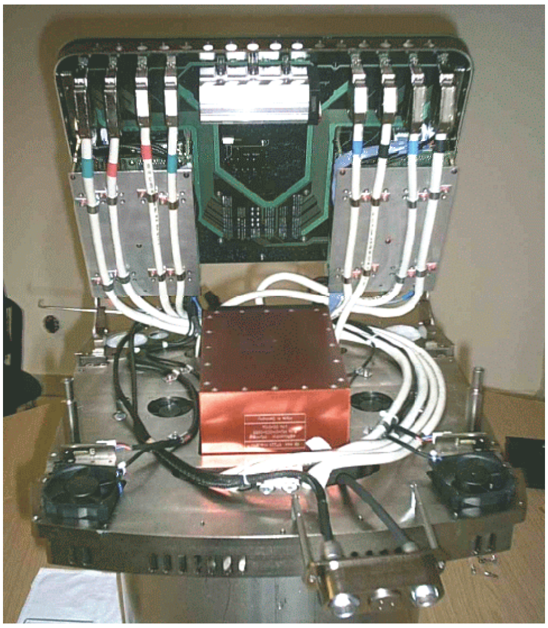

Figure 1: *DMC* with *AEROcontrol* IMU

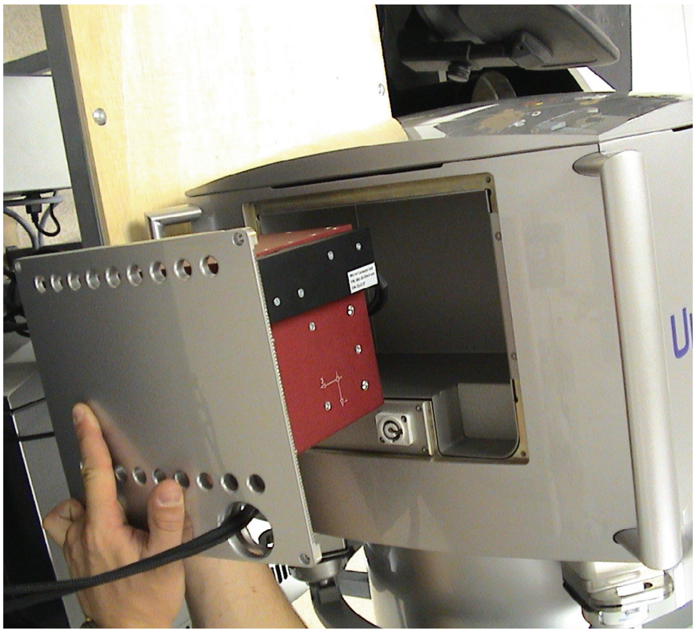

Figure 2: *ULTRACAMD* with *AEROcontrol* IMU ©Z/I Imaging

3. AIRBORNE SENSOR SYSTEMS

3.1. The LiteMapper

LiteMapper is a series of affordable airborne *LIDAR Te*rrain *Map*ping systems for topographic surveys in 3D with fixed-wing aircraft and for 3D corridor mapping with helicopters. They are designed to provide highly accurate measurements in a compact and lightweight package that can easily be installed even on small survey aircraft. The system can include up to two digital aerial cameras, e.g. one for RGB and one for color-infrared.

An optimized workflow with the *LiteMapper* is achieved by tight integration with the *CCNS/AEROcontrol* flight guidance and GPS/IMU system. The *CCNS4* guides the pilot on pre-planned flight lines, operates the LIDAR and triggers the digital camera(s). As a result of this tight integration, a dedicated LIDAR operator is not mandatory. Nevertheless, the systems contain a touch screen display to get real time information about the status of the system, to change the system settings, and to operate the system in manual mode.

Both, LIDAR and digital camera are coupled to the *AEROcontrol* GPS/IMU system. The *AEROoffice* post-processing software for the *AEROcontrol* directly provides the necessary orientation files for the georeferencing of the LIDAR points and for the "Direct Georeferencing" or "Integrated Sensor Orientation" of the digital images.

The latest model in the LiteMapper series is the *LiteMapper 5600* [Hug et al. 2004]. This system is based on the Riegl *LMS-Q560* which provides a unique feature: it digitizes the echo waveform of each measurement.

The *LiteMapper 5600* is one of the first commercial airborne LIDAR systems to use waveform digitization to provide the access to the full surface information available. The digitized waveforms of the echo signals provide a detailed insight into the vertical structure of surface objects. Used for forestry applications, they can reveal the vertical structure of the tree canopy and the understory with unmatched detail.

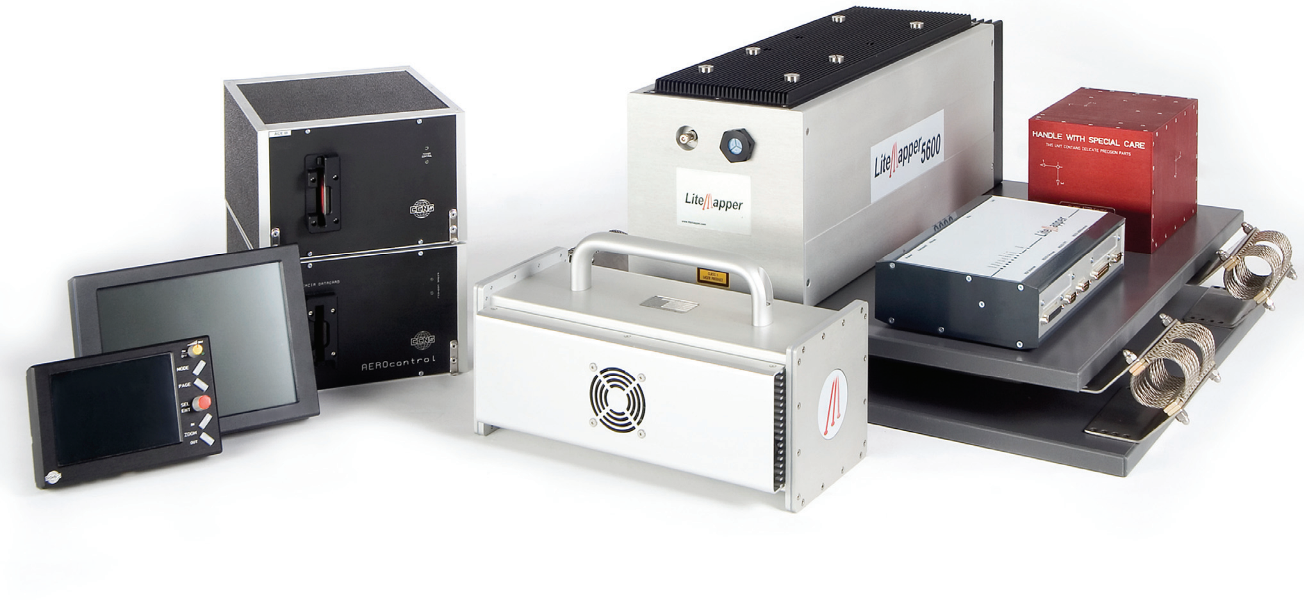

Figure 3: LiteMapper 5600

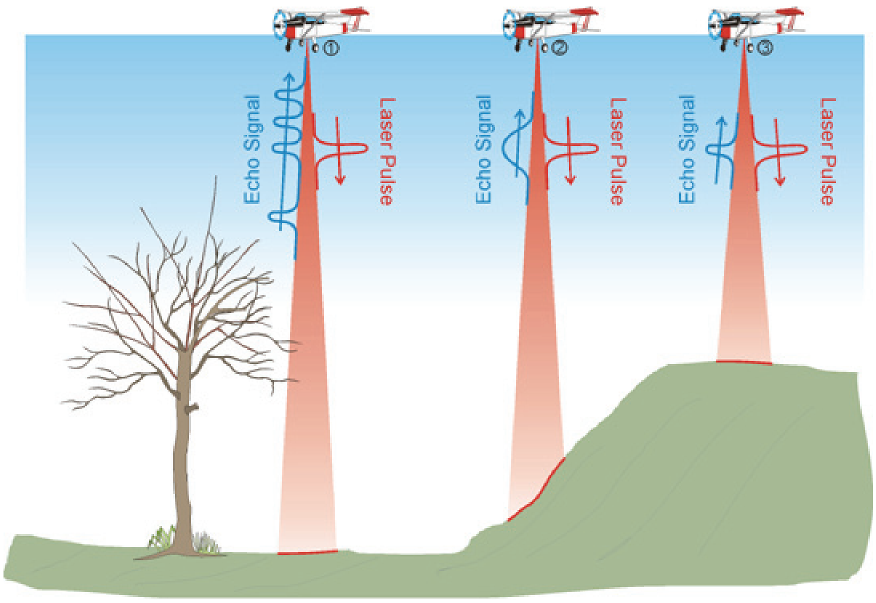

Figure 4: Waveform digitizing principle - Echo signals resulting from different targets [Riegl 2005]

Figure 4 shows the profile along line flown with the *LiteMapper 5600*. The flight was performed at the end of August 2004 at a flying height of approx. 340 m, speed 65 m/s (234 km/h). The point density was 1.35 measurements/m^2 corresponding to an average point spacing of 0.86 m.
The amplitudes of the waveforms are represented by the grey level, darker color representing higher amplitude. Minimum amplitude values are shown in light grey to indicate where waveform data

was registered. The x-axis indicates meters along the profile, the y-axis shows relative height in meters. On the left a dense deciduous forest area is shown. In the center two gable-roofed buildings can be recognized, followed by a row of trees and a corn field on the right [Hug et al. 2004].

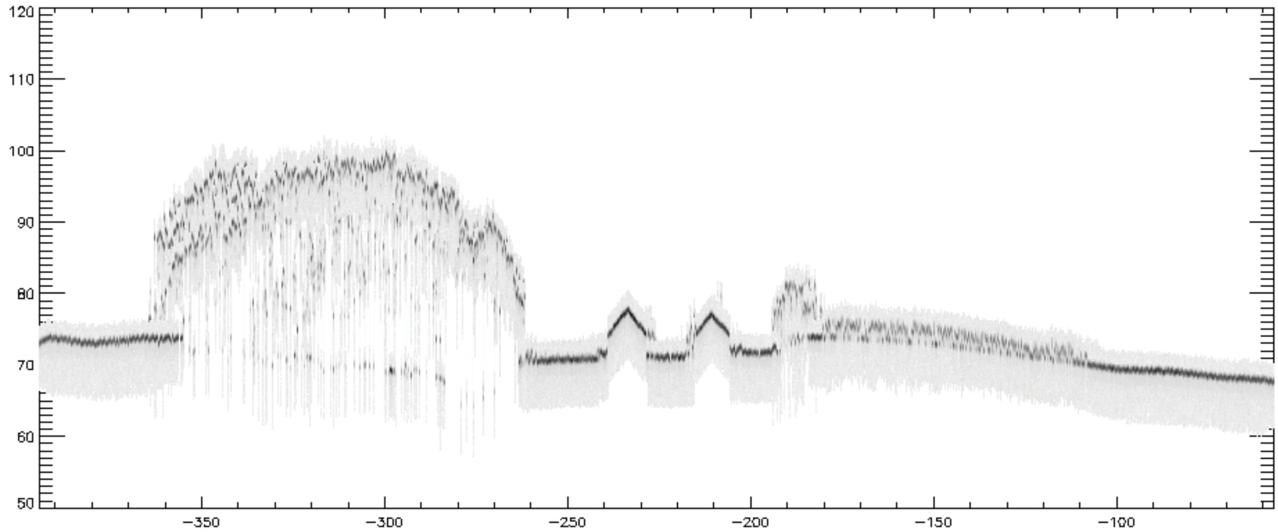

Figure 5: Data sample of the *LiteMapper 5600*

3.2. The DigiCAM

The *DigiCAM* digital airborne camera systems combine modified professional digital cameras with an easy to use graphical user interface for real-time preview capability together with the *CCNS/AEROcontrol*. The cameras can be operated in RGB or CIR mode, respectively.

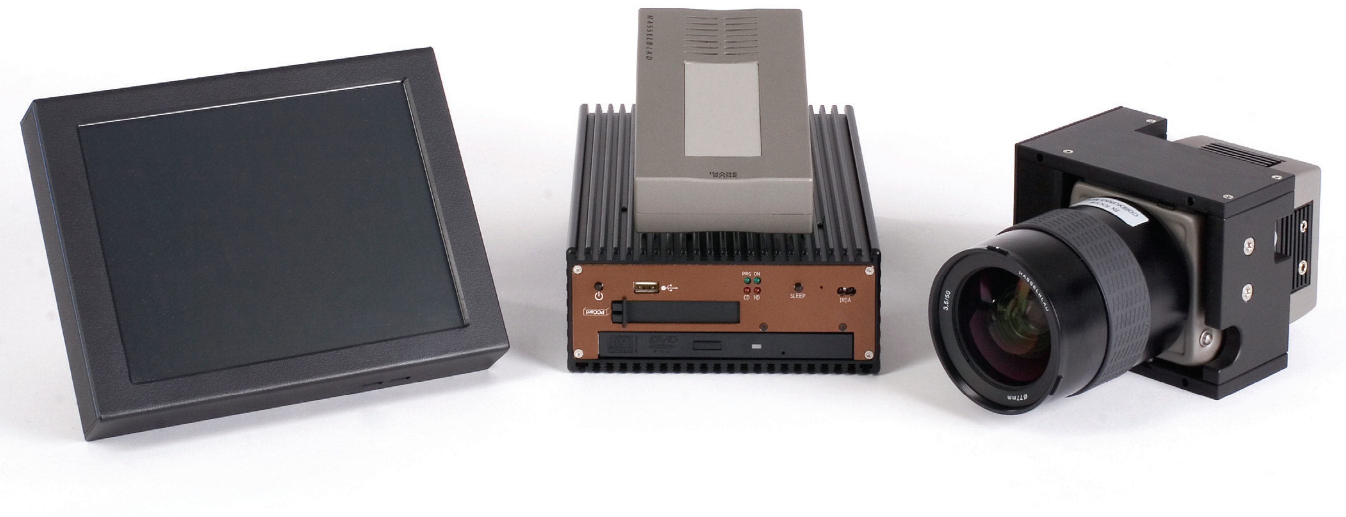

Figure 6: The *DigiCAM-H* system

Figure 6 shows the *DigiCAM-H*. The system is based on Hasselblad camera components with a modified IMACON 22 MPixel CCD backplane. The ImageBank stores 850 images in 16 bit color and full resolution, multiple storage devices can be used during one flight mission. The *DigiControl* computer with the touch-screen user interface can control several cameras at once. The operator can check quick-views and exposure histograms of the actually taken photos in real time and change all necessary settings of the different cameras. For pre-planned flight missions the cameras are triggered by the *CCNS4*.

The *DigiCAM-H* can be operated in an integrated system together with the *LiteMapper* or as a stand-alone unit including one or more cameras. Lenses with different focal length are available.
If used together with the *LiteMapper*, a 35mm or 50mm lens might be used to adjust the field of view of the camera to the swath width of the LIDAR. The configuration with a 50 mm lens would result in the following typical mission parameters:

	Flying Height	Speed	LIDAR Corridor Width	Camera Corridor Width	LIDAR Point density	Camera GSD
Helicopter	200m	40kn	230m	196m	15 Pts/m^2	3.6 cm
Fixed Wing Aircraft	500m	100kn	575m	490m	2.4 Pts/m^2	9.0 cm

Table 1: Typical Mission Parameters for the *LiteMapper* with *DigiCAM*

For small orthophoto projects in urban areas 80 mm and 100 mm lenses are available.
The modular design of the *DigiCAM-H* enables a change from RGB mode to color-infrared mode within minutes. At the current speed of the development of the number of pixels available for the backplanes, it is important that the digital backplane of the camera can be exchanged without changing the rest of the camera system.

Figure 7: *DigiCAM-H*

4. CONCLUSION

Besides the ongoing improvements for the *CCNS/AEROcontrol* guidance, sensor management and GPS/IMU system for all kind of airborne sensors, IGI has integrated LIDAR and medium format digital cameras to provide integrated airborne sensor systems for special applications.
The *LiteMapper* LIDAR system is optimized for corridor mapping with helicopter or fixed wing aircraft and for small to medium sized topographic mapping projects with highest accuracy requirements. The waveform digitizing *LiteMapper 5600* opens new possibilities for forestry and agricultural applications.
The *DigiCAM-H* digital camera system provides a cost efficient solution for small infrastructure photogrammetry projects and corridor mapping. The capability to switch from RGB to CIR and to change between different lenses, together with the possibility to combine two or more cameras together, makes the *DigiCAM* system a versatile tool for all kind of projects where a large format digital camera can not be used efficiently.

5. REFERENCES

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