REMOTE SENSING AT AGUSTA S.p.A. - A REVIEW AND NEW TRENDS

A. Cecca(*), A.M. Colla(*), R. Marchetti(*), A. Bianchi(**)

(*) AGUSTA S.p.A. - Unita' di Roma, Roma - Italy
(**) AGUSTA S.p.A. - Unita' di Tradate, Varese - Italy

Abstract

Remote Sensing in general and its applications for monitoring the environment, detecting and measuring the most common and dangerous polluting agents, verifying the effect of the remedial actions, require a considerable know-how in a variety of high-tecnology fields.

Agusta S.p.A. has a consolidated experience in the visible band with Photogrammetry, in the active and passive thermal band and electrooptic systems, in addition to being a manufacturer of helicopters, for which it is well-known worldwide.

This paper presents the general concepts of photogrammetry and remote sensing, and describes the work being done for the development of a multisensor, heliborne data acquisition system.

Introduction

AGUSTA S.p.A. is not only active with rotary wing and fixed wing airframe contruction but also with research, development and production of aerospace-related equipment and systems.
Remote sensing is one of the activities that during the last decades have been able to drammatically develop thanks to the more and more diffused availability of airborne and space platforms.
Remote sensing is generally described as "the technology and technique used for non-contact acquisition of data regarding a specific object or environment and their porocessing, with the scope of obtaining significant, reliable and useful information": it is becoming the most powerful tool for monitoring the environment with the purpose of helping to plan preventive and remedial actions for its preservation.
Photogrammetry, that is "the science of obtaining reliable measurements by means of photographs", is one case of remote sensing. Incidentally photography as such probably represents the first example of Remote Sensing to have become available to us.
The word **Photogrammetry** came into general usage at the beginning of this century, as the several potential uses of photography were starting to be fully appreciated by the scientific community: it is derived from the greek words **photos** meaning **light, gramma** meaning **something drawn or written** and **metron** meaning **to measure**. The root words, therefore, originally signified "measuring throught images, obtained by means of light".
This short mention to the concept of Photogrammetry was made on purpose, as it was no accident the fact that a company of such a long standing and leader in photogrammetry as OMI - Ottico Meccanica Italiana of Roma-Italy was now for a decade incorporat-

ed with AGUSTA S.p.A. under the name of AGUSTA S.p.A. - Roma Business Unit.
For OMI, active since 1924 with design and production of photogrammetric and aeronautical instrumentation and systems, and now for AGUSTA, stepping into today's Remote Sensing activities was only a natural evolution.
AGUSTA Roma Unit has throughout the years produced under the name OMI a wide range of photogrammetric systems, from aerial and ground survey cameras to the most advanced Analytical Stereoplotters the concepts of which represented in the early sixties a technological breakthrough that has since then positively conditioned not only the producers but also the working methods of the users, which simpler-to-use, more versatile and more productive tools have been made available to.
The advancements in computer technology have considerably impacted on today's photogrammetric systems that have now reached degrees of precision, automation and user-friendliness that were unthinkable of only a few years ago.
Among the users of our analytical photogrammetric systems we can count, besides a large number of independent map-making and engineering companies, the most outstanding western governement agencies concerned with defence mapping and cartography, targeting 3-D modelling, thematic data acquisition.

A multi-sensor heliborne platform

AGUSTA has developed, in cooperation with, and based on a project by AGIP, the Italian national oil exploitation and distribution agency, a heliborne twin-camera system called S.E.R. [i].
The S.E.R. , now commercially available and so far certified for the AB 412, is a unique system in that represents the first operational heliborne stereoscopic camera system for short-range and all-condition precision photography. This Remote Sensing system in the visible band offers all the advantages of the bi-camera arrangement, first of all the capability of making precision takes of moving objects.
The helicopter has proved itself as an ideal platform for middle/short range Remote Sensing, and one of AGUSTA's current goals is to develop a **multi-sensor Remote Sensing platform** capable of gathering the largest possible amount of information about the environment with the purpose of making available an advanced monitoring system.
The concept of such a system is that of employing a number of different sensors, each operating within different bands of the electromagnetic spectrum, on a highly manouverable platform.
The state-of-the-art sensors that are being considered and proposed are :

1. **Visible band sensors (photogrammetric and video cameras)**

2. **FLIR (Forward Looking InfraRed)**

3. **LIDAR (Light Detection And Ranging)**

[i] S.E.R. is a Registered trademark of AGIP S.p.A.

Photogrammetric Cameras, in addition to supplying a large amount of information due to their high space resolution, shall also supply the metric base reference to which the information and the data supplied by the other sensors can be related.

FLIR (Forward Looking InfraRed), consist of scanning-type analyzers in which three main functional blocks can be identified :

(1) - An Optical-Mechanical scanning sub-system
(2) - A sensor in the 8-14 micrometer band
(3) - An image recording sub-system.

These analyzers, known as stationary scanning type analyzers, are widely used on a board of helicopters. A prismatic mirror that rotates about its vertical axis provides scanning on the orizontal plane, and a plane mirror that rotates about its horizontal axis provides scanning in the vertical plane. The received radiation is focussed onto a sensor that converts it into electrical signals so that the resulting image can be displayed in Real-Time on a TV monitor and/or sent to an analogue/digital device for further processing. The sensor consists in this case of a bi-dimensional array of Hg Cd Te crystals working at a temperature of 77oK in order to minimise the electrical noise produced by the molecular vibration of the crystals. Such a sensor features a thermal resolution better than 0.1oC and a minimum measurable noise better than 0.05oC.
By proper signal processing a false-colour image can be produced and a significant thermal map showing the different polluting agents and their consistence can be obtained.

LIDAR (Light Detection And Ranging), is a device based on the fact that the emission spectrum of each body is a function of its chemical/pnysical nature and that it can be used as a characteristic parameter of the phenomenon under observation.
Fluorescence spectra are generally obtained by irradiating the body being studied with a monochromatic light beam, e.g. a laser beam, and the reflected radiation is analyzed spectroscopically. Since a part of the incident energy is returned at a lower frequency that is a function of the nature of the reflecting media, the fluorescence phenomenon can be exploited for identifying and analyzing the reflecting media itself. The fluorescence of each frequency band is axcited by an incident radiation of appropriate wavelenght and pulse duration.

A LIDAR basically consists of a transmitter, a receiver and a subsystem for the acquisition, processing and presentation of the returned signal. The most appealing applications for a LIDAR are those that permit the identification and quantisation of different polluting agents :

- in the atmosphere, as O, CO_2, SO_4, N_2, etc.

- on the water surface, as hydrocarbons, phitoplancton, sewer and urban dumps, oxigen impoverishment
- on the ground, for monitoring the presence of pest-control

chemicals and of other pollutants, the plant growth and deseases.

Conclusions

A multisensor system as devised above represents an effective tool for the knowledge and the protection of the environment.

Integration of the different techniques permits the acquisition of the most complete set of information, although each of the techniques is in itself specific to a definite domain of data.

Photogrammetric techniques, for example, are typically and predominantly utilised for metric purposes, although often in conjunction with interpretation and thematic techniques.
Photogrammetry, in addition to the original well-Known use for mapping and cartography, finds today extensive application for activities such as :

- **Urban Survey** intended as data on the population and land use data for a large information system having the scope of optimizing urban planning.

- **Civil Engineering** in this case photogrammetric techniques are used for the collection of the data necessary for the planning and designing of large artifacts, such as roads, railroads, bridges, and water reservoirs.

- **Inventory and management of forest and agriculture resources** rapid forest and crop inventory techniques that utilize photogrammetry have been developed and are now widely used for crop planning,growth evaluation and production estimate.
Complemental parameters such as plant desese, forest fire and water resources monitoring are all tasks that have derived great advantages from the use of photogrammetry integrated by other remote sensors such as FLIR and LIDAR.

- **Monument conservation and restoration** ; photogrammetric techniques are here used for the numerical and graphic description of the monuments for archive and for planning restoration actions.

- **Geology** ; in conjunction with monitoring in the IR band (FLIR) photogrammetry is utilized by geologists for structural survey, thermography, stratigraphy, damage assestament and analysis of catastrophics events.

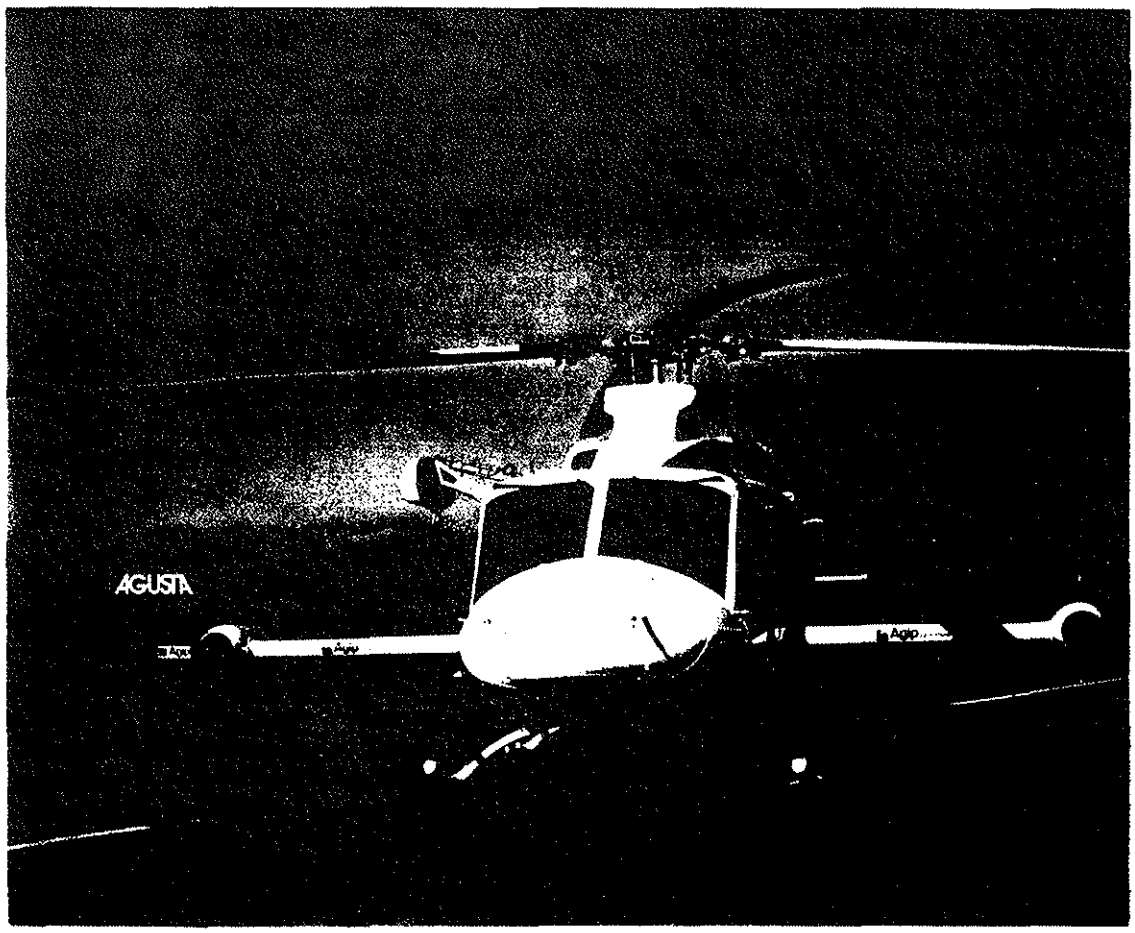
- **Industrial photogrammetry** consists of all those applications concerning stress and deformation analysis of large structures, "as-built" surveyof off-shore clusters and industrial plants (S.E.R.), modelling for the automotive, aeronautical and naval industries.

- **Biostereometrics**, that is the study of the human body in the presence of bone deformation and fractures in orthopedics, dentistry research, x-ray photogrammetry.

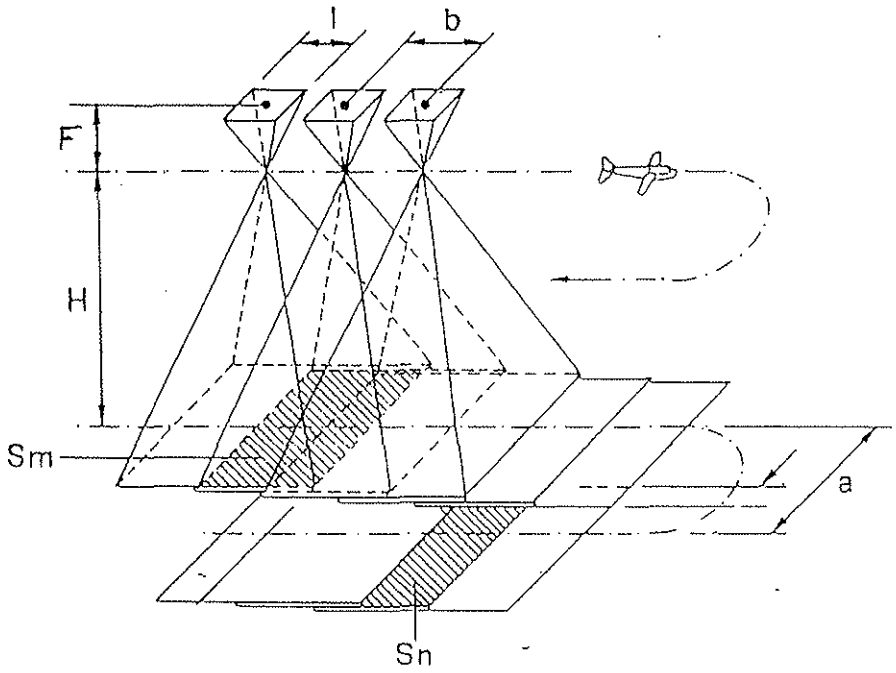
Thermal, IR and laser techniques (FLIR and LIDAR) provide the information required for the compilation of pollution maps (industrial, urban, thermal, and hydrocarbon) and **water quality** maps (salt content, suspended solids, temperature, turbidity).

The same techniques are used for **soil analysis** : study of urban and industrial congestion with the scope of evaluating its impact on local micro-climate and the possible conseguent pollution. Thermal dispersion and pollution control, fire prevention, forest and crop inventory are also important activities that, although so different from one another, will all benefit from the availability of a multi-sensor platform of the type described.

A computer-assisted analysis of the cross-related information obtained by the different sensors will provide the means for a better knowledge of a wider variety of environment-related phenomena, in the form of appropriately coded thematic maps, of numerical data and of data files for later comparison and action effect analysis.



The AB 412 SP Helicopter together with S.E.R Photo System and its storage and shipping container, also used as a field darkroom.



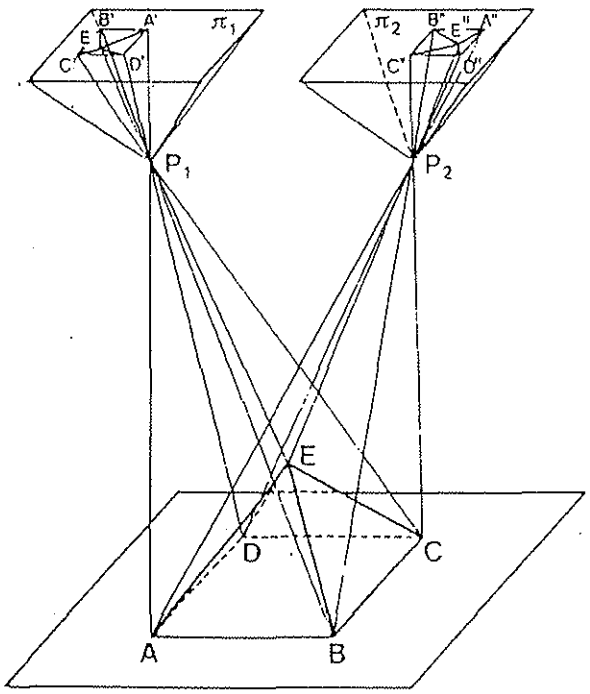
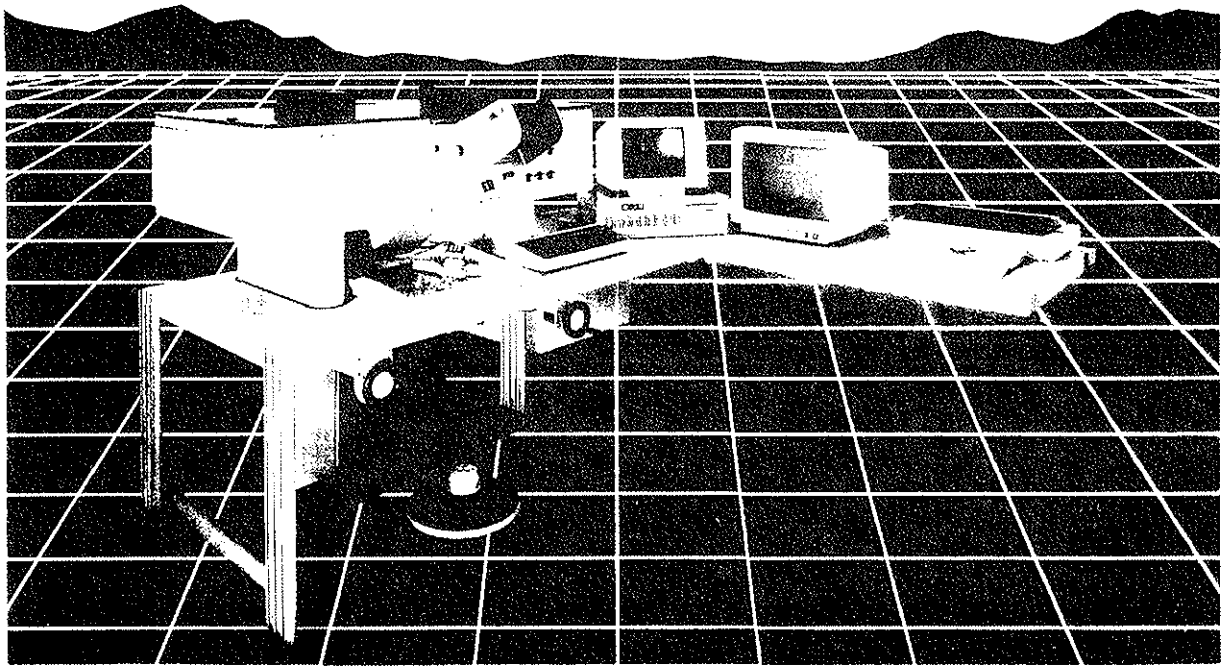


Diagram of a typical photogrammetric flight.
Above : flight path for "Block" survey,
Below : the geometry of one stereopair.



A fourth-generation Analytical Stereoplotter, the AP5 MKIII, for digital data acquisition from photo-pairs.

The AB 412 Helicopter shown with prototype 3-field of view FLIR mounted on a 4-axis stabilized gimbal. Magnification factors are 12X, 3X and 1.2X.