PROCESSING OF CORRELATED INFORMATION

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ABSTRACT

Data acquisition has, for a long time, required heavy engagement bot of manpower and technical support. On the contrary, at present time, large sets of data are easily acquired. However this enormous amount of information contains often correlated data which should be treated with particular care. Indeed to neglect correlation means to consider much more information available than in the reality. This means to supply estimates with relative errors, one or more times better than the correctly expected ones. The complete development of the mathematical and statistical models proofs this assertion to be correct. Furthermore the same developments show that only innovations, of full rank, give valid contributions, to improve the estimates themselves. Practical experiments, concerning both elementary examples and real sets of data, have already been analyzed and tested, in the recent past, proving the correctness of these assumptions.

1 INTERNATIONAL COOPERATION AND TECHNOLOGY TRASFER

A very well philosophy is that "cooperation" is better than "competition" and assures bigger and more stable advantages; furthermore democracy is to accept voting procedures and their results. For these reasons the responsibility of the ISPRS WG VI/3 “International Cooperation and Technology Transfer” was assumed and its activities has been carried out in the last four years.
The following sentences represent the terms of reference of this Working Group”:

- Foster relationship between Regional Member Organizations and the relevant Working Groups.
- Development of connections with International Organizations to urge the wider promotion and use of photogrammetry, remote sensing and GIS.
- Promotion of the general understanding of our profession and improvement of public relations for our discipline.

These terms of references should be suggestions and not boundaries, because it is impossible to cut science and related techniques; furthermore new arguments are riches and not uncertainty. A comparison between Middle Ages and Renaissance proofs that the first had a lot of constraints, but sciences and arts increased strongly in the second epoch. A second consideration recognizes that science and technique should grow together, exchanging theoretical contributions and practical experiences positively.
The following list provides some informal ideas, to better focus the problem of international cooperation and technology transfer:

- offer an open floor for people entering, for the first time, the society;
- collect real examples of knowledge sharing and technology co – generation;
- promote the growth of basic knowledge and its circulation;
- encourage a peaceful use of mature and innovative technologies;
- enforce, in the field of peculiar disciplines, a sustainable development under a true international consensus;

establishing close contacts with Regional Member Organizations and, through them, ISPRS Ordinary and Associated Members. Moreover close contacts can be established with Technical Commissions and their Working Groups, as well as Sister Societies, Regional Member Organizations and other International Institutions, which agree with the above mentioned sentences.
Notice that whatever the level of participation, nobody can change his/her interest, but focus his/her attention in a field wider than the traditional one. Cooperation imposes to exit from the everyday routine and to enter the world meeting

new people, with the aim to exchange experiences and to transfer useful technologies positively. Indeed the most important emerging result realizes that the market, as well as some academic affairs, are able to transfer technologies, but often in conflict with the spirit of the international cooperation which implies co-generation of scientists, technicians and users, in a peaceful world, independently on their country of origin. Consequentially it is completely wrong to think that technology transfer could be, depending on the point of view, to buy or to sell expensive technologies, as well as to copy or to diffuse, a priori, prepared projects. International cooperation requires to stop the market and the connected business, sincerely hoped better conditions, concerning the life quality in the underdeveloped countries too, under a true international consensus.

It is a big pleasure to note as the Working Group cooperates officially, or unofficially, with some Cooperating Members, so that it isn't small, isolated and maybe useless. However it plays an important role among the Technical Commissions and their Working Groups, increasing their cooperation and emphasizing the topics of international cooperation and technology transfer. Furthermore a special attention to real examples should be given by every member, paying a lack of content unfortunately frequent in the university people; indeed the ISPRS WG VI/3 according to its Terms of Reference cannot neglect or dismiss contributions from industry, engineering firms, etc.

Consequently this Working Group could play an important role with the aim to enlarge the participation and to have activities at a really important level. Indeed the bigger danger is to restrict the responsibility and participation to a few number of countries and/or groups. There are two possibilities to overcome these troubles: the foundation of democracy for an elite or to enlarge democracy and participation. The spirit of the international cooperation proved that only the second hypothesis is correct, able to build up a peaceful world and to put the whole humanity under satisfactory life condition.

Part I – Collection of Real Examples of Knowledge Sharing and Technology Co – generation

2 DIGITAL PHOTOGRAMMETREY AND IMAGE PROCESSING

Photogrammetry is technology driven and not application driven, what is obvious from the main technological eras in photogrammetry, namely graphical, analog, analytical and digital.

At present time, 3D feature-based matching of linear features and the theory and practice of complex surface representation, where different algorithms were used (e.g. Catmul-Rom splines with local control, Bezier splines on triangular patches, Delaunay triangulation) represent some optimum tools, on the way of data management and integration. In digital photogrammetric and image processing, researches were carried out in the camera calibration and image restoration, as well as in the automatic reconstruction of multi – planar environment, by maximum likelihood, and automatic mosaicking of planar surface.

Some applications of these techniques, to architectural and archaeological photogrammetry, present historical studies on an ancient perspective in Lecco, matched with a new survey, the orthoimage of the ancient engravings in Capo Di Ponte, a hypertext on architectural object oriented GIS of the St. Marcu's Basilica in Venice. In the same field, other applications show a photogrammetric approach of surveying and mapping of ancient sculptures of the Dome of Milan, the photogrammetric survey of the internal bearing structures of the Dome of S. Maria del Fiore in Florence and the static control of Palazzo della Ragione in Padua.

Low cost photogrammetry systems, classical analytical photogrammetric instruments and purely automatic (supervised or unsupervised) image processing are applied to these projects. In the same frame, biologists showed the first results, concerning a special type of image processing, concerning the participation in the gene functional mapping project. Finally very interesting is the integration of photogrammetric data and metadata, like virtual reality sequences and GIS technologies, e.g. for earthquake damage evaluation on buildings and other structures.

A very good example of interdisciplinary is furnished by the result of works in the field of photogrammetry, archaeology and history of art. The problem of classification of documentation, for architectural photogrammetry, is also dealt with a special attention paid to the safeguard for a Romanesque Baptistery and for two different archaeological sites.

The results of laser scanning and animation techniques prove of considerable interest, for a virtual museum. In the same field, attention is also paid to a new tool, which allows people involved in documentation and restoration of cultural heritage to navigate in a stereo-plotter. Furthermore also in close-range photogrammetry, the best approach is constituted by stereo-plotting with rectified images.

Determination of terrain models, especially in wooded areas, with airborne laser scanner data is a new very promising tool in photogrammetry. Airborne laser scanners for recording topographic data are ready to be used in various applications. Some experiences, acquired during the pilot project, compares photogrammetry with laser scanning from the user’s point of view. Laser scanning is the dynamic method of data acquisition, with laser rays from airborne, and is especially suitable for measurements, to obtain terrain models in wooded areas. It is necessary, to use GPS and INS during the laser scanning, in order to be able to define the position of ray origins. Thus the geoid undulations of the area are required.

Laser scanning supplies data with a skew distribution of errors, because a portion of the supplied points is not on the

terrain, but on the treetops. Thus the usual interpolation and filtering has to be adapted to this new data type. The implementation of this new method is based on linear prediction algorithm and it works iteratively, taking into account robust estimators. Laser scanner data provide DTM's, in wooded areas, with an accuracy equivalent to photogrammetry DTM's, in open areas, derived from wide-angle images of scale 1 : 7000. In flat terrain, the accuracy is + / - 25 cm. After further improvements in the data processing, an accuracy of + / - 10 cm can be achieved for laser DTM's. With a special filtering and interpolation method, an automatic classification of the laser points, into terrain and vegetation points, is possible.
An important recent progress, in the field of airborne sensors, describes the features of a digital camera, the so called three line camera. A remarkable project deals with integration of data from laser scanning techniques and data from photogrammetry, in order to obtain ortho-images.
Apart from the typical projects of digital photogrammetry and image processing (e.g. the use, in the field of deformation monitoring, of an automatic DEM generation in quarries), SAR Interferometry and X-ray photogrammetry constitute parallel topics of high interest too (Kosmatin Fras, 2000).

3 REMOTE SENSING AND MAPPING FROM SPACE

Color science covers interdisciplinary the physical, physiological, psychological and psychophysical aspects. The simple question: what is color?, shows that most people believe to know the right answer, but the correct and complete answer is much more complex. Just to have an idea, a classification system based on opposite couples: black and white, blue and yellow, reed and green, is preferable to the classical additive synthesis of the three fundamental colors.
A future professional challenge lies in the mapping from space. A practical motivation proves that mapping from space is important, taking into account what can be accomplished today, for the benefit of the whole humanity, and what could be opened the challenged scenario, in the future.
A global geo – engineering approach uses remote sensing and GIS, for the prediction of global deforestation from NOAA AVHRR and geo – spatial data. The principal topics are remote sensing, the growth of the population, the deforestation and other geo – disasters, where a very well experiment proves the high correlation of the two dangerous phenomena by using regression methods and robust procedures.
A linear relation exists between the growth of the population, in the different parts of the world, and the deforestation. Indeed there is a linear dependence (and the classical index, like the linear correlation coefficient, is unfortunately high enough) between the request of wood, in the developed countries, and the acquisition of it in the remaining part of the world, especially where the increasing of the population is remarkable.
The analysis, concerning the deforestation, starts from the processing and classification of images, taken by the remote sensing satellite NOAA AVHRR. Data, concerning the population, are acquired by geo – spatial data atlas, available on global statistics databases; the population growth is firstly analyzed by countries and successively reassembled by sub – continental regions.
The linear regression is performed using robust procedures, so that outliers (i.e. data with anomalous behavior) are eliminated, increasing the quality and the validity of the explanation itself. The difficulties to stop this market and the connected business require appropriate initiatives, under a true international consensus, sincerely hoping better conditions, concerning the life quality in the underdeveloped countries too.
Local applications shows LANDSAT-TM and SPOT-HRV imagery usage for engineering and cartography; they are new automatic, soft classification methods, for estimation of the blanket of snow and mapping of hydro - thermal alteration.
In the same context, a new extraterrestrial mapping is the main objective of the international project – GAIA. The goal of the project is to upgrade the existing star catalogues, by providing a precision catalogue of one billion stars, using high – resolution measurements with micro – arc second astrometry from space (Mussio, 1999).

4 SPATIAL INFORMATION SCIENCES AND TECHNOLOGIES

The dynamic concept of survey, the integration of different sensors and systems, analytical models for the real time estimation and prediction of dynamic variables, the interaction with the information technology and geomatics offer a fashioning view of the current tools in the GIS / LIS world.
The image and/or map based automatic reconstruction and visualization of country take into account image and/or data – map acquisition, 3D data modeling, AI inference rules, 3D data visualization, GIS operability and it is performed by wide landscape models, using different techniques of artificial intelligence.
Therefore they are possible to extract from maps any kind of information, putting them on different layers of a GIS and/or LIS, according to a unsupervised, or only partially supervised, classification. The methodologies, involved in the automatic exaction, belong to the fields of both statistics and artificial intelligence. Furthermore special attention is paid to the actual and interesting problems of 3D data modeling and visualization.
The importance of this job is due to a very large amount of data which often are available today, in form of charts, and can be supplied as computer cartography, avoiding to operate manually or to proceed to new acquisition. It is obvious

that, if the whole process is able to run, with a very high level of reliability (ranging from 95% to 98%), it can substitute, in the future, expensive acquisition techniques, with relatively low cost procedures.
Many applications are possible, ranging from the model of the terrain deformation (by aerial photogrammetry) after a landslide, to the planning of the mobile – telephone antennas, as well as from different source data integration (e.g. over meshes determined by cadastral fiducial points), to economic data management (geomarketing)
Obviously the applications could be run in many other different fields. In this frame, a high precision leveling network studies the subsidence in the city of Como and its surrounding area. The aim is the monitoring of the soil behavior and to discover the deformation nature. Many other different researches involve environmental monitoring, land degradation and water resources.
In the same field, the effect of TEC (total electron content) on Antarctica GPS measurements show that TEC values, obtained from GPS observables, are in good agreement with those derived from the atmospheric sounding. Notice that the knowledge of the continuous TEC values can also help to better plan the GPS acquisition sessions, during the Antarctica Italian Campaign, in the context of the international project Antarctica.
Advanced professional applications deal with computer assisted cartography and GIS / LIS, and their application to land use city and environmental planning. Also samples of cartographic problems, from small to large scale, referring mainly to architectural photogrammetry (of high interest for cultural heritages), demonstrate on the usage of an architectural object oriented information system.
The increasing use of WEB in the survey and mapping disciplines is impressive, e.g. data transfer, GIS applications, 3D models, etc. can be handled and spread out via Internet. An interesting example of using HTML, to access via network the topographic and photogrammetric survey data, is the case of Archivio di Stato di Mantova. Moreover a WEB based GIS system shows a support for collection and diffusion of environmental data.
Interactive visualization, performed by an Animated Terrain Model, describes what is changing under the influence of digital procedures, Internet world and the development of animation techniques. An example is given by a problem of water flow analysis, where a DTM is implemented by means of geo-morphometric constraints. A special issue is the integration of different height data (having a different quality) for improvements of DTM, aiming at making a DTSM.
Another interesting application is given by the GeoMed project, dealing with GIS and spatial statistics. Obviously the fields of application of GIS and Geomatics are wider. Therefore in the urban analysis or management, as well as for many studies on landscape or vegetation, the conditions for a correct use of a GIS are often based on Remote Sensing.
A meaningful example is given by the analysis of the heavy social and economic consequences for the environment, caused by the mining activities, regarding to which a severe judgement must be pointed out, considering the importance to do valid efforts in the positive direction (Mussio, 1998).

5 MATHEMATICAL AND STATISTICAL ASPECTS OF DATA ANALYSIS

Many aspects of spatially referenced data analysis deal with spatial analysis itself, temporal aspects, data fusion and integrated approach, discrete mathematics, texture and pattern recognition, and parsers, furnishing a suitable mixture of theory and practice. They involve some methodology problems, in the field of the survey and mapping disciplines. Let recall that methodology is a longstanding theme which could sometimes appears boring and/or old – fashioned, but it furnishes practical instruments, capable to be applied in different times and at various situations.
The approximation theory, born in the field of the integrated geodesy (in its broadest sense) presents suitable contributions in the fields of signal / image filtering, digital object / terrain modeling, deformation monitoring, etc. This approach is classical in the earth sciences and works very well, when models and data are clearly defined, by using an hybrid norm to solve generalized least squares and some other related techniques (e.g. variance analysis, covariance estimation, robust procedures).
On the contrary, data management and processing in the field of the information technology often works with undefined databases and quite poor models. Therefore an attempt, to get order in single experiments, shows to be recommendable different techniques, coming from discrete mathematics, linguistics and AI. Actually the parsers are the most promising algorithms, able to solve texture and pattern recognition problems (e.g. feature extraction and grouping, image understanding / object recognition, scene interpretation, sequence analysis).
Specific considerations on metrology and data processing go deeply into some concepts of epistemology and linguistics related to metrology (the problem of uncertainty was especially taken into account). Furthermore advanced Kalman filter technique, for a dynamic survey, and the basic theory of the wavelet, including their applications in the survey and mapping disciplines, demonstrate the high level achieved in the data modeling, on a more professional point of view.
European initiatives are forwarded in order to improve present state and to achieve a higher standard of information quality. Later updating of land cover /l and use is treated, especially for describing changes of urbanized areas. Another example is the one of expansion of woodland, parallel to growing urbanization and decreasing agricultural land usage, which takes place extensively after WW2.
The problems, which usually arise in the European standardization of statistical classification in GIS, show that an object oriented classification may be chosen: so a number of countries should agree to this aim, for positive results.

Moreover algorithms and procedures or models, like the “Procustes analysis”, are suitable in order to transform datum in the framework of GIS.
In this frame, not only photogrammetry and cartography, but also geodesy and surveying are relevant too. The problem of the datum definition in the densification networks, the use of robust procedures in the network adjustment and analysis show interesting applications respectively in the control leveling network of a dam and in the Assisi landslide monitoring by a GPS survey.
Furthermore the establishment of a precise leveling network, for the monitoring of possible vertical movements in Pisa and in its surrounded area, and some surveying methodologies suitably applied in volcanic regions, like the Phlegrean district (near to Naples), are interesting topics, presented in the field of deformation monitoring.
In the same fields, a comparison between the classical ITALGEO95 geoid and its determination, via GPS, and the usage of GPS, in the datum transformation and in the development of an infrastructure mapping, demonstrate on different current problems.
GPS is a main theme because, as it is widely known, it makes possible to work in a unique reference system, as DGPS allows real time corrections upon a wide range. Further developments involve the integration of GPS and GLONASS, the waiting for achievement of future GALILEO system and the fusion of information supplied by GPS, photogrammetric triangulation techniques and computer vision algorithms.
GPS, GLONASS and other systems are used for real-time positioning. To this task, big powerful industrial firms are prepared to invest for establishing more permanent GPS stations in Italy; however not only money is needed, but also proper professional solutions must be considered as well. Last but not least, different partners from research centers and industries, recently achieve a full success, working on the Italian mission of satellite accelerometry – SAGE.
Notice that, especially in a context of international cooperation and technology transfer, the report of different activities, in the fields of survey and mapping disciplines, is very important, even if they are far from photogrammetry, remote sensing and GIS (Mussio, 1997).

Part II – Promote the Growth of Basic Knowledge and its Circulation

6 PROCESSING OF CORRELATED INFORMATION

Given a standard Gauss – Markov least squares problem, the normal matrix, coming from a linear functional model and the classical stochastic model, where all observations are assumed to be un-correlated, has the form:

$$C = A^T PA \qquad (1)$$

being *A* the design matrix and *P* the weight matrix.
On the contrary, if the “observations” are assumed to be “correlated”, the normal matrix becomes:

$$D = A^T (P^{-1/2} (R - I) P^{-1/2} + P^{-1})^{-1} A \qquad (2)$$

where the coefficients *r* of the matrix *R* represent the correlation among the observations. Consequentially the inverse matrix of the second normal matrix D^{-1} is different, with respect to the inverse matrix of the first normal matrix C^{-1}:

$$\begin{aligned} D^{-1} &= (A^T (P^{-1/2} (R - I) P^{-1/2} + P^{-1}) A)^{-1} = \\ &= (A^T PA - A^T P (P^{1/2} (R - I)^{-1} P^{1/2} + P)^{-1} PA)^{-1} = \\ &= C^{-1} + C^{-1} A^T (P^{-1/2} (R - I)^{-1} P^{-1/2} + \\ &+ (P^{-1} - AC^{-1} A^T))^{-1} AC^{-1} = \\ &= C^{-1} + C^{-1} A^T (P^{-1/2} (R^{-1} - (R - R^2)^{-1} P^{-1/2} + \\ &+ (P^{-1} - AC^{-1} A^T))^{-1} AC^{-1} \end{aligned} \qquad (3)$$

and its main diagonal elements are larger than the corresponding elements of the first one.
Furthermore given a standard Gauss – Markov least squares problem, the normal matrix, coming from a linear functional model, containing also a priori un-correlated information on parameters, and the classical stochastic model, has the form:

$$C = A^T PA + (I * Q)^{-1} \qquad (4)$$

where *Q* is the weight matrix of the pseudo-observations on the parameters.

On the contrary, if the “a priori information on parameters” are “correlated”, the normal matrix becomes:

$$D = A^T PA + (I * Q + (I * Q)^{1/2} (R - I)(I * Q)^{1/2})^{-1} \tag{5}$$

where the coefficients r of the matrix R represent the correlation among the a priori information on the parameters. Consequentially the inverse matrix of the second normal matrix D^{-1} is different, with respect to the inverse matrix of the first normal matrix C^{-1}.

$$\begin{aligned}
D^{-1} &= (A^T PA + (I * Q + (I * Q)^{1/2} (R - I) \bullet \\
&\bullet (I * Q)^{1/2})^{-1})^{-1} = \\
&= (A^T PA + (I * Q)^{-1} - (I * Q)^{-1/2} ((R - I)^{-1} + I)^{-1} \bullet \\
&\bullet (I * Q)^{-1/2})^{-1} = \\
&= C^{-1} + C^{-1} (I * Q)^{-1/2} ((R - I)^{-1} + I + \\
&- (I * Q)^{-1/2} C^{-1} (I * Q)^{-1/2})^{-1} (I * Q)^{-1/2} C^{-1})^{-1} = \\
&= C^{-1} + C^{-1} (I * Q)^{-1/2} (R^{-1} - (R - R^2) + I + \\
&- (I * Q)^{-1/2} C^{-1} (I * Q)^{-1/2})^{-1} (I * Q)^{-1/2} C^{-1})^{-1}
\end{aligned} \tag{6}$$

and its main diagonal elements are larger than the corresponding elements of the first one.
Notice that the main diagonal elements of both the inverse matrices are vice versa smaller than the corresponding elements of the inverse matrix without any a priori information.
The importance of these mathematical and statistical considerations is evident. Indeed information contains often correlated data which should be treated with particular care. Indeed to neglect correlation means to consider much more information available than in the reality. This means to supply estimates with relative errors, one or more times better than the correctly expected ones. The complete development of the mathematical and statistical models proofs this assertion to be correct.
Furthermore the same developments show that only innovations, of full rank, give valid contributions, to improve the estimates themselves. Practical experiments, concerning both elementary examples and real sets of data, have already been analyzed and tested, in the recent past, proving the correctness of these assumptions. Anyway only processing of precise data, by means of stable algorithms, assure to obtain accurate and reliable estimates.

7 FIELDS OF APPLICATION

Data acquisition has, for a long time, required heavy engagement both of manpower and technical support (figure 1). On the contrary, at present time, large sets of data are easily acquired. However this enormous amount of information brings with itself a number of problems (figure 2).

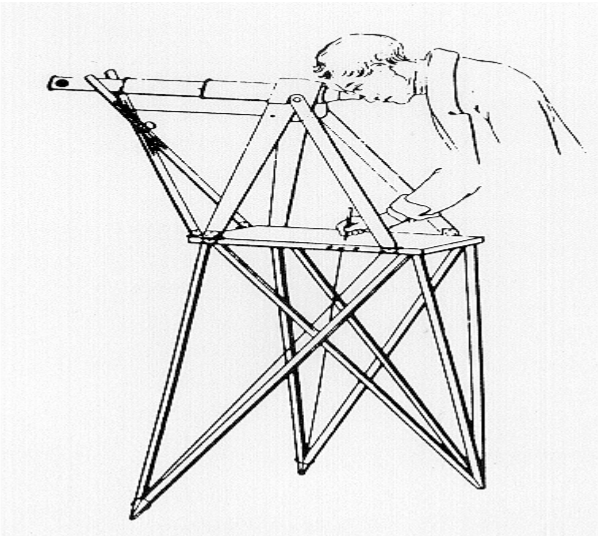

Figure 1. Ancient surveying

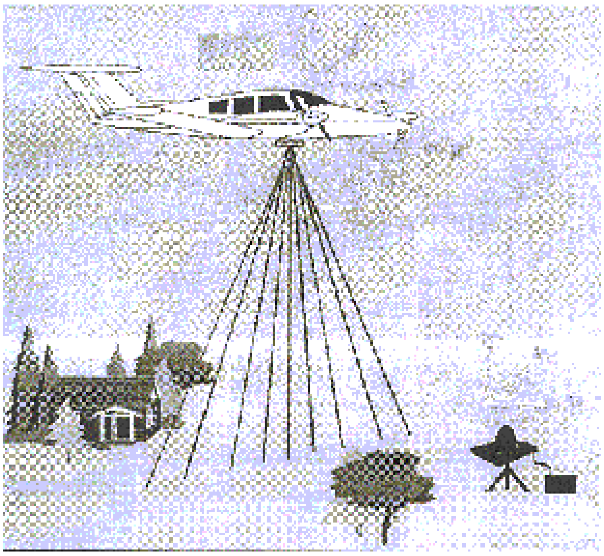

Figure 2. Modern technicalities

Actually the mere amount of data doesn't mean information in any case: information is not simple retrieval, or archiving of data, but a critical process, as Wiener said. Therefore redundancy of data may give some sort of misunderstanding, if a critical consciousness lacks. So in real world, confusion and conflicts may arise.
Least squares methods and some other related procedures may give solution to an important group of problems of image processing and spatial data analysis, as for example:

- network / block / joint adjustment;
- surface reconstruction, form descriptors;
- feature extraction and parsing;
- image / map / object matching.

Going further to the classical division of adjustment and interpolation/approximation problems relevant in photogrammetry, remote sensing, GIS and generally, in survey and mapping, the first area collects:

- on-line triangulation of images: space-borne, air-borne and terrestrial, taking into account both passive and active sensors and systems;
- GPS, INS and other sensor navigation data processing, automatic surveying (robotics).

Prior to processing, it should be pointed out a pre-processing of data collected by space photogrammetry and remote sensing techniques (LANDSAT, SPOT, MOMS, SAR, etc.), with due care, as well as by geodesy (e.g., GPS, INS, laser profile and laser scanning) and related sciences.
In this frame, the data acquired by the laser scanning, both form airborne and in close-range, are suitable to be emphasized, because they are quit new and offer a very deep perspective. Indeed whilst the classical photogrammetric data are in 2D (being the projection of an object on a suitable surface, and generally on a plane), they open out the 3rd dimension, measuring all the distances between a projection center and the object points.
In such a way, the survey becomes in 3D, after having performed the integration of the sensors and the fusion of the acquired information. Let recall that, as already said before, laser scanning is the dynamic method of data acquisition, with laser rays from airborne or in close-range (figure 2). It is necessary, to use GPS and INS during the laser scanning, in order to be able to define the position of ray origins. Thus the geoid undulations of the area are strictly required.
Data pre-processing and processing requires to proceed with particular care. To this task the problems of weights and/or correlation, among the different sets of data and/or within themselves, are particularly relevant. Indeed robust procedures, as well as the establishment of an appropriate stochastic models (in both cases, the search of a accurate and reliable reproducing point in an non-linear iterative strategy) need to process suitable weighed and/or correlated information.
Also simulation and optimization require to proceed with the same care. Indeed a fine analysis of weights and correlation allows for the selection of an adequate functional and/or stochastic model, by using some proper criterion matrices, with the aim is to obtain accurate and reliable expectations. Let recall that longstanding methodologies and procedures contribute also in the positive solution of the problems derived from the new techniques.
As far as interpolation and approximation are concerned, one should remind a class of problems of photogrammetry, remote sensing and GIS, related to:

- measurement devices (camera calibration and other sensors and systems) and secondary effects;
- morphological features extraction, image / map / object matching;
- shape from shading and phase unwrapping;
- DEM generation, orthoimage production and superimposition;
- transforming "spaghetti" into topologically consistent structures and tesselation of concave non stellar objects;
- image processing, spatial data analysis (classification) and understanding (semantic interpretation).

Let recall that the theory of models has a proper classification for both cases as "grey box" model and a "black box" model, respectively. In the "grey box" model, the aim is the estimation of model coefficients, followed by proper significance tests for estimated parameters.
In the "black box" model, the main deterministic and stochastic approaches are preferred. In the deterministic one, aside from further details, one has a number of steps, as in the choice of an interpolation strategy (finite elements, Fourier analysis, wavelet interpolation, etc.), the estimation of coefficients for the chosen model, the variance analysis (in order to estimate altogether significance of parameters and quality of model); the stochastic approach, on the other hand, employs covariance estimation, covariance function modeling and collocation (linear filtering and prediction).

8 ENCOURAGE A PEACEFUL USE OF MATURE AND INNOVATIVE TECHNOLOGIES AND ENFORCE, IN THE FIELD OF PECULIAR DISCIPLINES, A SUSTAINABLE DEVELOPMENT UNDER A TRUE INTERNATIONAL CONSENSUS

The survey and mapping disciplines, particularly photogrammetry, remote sensing and GIS, can give very important contribution to many human activities, like:

- global monitoring and databases, integrated geo-information (spatial data handling, temporal aspects and data

revision, real time mapping, etc.);
- geo-sphere / biosphere studies, thematic applications (non-removable resources, sustainable development, human settlements, waste / disasters / land degradation, etc.);
- cartographic systems (digital mapping, DTM's, ortho-images and 3D GIS, etc.);
- close – range techniques (world cultural heritages, CAD/CAM, medical images, etc.);
- surface reconstruction, feature extraction and grouping, image understanding / object recognition, scene interpretation, image sequence analysis;
- international cooperation and technology transfer, education (computer assisted teaching, internet resources, etc.), dissemination of data.

On the contrary, they can terribly support, in very sophisticated way, the escalation of armies, wars and destruction, producing negative effects, both in high intensity and large extension.

Science and technique cannot be isolated from the whole human life context, but they should positively play a fundamental role in the real world. The encouragement of a peaceful use of mature and innovative technologies, in order to achieve concrete social, economic and cultural benefits for all the people, increases, to a high level standard, the quality of their life.

Furthermore both it is, near always, really impossible to split correct and wrong behaviors among the different situations, going back through the complex paths of history, and nobody can be appointed as maximum judge. Dialogue, comparison and cooperation (transferring real riches from the development part of the word to the developing countries) are optimum, alternative and effective ways.

For these reasons, it is recommendable to stop any war and built up the peace, because the war cannot be, in any case, an acceptable way to solve domestic and/or international conflicts. On the contrary, a real peace, overcoming each undesirable conflict of any nature or source, surely promotes further developments and riches, where all people, including every minority too, are totally respected and guarantied.

The motto: "bridging the gap", is especially suited to express a difficult-often painful transition toward a western type development. It should keep, at the same time, a stable individuality and a well-shaped cultural heritage, also in the field of the sustainable development, which includes a safe management of natural resources. However it becomes clear that the transfer is far from being a one-sided one, as experiences and attitudes, from the other sides, may prove of extreme use and interest to the more developed countries too, and to their scholars.

The authors kindly invite all people to accept this conclusion, as a personal and liberal opinion which totally doesn't involve the ISPRS. However let add that, even if it seems to be partially in conflict with the ISPRS Statute III, the ISPRS Statute I says about International Cooperation and it is really very, very difficult to obtain it without the benefits of a real peace.

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REFERENCES

Kosmatin Fras, M., Mussio, L., Crosilla, F., (Ed's), 2000. International Cooperation and Technology Transfer, IAPRS, Ljubljana, Croazia, Vol. XXXII, Part 6W8/1, Part 6W8/2.

Mussio, L., Crippa, B., Forlani, G., (Ed's), 1999. International Cooperation and Technology Transfer, IAPRS, Parma, Italy, Bandung, Indonesia, Cotonou, Africa, Vol. XXXII, Part 6W7.

Mussio, L., Crippa, B., Radicioni, F., (Ed's), 1998. International Cooperation and Technology Transfer, IAPRS, Bahia Blanca, Argentina, Perugia, Italy, Vol. XXXII, Part 6W4.

Mussio, L., Crippa, B., Vettore, A., (Ed's), 1997. International Cooperation and Technology Transfer, IAPRS, Padua, Italy, Vol. XXXII, Part 6W1.