

# INTERNET DATABASE FOR PHOTOGRAMMETRIC CLOSE RANGE APPLICATIONS

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## Commission V

**KEY WORDS:** digital camera, photogrammetric data, close range, database, Firebird®, the Internet

## ABSTRACT:

The paper presents the concept of an information system dedicated to storing, presenting and publishing via the Internet numerical and digital results of photogrammetrical measurements from various close range applications. The presented information system is not an on-line application for real-time Internet measurements. In the system a standard client-server model was applied. Three levels of access (system administration, limited and passive access) of entitlement were defined to protect the database and its structure. The structure of relations, concept and functioning rules were defined. In the system, a freeware Firebird® database server was used. It was serviced by Borland Delphi™ programming environment. The design stage was supported with CASE tools. The system is characterized by independence from native Microsoft Windows technologies, uniqueness, use of practical solutions and reduction of system limitations. The project met all relevant security standards. Applied solutions considerably reduced costs of the project.

## 1. INTRODUCTION

Modern digital close range photogrammetric measurement techniques are commonly used in many fields of science and technology: in industrial design, production and quality control processes, in industrial and autonomous robotics, in metrology, architecture, in medical and biometric applications, etc. (Atkinson, 1996; Luhmann, 2003). Photogrammetric techniques enable measurement in pointwise mode and continuous 2D plane and 3D object surface measurement. Images are registered in various electromagnetic wavelength ranges, eg. in the visible spectrum, ultraviolet (UV) as well as in near infrared (NIR) and thermal infrared. Applied close range vision measurement systems enable repeated collection of hybrid data on the geometrical and physical characteristics of registered objects, eg. vector and raster data, thermal information or semantic data. Moreover, these systems enable the creation of a wide range of documentation of measurement results.

In practice, the wide thematic range of the application creates large, multi-temporal sets of numeric and digital image data. Consequently, designing an independent information system is essential for complex storage, archiving, presenting and sharing for further advanced analysis and processing and extraction of data. A database designed in such a manner should be dedicated to the widest possible range of professional users.

## 2. PREMISES OF THE SYSTEM

The concept of the system (Figure 1) is based on granting defined users access to the close range photogrammetric database and its operation in the Internet environment (Janowski et al., 2006). Designing an on-line application for photogrammetric measurements was not the aim of the project.

The Internet was chosen as the mean of communication with database due to needs of a modern user, who demands up-to-date data and common access. Use of the Internet and its related technologies for the controlled sharing, presentation and transfer of data also allows implementation of the proposed solutions across local and corporation networks (LAN, WAN, MAN).

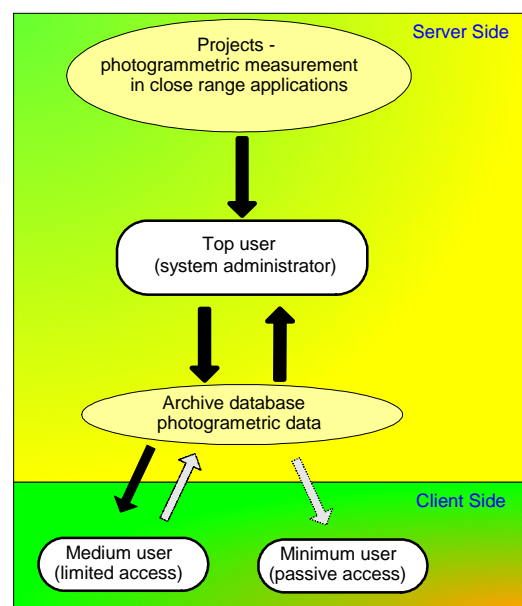


Figure 1. Concept of the Internet database for photogrammetric close range applications

Analysis of potential users demands and needs was carried out before the database was created. Designed photogrammetric database may be used in numerous close range photogrammetric applications: in production and quality control processes, vision metrology, deformation measurement, medical and biometric applications, cultural heritage recording and documentation, etc. Existing projects, such as ARPENTEUR 3.0 (Grussenmeyer et al., 2002) and other solutions (Cosmas et al., 2003; Herbig, Waldhäusl, 1997; Kadobayashi et al., 2003), or author's solutions, such as SIPOF (Janowski et al., 2003) and ISUOIPF (Łuczycki et al., 2005) were assessed. A conceptual model was designed in the first phase of the project. The model was then transformed into a relational model and prepared in accordance with the predefined needs and demands of users.

Three levels of access entitlement were defined to protect the database and its structure:

1. Top-Level User – system administration and administrator of DBMS (Data Base Management System), full access, management of projects and access rights
2. Medium-Level User – limited access, authorized user with wide, pre-defined rights, e.g. access to projects and data, ability of its modification and update
3. Minimum-Level User – passive access, viewing and downloading of projects and images without right of modification

Determining three levels of users involved defining their rights, which can be limited depending on a user's abilities and reliability. Users' roles can be dynamic, depending on the present size of the database and users' expectations.

### 3. THE STRUCTURE, FUNCTIONALITY AND LOGIC OF THE DATABASE

The universality of the system results from creating a database structure which is able to store all significant parameters of various project types and enables accurate, quick and efficient access to the collected data, as well as its transfer. In order to achieve this aim, the structure of relations, concept and functioning rules were defined.

The usefulness and significance of photogrammetric data, which have to be archived in the system was assessed in the first stage of the project. Following the results of an analysis, a two-level approach was applied, i.e. a standard client-server model instead of three and more layered models, which are oriented on multi-client systems or require enormous computational powers and faster data transfer. In the later phases of the system's development, adopting a three-layered system is possible.

The elaborated basic structure of the database provides following information:

- subject of projects and measurements
- the type of digital elaboration
- the type of digital measurement
- data concerning project
- information on the performer
- parameters of applied digital sensors
- parameters of capture sessions
- parameters of a single digital image (EXIF Info, interior and exterior orientation parameters)
- types and data from image measurements

- types and geodetical observations (control points, distances, lines, polygons, planes)
- results of point measurement
- results of vector measurement
- results of digital image orthorectification
- results of quality and quantity thermal measurement
- results of multi-sensoral processing
- results of data extraction
- parameters of thematical analysis
- 2D and 3D visualizations data and parameters

Moreover, the database provides users with a wide range of additional, detailed information. The list of attributes connected with the "Digital Camera-Sensor" table and "Lens" table were used as an example (Table 1, Table 2).

"Digital Camera-Sensor"	Characteristic
<u>ID_Sensor</u>	SMALLINT NOT NULL
ID_Name	SMALLINT NOT NULL
Model	VARCHAR(15)
Type_of_Sensor	VARCHAR(4)
Number	VARCHAR(20)
Date_of_Production	VARCHAR(8)
Characteristic	VARCHAR(100)
Total_Resolution	FLOAT
Number_of_Columns	INTEGER
Number_of_Rows	INTEGER
Sensor_Dimension_H	FLOAT
Sensor_Dimension_V	FLOAT
Pixel_Dimension_H	FLOAT
Pixel_Dimension_V	FLOAT
Spectral_Range_Min	FLOAT
Spectral_Range_Max	FLOAT
Radiometric_Resolution	FLOAT
Formats_of_Data_Record	VARCHAR(10)
Firm_Ware	VARCHAR(10)

Table 1. Keys and attributes in the "Digital Camera-Sensor" table

"Lens"	Characteristic
<u>ID_Lens</u>	SMALLINT NOT NULL
Lens_Name	VARCHAR(15)
Model	VARCHAR(15)
Number	VARCHAR(15)
Date_of_Production	VARCHAR(8)
Characteristic	VARCHAR(100)
Focal_Length_Min	FLOAT
Focal_Length_Max	FLOAT
Aperture_Range_Min	FLOAT
Aperture_Range_Max	FLOAT
Schutter_Speed_Min	FLOAT
Schutter_Speed_Max	FLOAT
VOF	FLOAT
Focusing_Mode	VARCHAR(10)

Table 2. Keys and attributes in the "Lens" table

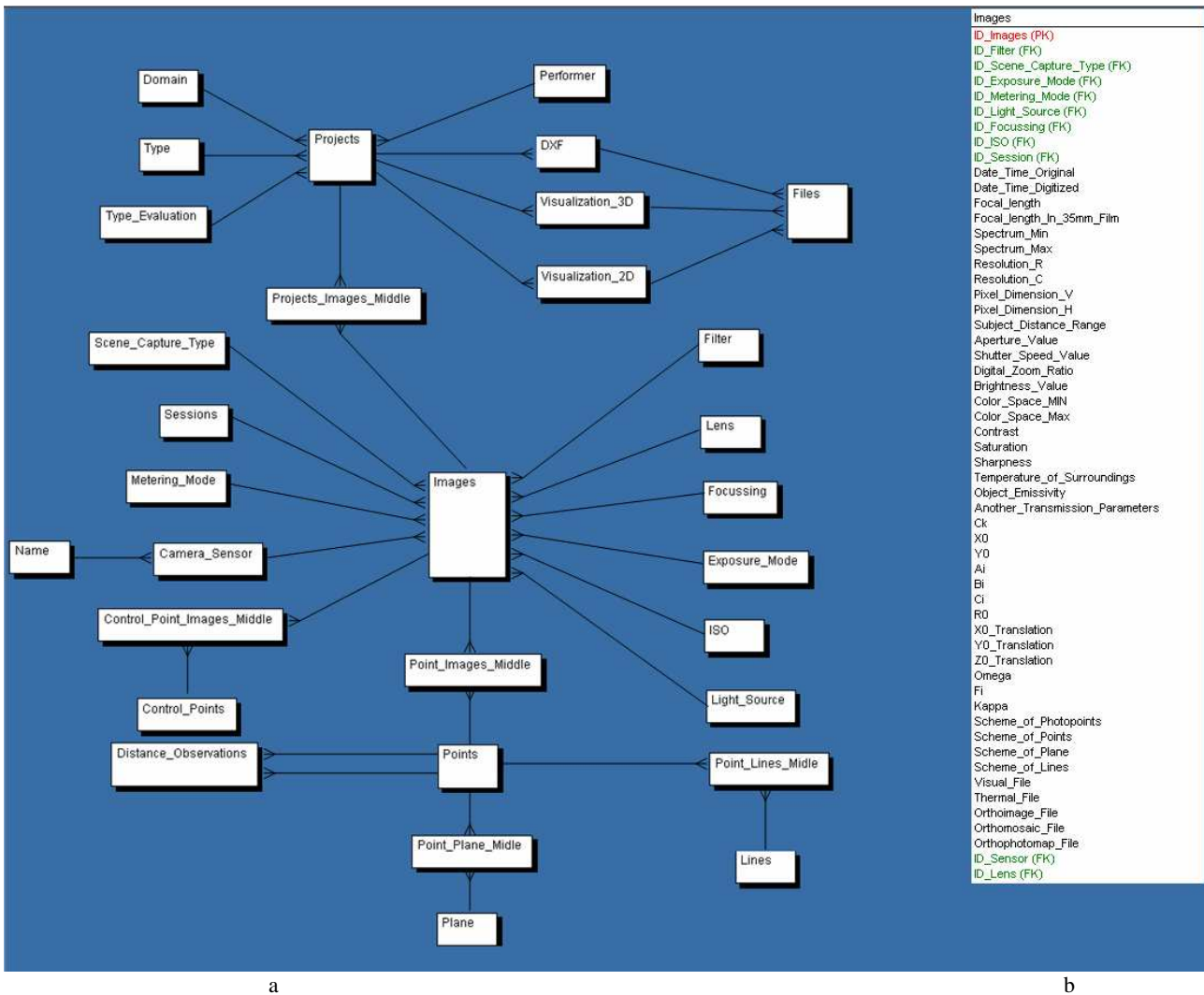


Figure 2a. Entity-Relationship Diagram of the database  
2b. Attributes of images entity

Their structure was prepared to work with CCD video cameras, digital compact and single-lens reflex (SLR) cameras and is connected with the table entitled "Cameras". In order to achieve universality and, as a consequence of a wide range of potential users operating in numerous fields of science and technology, the database structure was created using English as the base language.

The relations between tables for the designed photogrammetric database structure are presented in Figure 2.

Professional and reliable tools which guarantee security, cohesion, integrity, efficient data search, as well as management of collected data had to be used to make the system available to a wide range of users. In the presented system, a freeware Firebird® database server was used. Firebird License Conditions: InterBase® was released by Borland under InterBase Public Licence, a variant of Mozilla Public License Version 1.1 (MPL). It was serviced by Borland Delphi™ programming environment. Applied solutions considerably reduced costs of the project.

A significant division of data was introduced in order to facilitate management of client user groups, reduce data redundancy and increase flexibility and efficiency. As a result, 31 mutually connected tables and views with ascribed various

rules were achieved. Advanced access to the database is enabled by the application interface, which enables use of the database structure. The interface's menu varies depending on the logged-in user's entitlement and resources available for a specific elaboration. All relations are a 1:N (one-to-many) type. Tools which significantly support the integrity of data, i.e. triggers, cascade update and, deletion of data from dependent tables, parentless record protection, performance, etc., were also introduced. The design stage was supported with CASE (Computer Aided System Engineering) - type tools. The modeling of the data was based on the idea of a two-level approach to the data model, which assumes conceptual CDM (Conceptual Data Model) and physical PDM (Physical Data Model) independence of data.

One of the primary data sources used in the presented database is an updated digital multi-sensoral video-thermal system VISION PLUS (Sawicki, Więcek, 1998; Sawicki, 2000).

#### 4. ELECTRONICAL DATA SECURITY

The database, which is available across WAN (Wide-Area Network) environments, is used as a teleinformatic system. Security of such databases is supported with computer and network security certificates. The security of the system is a

measure of its susceptibility to unwanted changes and interference. The database is designed for operating in VPN (Virtual Private Network). Determining three levels of access entitlement ensures database security and integrity. Only the Top-Level User is allowed to modify the database structure. The database must respect the confidentiality of processed data and user access rights. In the case of commonly accessible data, the level of protection must be equal to the level of protection of the most confidential resource.

The proper point of reference for assessment of security and functionality classes are valid in Poland TCSEC (Trusted Computer Security Evaluation Criteria) (Orange Book, 1985) and ITSEC (Information Technology Security Criteria) (European Orange Book, 1991) security standards. In the process of designing the internet database, EU ITSEC standards and the "Code of Practice for Information Security Management" ISO/IEC 17799:2000 standard, which is known in Poland as PN-ISO/IEC 17799:2003 were followed. None of the information included in the presented photogrammetric database for close range applications was given a confidentiality clause.

The non-commercial character of the database determined the choice of tools and solutions for providing data security in the Internet environment. Assuming full security of the host, on which the database system is operating, data transfer is the most vulnerable component of the system. Applied levels of user access are a consequence of efforts to design an efficient system. In comparison with other products, Firebird® presented a safe and efficient database engine.

The standard usage of Firebird® does not enable introducing any cryptographic options. Consequently, there is threat of unintentional disclosure of information about customer (login/password) and transferred photogrammetric data packets. For this reason, tunneling SSH (Secure Shell) was introduced with additional, dedicated tools, e.g. PuTTY, ssh.com, OpenSSH. As a consequence, cryptographic properties and data transfer speed were amplified, with the additional application of on-line compression.

## 5. USER INTERFACE

As a result of the complicated structure of the tables interrelations (the existence of indirect tables), the core problem was to design a user-friendly interface. A GUI (Graphical User Interface) based on MDI (Multi Document Interface) which enables, for example, working on several projects simultaneously (Figure 3), was chosen. Visualization of the concept of data flows between system tables was conducted based on the tree model, which is subscribed to every strategic table in the system.

Options offered by the client application:

- pre-selection of projects based on their basic parameters
- adding new projects
- showing parameters of chosen projects
- downloading data from projects (Figure 4, Figure 5), e.g. input data (original images and files), output data (interior and exterior orientation parameters, rectified images, orthoimages, files, schemes and ID number of measurement points, visualization 2D/3D and their parameters)

- modification of chosen parameters – option available only for top level users

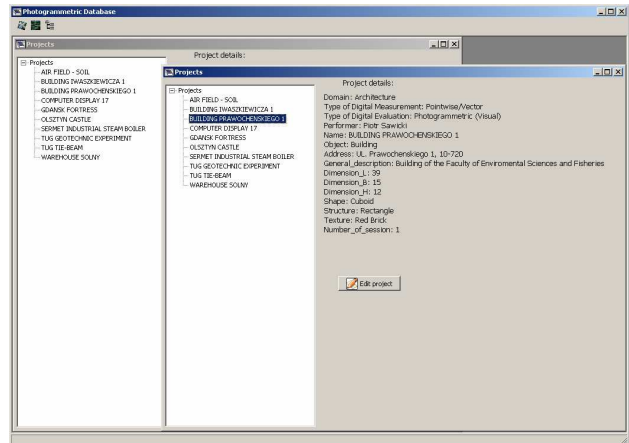


Figure 3. Users' interface window – chosen project

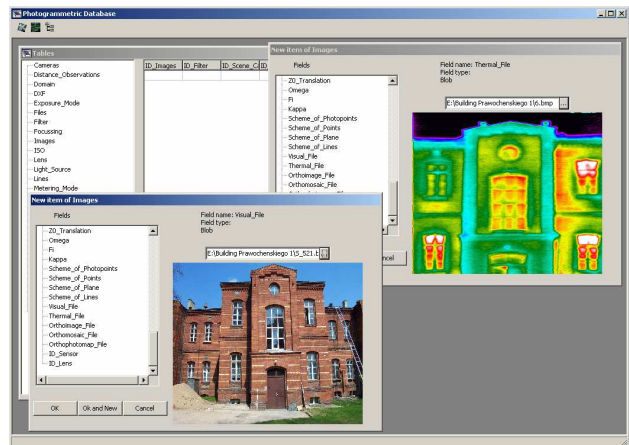


Figure 4. Users' interface window – chosen "Building" project

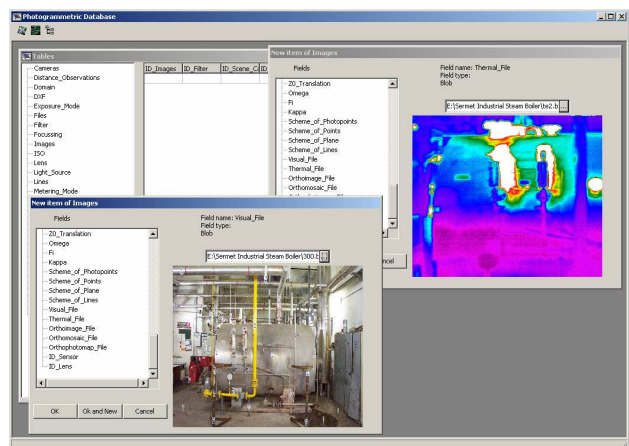


Figure 5. Users' interface window – chosen "Industrial Steam boiler" project

## 6. CONCLUSIONS

The elaborated database stores and makes numerical and digital photogrammetric and thermographic data obtained from *n*-dimensional, close range elaborations executed in *i*-epoche available by the means of the Internet. Access to the database enables further analysis, processing and extraction of information from photogrammetrical data. However, the presented information system is not an on-line application for real-time Internet measurements.

In the paper, the authors defined user rights and presented a conceptual and functional model of the database structure. The design of the project consisted of selecting proper programming tools to design a database model and software. In the designed system, a freeware Firebird® database server was used. The project met all relevant security standards.

The system is characterized by independence from native Microsoft Windows technologies, such as MS Access™, or MS SQL™, uniqueness, use of practical solutions, reduction of system limitations and a high level of data security. Applied solutions considerably reduced costs of the project.

## REFERENCES

- Atkinson K.B., 1996. *Close Range Photogrammetry and Machine Vision*. Whittles Publishing.
- Cosmas J., Itegaki T., Green D., Joseph N., Van Gool L., Zalesny A., Vanrintel D., Leberl F., Grabner M., Schindler K., Karner K., Gervautz M., Hynst S., Waelkens M., Vergauwen M., Pollefeys M., Cornelis K., Vereenooghe T., Sablatnig R., Kampel M., Axell P., Meyns E., 2003. Providing Multimedia Tools for Recording, Reconstruction, Visualisation and Database Storage/Access of Archaeological Excavations. *Proceedings of VAST*, Brighton (UK).
- European Orange Book, 1991. ITSEC Information Technology Security Evaluation Criteria.
- Grussenmeyer P., Drap P., Gaillard G., 2002. ARPENTEUR 3.0: current developments in web based photogrammetry. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Sao Jose' dos Campos, Brazil, Vol. XXXIV, part 6, pp.141-146.
- Herbig U., Waldhäusl P., 1997. APIS – Architectural Photogrammetry Information System. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, CIPA Symposium in Goeteborg, Sweden, Vol. XXXII-5C1B.
- Janowski A., Paszotta Z., Szulwic J., 2003. SIPOF – Photogrammetric Images Internet Measurements System. State Committee for Scientific Research, Report, KBN nr 8 T12E005 21, Vol. 1 i 2, (in polish).
- Janowski A., Sawicki P., Szulwic J., 2006. Conception of Close-Range Photogrammetric Internet Database. *Annals of Geomatics, Polish Association for Spatial Information*, Vol. IV (in polish).
- Kadobayashi R., Furukawa R., Kawai Y., Kanjo D., Yoshimoto J. N., 2003. Integrated Presentation System for 3D Models and Image Database for Byzantine Ruins. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Ancona, Italy, Vol. XXXIV-5/W10, pp.187-192.
- Luhmann T., 2003. *Nahbereichsphotogrammetrie–Grundlagen, Methoden und Anwendungen*. Wichman Verlag, Heidelberg.
- Łuczycycki M., Moszyński M., Szulwic J., 2005. ISUOIPF – Photogrammetric Images and Products Internet Sharing System. *Scientific Books of Institute of Mining Vol. 114 series: Conferences, Wrocław University of Technology*, Vol. 45 pp. 239-246, (in polish).
- Orange Book, 1985. American Department of Defense, DOD 5200.28-STD.
- Sawicki P., Więcek B., 1998. Digital video-thermal system for close range applications. *Archiwum Fotogrametrii, Kartografii i Teledetekcji*, Vol. 8, s.13/1-13/8, (in polish).
- Sawicki P., 2000. Digital multisensoral video-thermal system for close range metrology applications. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Amsterdam, The Netherlands, Vol. XXXIII Part B5/2, pp. 691-698.