SOFTWARE DEVELOPMENT FOR CLOSE-RANGE APPLICATIONS UNDER CONSIDERATION OF PRESENT STANDARDS

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Writing software today is not only the implementation of algorithms in a high level programming language like C or user Fortran. The final product has to be a userfriendly system running in different environments. The existing standards for interfaces, graphic concepts or data formats are as important as the algorithms behind. The digital photogrammetric workstation for close-range applications from Rollei Fototechnic is explained under consideration of software design and usage of development tools.

Key Words : Software development, software tools, hardware, application software

1. COMPUTER HARDWARE TODAY

1.1 PC TECHNOLOGY i286/i386/i486

Intel introduced the first 16-bit processor in 1978 with it's 8086 processor. In 1979, the Intel 8088 processor contained the same architecture as the 8086 but with an external 8-bit bus. The 20 bit adressing gives access to 1 MByte memory with 64 KByte segment size.

In 1982, the i286 offered to adress 16MB of physical memory and 1 Gigabyte of virtual memory with 64KB segments in the 16-bit Protected Mode. This machine could perform 2 Mips, 7 times more than the former 8086. For compatibility with the 8086/88, the 80286 could run in a Real Mode with 1MB memory limitation.

A significant drawback of the 80286 was the 16-bit barrier, instead of using the 32-bit architecture for far greater performances. Therefore, the introduction of the 80386 microprozessor in 1985 with its capability of linear adressing of 4 Gigabyte physical memory and 64 Terrabytes virtual memory (swapping of blocks between RAM and Disk) was a breakthrough for using PC in a technical environment.

The operation modes of the 80386 start with the Real Mode for compatibility with the 8086/88 (memory access to 1 MB), up to ten times faster due to the faster clock rate. In Protected Mode, the 80386 can execute a subset of 80286 Protected Mode instructions (16 MB memory access) or it can run its own full 32-bit adressing mode with individual memory segments up to four Gigabyte.

In Virtual 8086 Mode, the 80386 can run multiple 8086/88 programs unchanged and simultaneously. Due to the higher clock speed, the software runs eight times faster. Software that implements a set of virtual machines is called 80386 control program and is not an operating system. Samples for 80386 control programs are MS Windows/386, Desqview or VM/386. The Virtual 8086 Mode allows virtualization of Real Mode applications only.

The advantage of the i486 , available since 1990, against the i386 is its higher speed (i386 5 Mips, i486 20 Mips). Including the floating point processor on board, this microprocessor, fully compatible to the 80386 chip, is the recent hardware standard on a PC basis.

Competitive sellers of 32-bit microprocessors are for example Motorola or National Semi Conductor and other companies.

For photogrammetric applications, only the 32-bit protected mode is of interest as this operation mode is the key to perform workstation applications on a personal computer.

The above given information may answer some of the common questions why a software package sometimes is not running under any environment.

1.2 WORKSTATIONS

A typical workstation is a stand-alone unit with a 32-bit CPU running under an engineering operating system like UNIX. Workstations offer high performance graphic capabilities and network facilities. When tied in a network, workstation users have access to huge data storage capacities and mainframes.

Since 32-bit personal computer with integer performance of 1 MIPS or more and running under UNIX operating systems have been available, the line between PC and workstations is overlapping.

Differences are in the main memory of PCs (up to 8 Mbytes) and workstations (up to 32Mbytes) and the adaption of RISC microprocessors. The most important performance parameter for technical applications is the millions of floating-point operations per seconds (MFLOPS). An IBM RISC System/6000 for example is working with 10.9 MFLOPS.

Because of the convergence of workstation and PCs, the key for successful software development is the use of standards like high level languages and utilities for easy transportation of special application packages, like close-range photogrammetry, to different hardware platforms to benefit from the power of the machine. Running technical programs in a DOS compatibility box with all the limitations of the DOS operating system on a powerful workstation is not what I understand as transportation.

1.3 GRAPHIC STANDARDS

High performance graphic subsystems do not have such a standard like hardcopy units for graphical output. All vector plotters today can understand Hewlett-Packard's Graphic language. Therefore, plotting programs can be written widely device independent.

In the PC world there are only two video standards: IBM's video graphics array with a resolution of 640 x 400 pixel and 16 colors and the IBM 8514/A standard with a resolution of 1024 x 768 pixel. A program written under consideration of these standard is running on all machines which support the specifications, and they exist in large numbers. Most graphic boards with higher performance can also support VGA or 8514.

To benefit from higher sophisticated graphic boards, the software developer must have access to device drivers. In special cases, he has to write his own drivers. If he is using a software interface like GKS or PHIGS, the hardware supplier will deliver the requested tool.

2. PRESENT SOFTWARE STANDARDS

2.1 OPERATING SYSTEMS

2.1.1 DOS

MS-DOS is the leading operating system for personal computers. Today, there are over 60 million DOS machines running worldwide. DOS is a single user, single tasking system which can run all applications written for 640 Kbyte Intel-based PCs. But the 640 KByte memory limitation is a great disadvantage for the more sophisticated end user. Two kinds of software products are available to overcome this limitation: 386 control programs and DOS extenders.

Control programs like Microsoft Windows/386, DESQview or VM/386 allow the i386 to run various PC-DOS programs simultaneously in the accessible RAM area.

A control program is not able to offer enough memory for programs like a bundle adjustment. A powerful tool for applications like this is the Phar Lap 386 DOS Extender. This software loads and executes 80386 protected mode programs and handles access to DOS system calls. The Phar Lap 386 DOS Extender supports a wide range of various 32-bit compiler.

Some modern 32-bit Compilers include also functions to run 386 protected mode programs under DOS.

2.1.2 OS/2

The operating System/2 was introduced to replace MS-DOS and the related limitations. OS/2 offers several advantages over DOS such as multitasking, background processing, dynamic linking of software modules during runtime, access to much more memory than 640KByte and others.

But OS/2 needs more memory and harddisk space. Because of the delay in providing the promised features at the announced schedule, OS/2 has not yet succeeded. It is possible that the typical PC user has no real requirement for the OS/2 system. But if OS/2 is available with all it's features, it can be a system, which is competitive to UNIX.

2.1.3 UNIX

UNIX is the only standard multiuser multitasking operating system that runs on different hardware platforms from PC's up to super computers. The UNIX workstation plays an important role in engineering applications. It delivers minicomputer performance to the desktop and is as easy to use as a PC. Any Software application, written under UNIX can run on any UNIX platform.

PC based UNIX systems will be a fast growing segment of the UNIX market. AT&T licensers resell the generic 386 code adding different features to the system. UNIX operating software is available from Interactive Systems or Santa Cruz Operation (SCO) for example.

From my point of view, it is out of question that a software development for photogrammetric applications under UNIX is worthwhile and will be an investment in the future.

2.2 STANDARDS FOR DEVELOPING END USER PRODUCTS

Software developing means writing the source code including the algorithms and calling of library functions for user interfaces, and graphic output or data base management facilities in a high level language like C or FORTRAN. The compiler outputs the object code. The linker has to organise the adresses of each different software module and to connect the called up libraries.

Languages like FORTRAN are designed for mathematical-engineering problems where as C has more advantages for hardware access. But today, mixed language programming can combine the features of languages. Including an interface in the calling modules is necessary for correct access to variables of different types.

Designing own application libraries guarantees a redundancy free code and is easy to handle for a programming team. Some discipline is necessary to cooperate with the complete group, but the costs of higher development quality will turn out to be a good investment.

Graphic applications can be written device independent by using libraries compatible to the GKS or PHIGS standard. The software is thus easily portable to other hardware platforms. Using standards like this makes documentation of interfaces and calling procedures unnecessary.

In 1987, IBM published a unique System Application Architecture (SAA). SAA consists of four componets:

- Common User Access (CUA) for the end-user interface,
- Common Programming Interface,
- Common Communications Support and
- Common Applications for connectivity and transportability of applications across the entire line of hardware and operating systems.

This publication resulted in a unique end-user interface for all alphanumeric shells as well as graphic user interfaces. Everyone who is talking about SAA standard, probably has in mind the CUA. But a lot of toolboxes for high quality looking interfaces like OSF/Motif for UNIX platforms or Formation on the PC and UNIX are existing today. Using these toolboxes is the only chance to write high quality software with acceptable effort.

3. DESIGN OF A CLOSE RANGE SOFTWARE PACKAGE

3.1 THE PHOTOGRAMMETRIC DATA BASE

Modern data base management programs allow access to the designed data base from different application programs by using an interface on the programmer's level. Therefore, it is possible to manage the complete data base with a data base management tool in the background. This results in a redundancy free data base with fast and secure access. Software development in a team will benefit from this standardisation. Today there is no consequent handling of this concept, but future developments have to take care of existing standards in order to reduce development time.

In close-range applications, there are approximate values of photo positions worthwhile for preparing huge orientation jobs and some algorithms even request these values. The access to camera data is given by the camera number. According to this number, the values for fiducial marks or réseau crosses are stored. The photo number gives the relation to the image measurement. The point number here points to the coordinates in the data set for point coordinates. Special coding is referring to the image coordinate system. The bundle adjustment program needs the input of weighted additional observations and results in object coordinates and improved image coordinates including some statistics. Further processing of the image material gives graphic information. Compiling the internal graphic format results in standard data file formats for interchanging data with further processing programs (Fig. 1).

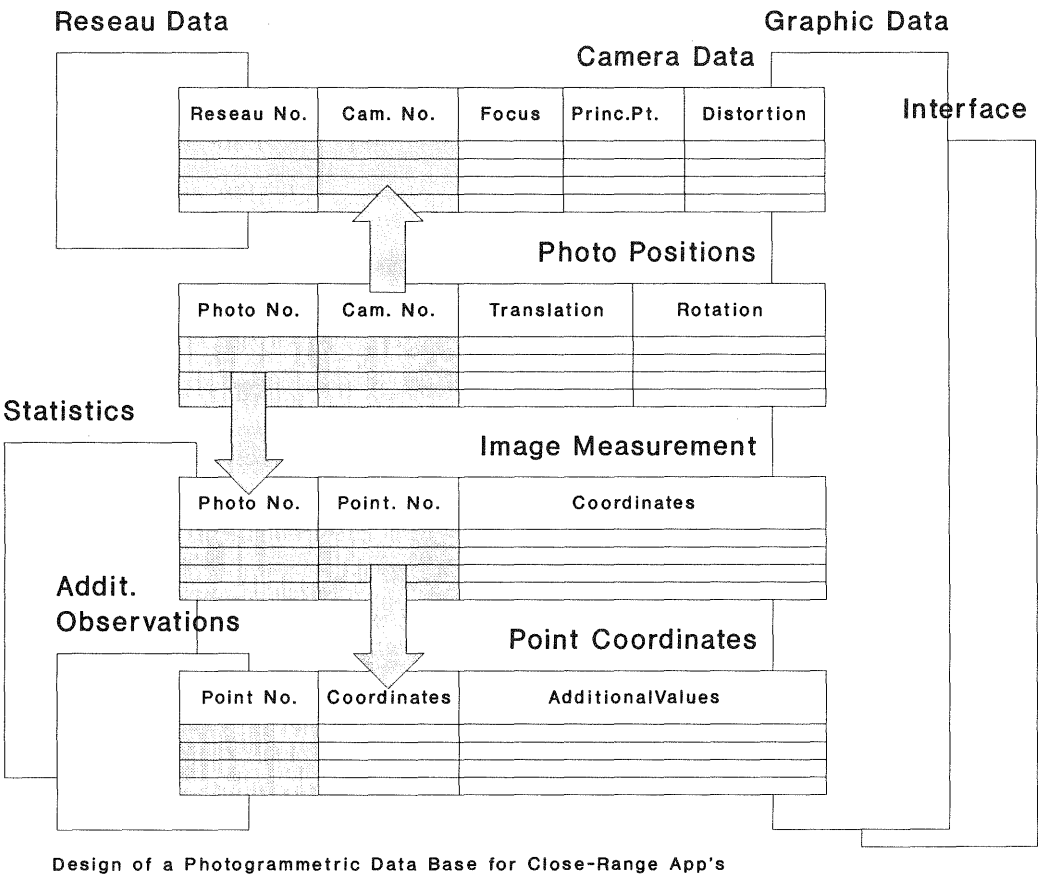

Fig. 1: Design of a Photogrammetric Data Base

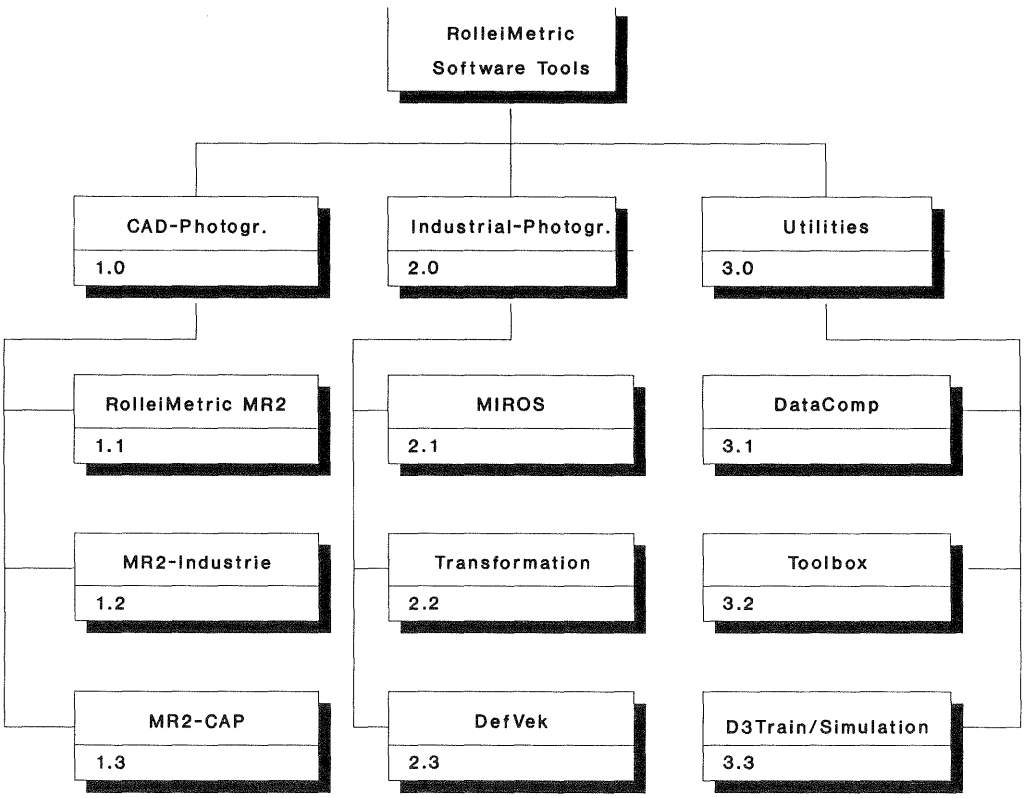

Fig. 2: Application components

3.2 A COMPLETE CLOSE-RANGE APPLICATION PACKAGE

Rollei Fototechnic, Braunschweig, is a supplier of a complete application package of hardware and software for close-range industrial applications. System components are described in /1992 Suilmann, 1992 Knobloch,Rosenthal/. Figure 2 shows the application components of this package. There are three branches:

- CAD-photogrammetry,
- industrial photogrammetry and
- utilities.

The most popular package is the multi image evaluation system RolleiMetric MR2 including several complex sub functions and a drawing editor which performs rectifications, over determined plane similarity transformations and other special functions. Applications in architecture, forensic sciences, industry and other different fields are existing. This program is available in upgrading versions and as an industrial release. Another version is interfaced to the Combined Adjustment Program developed by L. Hinsken. The image coordinate measurement device is a digitising tablet. Data import from other devices is possible.

Higher accuracy measurements can be carried out with the reséau-scanner Rollei RS1, driven by the MIROS Software. Geometric transformation software and presentation graphics of deformation vectors is adapted. Other utilities are the data compilation programs between standard file formats like HP-GL, DXF or VDAFS.

A special simulation software package can be used for training, planning the exposure arrangement and accuracy calculation in advance.

Figure 3 gives an impression of software systems supported by the RolleiMetric development team. Beside the own CAD-system there is an DTM - program existing. Rollei supports the CAD-Overlay software and the DVP digital rectification program. The libraries used are user interface libraries and graphic libraries, a subset of GKS or PHIGS compatibel procedures. Furthermore, we are writing our own device drivers or have to give access to third party developments.

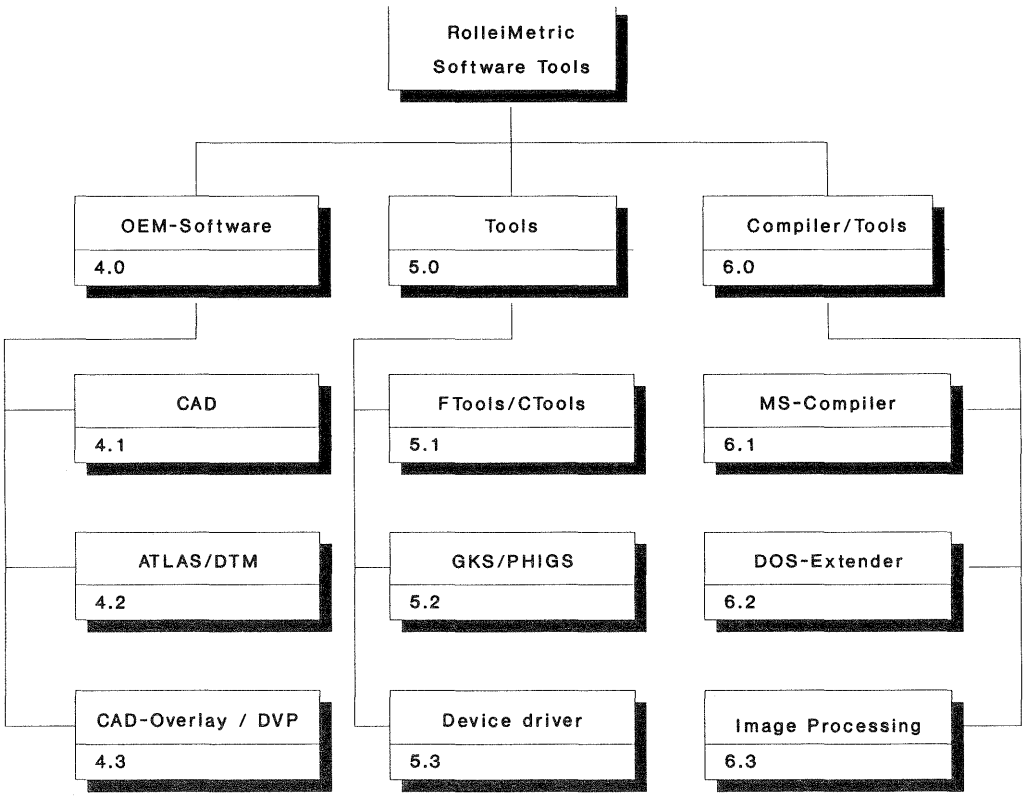

Fig. 3: Software systems

Beside the Microsoft family of compilers, Assembler, C and FORTRAN, Rollei Fototechnic is using 32-bit compilers and DOS-Extender to overcome the DOS memory limitations. Another development task is the programming of image processing algorithms under consideration of existing libraries and hardware functions.

The above given information shows the complex process of software development for end users today. Under consideration of dramatic changes in hardware and software it is a hard job to produce quality products for a niche market we all act in with close-range photogrammetry.

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