25 YEARS SPACE PHOTOGRAMMETRY IN GERMANY – A RESEARCH FIELD INITIATED BY GOTTFRIED KONECNY

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ABSTRACT:

The German photogrammetrists started to show interest in the field of "Space Photogrammetry" at the beginning of the Eighties. The first space experiment especially devoted to photogrammetry was proposed by Gottfried Konecny; it was the "Metric Camera Experiment" based on a conventional aerial survey camera, which was successfully conducted under his supervision in 1983 on the first Spacelab Flight. In cooperation with other colleagues he was also involved in the follow on DLR-missions MOMS-02 on the D2 Space Shuttle Flight in 1993 and in the MOMS-2P/Priroda Flight on the Russian MIR station from 1996-1999. In these missions the so called along track stereo-imaging principle was applied for the first time in space. This principle is now also used in remote sensing space missions of other countries e.g. in the French SPOT-5 mission.

The same imaging principle is also used for the HRSC-camera developed by DLR and presently successfully used in ESA's "MARS EXPRESS Mission" for topographic mapping of the Mars surface.

A complete new method – SAR-Interferometry – for deriving digital terrain models from space was used in NASA's "Shuttle Radar Topography Mission (SRTM)" in the year 2000. DLR participated in this mission with an own X-band Sythetic Aperture Radar (SAR)-System. The processing of the X-band data to digital terrain models covering about 30 Mio. km^2 of the earth's surface was completed in 2004.

The paper gives a survey on the development of space photogrammetry in Germany and refers to Gottfried Konecny's contribution to this development. Facts of the above mentioned missions will be presented and their results will be reviewed.

1. INTRODUCTION / ROLE OF GOTTFRIED KONECNY

In the context of this paper the term "Space Photogrammetry" is understood as "surveying and measuring of the three dimensional form of the solid surface of the Earth and of other planets from space images and generating cartographic products, such as DEMs, orthophotos and topographic maps from these image data". Nowadays also the visualisation of the three dimensional landscapes can be regarded as a presentation of topographic information.

Gottfried Konecny was one of the first scientists in the field of surveying and mapping in Germany who recognized that space techniques can be used to cover the worldwide need for topographic mapping at various scales. A first opportunity to realize his ideas was offered to him by ESA's Spacelab Program which foresaw to operate European payloads on the American Space Shuttle Flights. Konecny's proposal for a cartographic space experiment was accepted and flown in November / December 1983 as the so called "Metric Camera Experiment" on the first Spacelab Mission. This was the begin of Space Photogrammetry in Germany.

That this first photogrammetric space experiment could be performed is owed to Konecny's skill to convince scientific advisory boards, the funding governmental authorities and even sceptical colleagues of the advantage of space sensors for mapping tasks. His ability to combine a "technical vision" with a "practical application" was very beneficial to succeed with this photogrammetric experiment proposal in competition to many other proposals from various scientific disciplines.

Beside its scientific goals the Metric Camera Experiment had also the effect that it led to a closer cooperation of the Remote Sensing Community and the "classical" Photogrammetric Community in Germany. In particular the photogrammetric University Institutes started to show stronger interest in space activities. This common understanding for "using space techniques for mapping tasks" had in the medium term the effect, that further photogrammetric space experiments, e.g. MOMS, were decided on and carried out. It is the merit of Gottfried Konecny to have made most of the German photogrammetric institutes "space minded".

Konecny worked after his return from Canada and the USA and since he took over the position of the director of the Institute of Photogrammetry and Surveying at the University of Hannover in the year 1971 always close together with the German Aerospace Research Center (DLR), particular with its former Institute of Optoelectronics - now integrated in the Remote Sensing Technology Institute. In the eighties and the nineties he was a scientific adviser to this institute and in this role he strongly influenced and promoted the MOMS mission as well as the HRSC-Mars mission.

This cooperation between space engineers and photogrammetrists was very fruitful for both sides: Technical requirements for advanced sensor technology were defined and innovative methods for digital data evaluation and new mapping techniques were developed. Through this cooperation between photogrammetrists and space engineers the development of "Digital Photogrammetry" in Germany got a strong impulse.

Since more than 5 years high resolution optical sensors deliver image data of a ground resolution of 1 m and better and also sophisticated Interferometric Side Looking Radarsystems (IF-SAR) have been employed in space. Both techniques offer unique possibilities for the generation of topographic products. Especially in the field of IF-SAR DLR has developed a high standard of know how which can be used in future space missions with topographic applications.

For the coordination of the interests of photogrammetric University Institutes and the German Aerospace Center/Space Agency with respect to future mapping space missions it would be very helpful if a young colleague could take over the role of a mediator and adviser which was hold by Gottfried Konecny until the end of the nineties.

2. METRIC CAMERA EXPERIMENT

Topographic mapping tasks could not be fulfilled satisfactory with space images of the LANDSAT-type at the end of the seventies. Therefore the surveying community requested high resolution stereoscopic space imagery taken with a calibrated mapping camera. Two photogrammetrists in particular articulated the requirements for “Space Photogrammetry” on behalf of the surveying science community: Gottfried Konecny in Europe and Fred Doyle in the USA.

These requirements were favoured by the American plans for a Space Shuttle Program. The Space Shuttle has two properties which makes it an ideal platform for photographic space missions:

- it orbits the earth at relatively low flight altitude (220-350 km)
- It guarantees the safe return of the exposed film to earth.

A proposal by Gottfried Konecny, to operate within the first European Spacelab Mission on board the 9th Space Shuttle Flight an Aerial Survey Camera was accepted as “Metric Camera Experiment” by the European Space Agency (ESA) in the year 1977. The instrument was a slightly modified Zeiss aerial survey camera with a focal length of 305 mm, which was provided to ESA as multi experiment facility. ESA in term ensured the experiments flight and selected principal investigators.

The Metric Camera Team was composed of:

- Principal Investigator: G. Konecny, University Hannover
- Project Engineer: M. Schroeder, DLR, Oberpfaffenhofen
- Project Manager: A. Langer, DLR. Cologne
- Industrial Contractor: T. Miski, ERNO, Bremen
- ESA-Project Coordinator: M. Reynolds, ESTEC, Noordwigk

ESA was assisted in scientific and operational matters by a “Metric Camera Working Group”, chaired by G. Konecny. The other members were:

I. Dowman (UC, London), G. Togliatti (PT, Milano), M. Ducher (IGN, Paris).

After several launch shifts the Spacelab-Flight took place from November 28th to December 8th 1983 (Konecny, 1984, Schroeder, 1984).

The Metric Camera Experiment was unique in that it was the first calibrated mapping camera in space to take stereoscopic images on the large film format of 23 cm x 23 cm. The camera was operated over nearly all continents (with the exception of Australia) and obtained over 1000 images, of which 550 were on colour infrared film and about 450 on black and white film. All photos were taken with at least 60 % overlap in flight direction for stereoscopic evaluation. In total an area of 11 million km^2 was photographed, each photograph covering in area of 190 km x 190 km at a scale of 1:820 000.

One event that happened during the operation of the camera which is unforgettable to the Metric Camera team and for which Gottfried Konecny and his colleagues sacrificed one sleepless night:

> During the mission some operational changes to the camera control were necessary. Exposure of the first film (false colour infrared) went according to plan. However shortly after the schedule changeover to the B/W film magazine, it was seen that the film transport was no longer functioning. After trouble-shooting actions by the crew the problem was analysed as a film jam in the magazine.
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> This led to a period of intensive ground activity for the metric camera team to define a procedure to clear the film jam. This activity resulted in a new and unplanned “first” for the Shuttle, namely rigging of a photographic darkroom in the crews bunk. Most important, however, it resulted in clearing the film jam and permitting further operations, although the crew found it necessary to assist manually the film take-up after each exposure. A post mission failure analysis revealed that the film jam was caused by a mechanical clearance problem between the take up spool and another part of the magazine.

The objective of the experiment was to test the capability of high resolution stereoscopic space images for compiling and updating topographic and thematic maps. About 50 principal investigators participated in the evaluation of the image data and their final results were presented at a Metric Camera Workshop at DLR, Oberpfaffenhofen in February 1985. The results can summarized as follows:

- Ground resolution: 10-15 m (pixel equivalent)
- Planimetric accuracy: ± 10 m
- Height accuracy: ± 15 m
- Due to the limited ground resolution the maximum map scale that can be derived is 1:100 000.

In his welcome to the Workshop G. Konecny ended with the sentence:

“Despite the trend to digital imaging systems of lower quality I therefore believe that space photography will maintain an important data acquisition tool for mapping and remote sensing”. That this forecast became not true is due to many reasons and events and will be explained by the following text.

Since the launch for the Metric Camera Flight, originally planned for the summer months, was slipped to end of November, the lighting conditions over the earth became very unfavourable and the sun elevation never exceeded 30° for all camera operations. NASA therefore promised to refly the camera on the American Earth Observation Mission (EOM 1/2) scheduled for launch in summer 1986. For this flight the camera was equipped with a forward motion compensation and high resolution films to improve the ground resolution considerably. The camera system was already integrated into EOM 1/2 – payload and waiting for launch when the Challenger accident happened in early 1986.

After this accident the schedule of the Space Shuttle Flights was completely revised by NASA and the Metric Camera Experiment was assigned to the ATLAS-mission to be launched in 1989. In this mission the camera would not have been operated in the pressurized Spacelab module but had to be installed in a pressurized container, which was covered by an optical window at the inner wall of the cargo bay of the Shuttle. Operation of the camera in this configuration required a complete redesign of the camera system. The phase-A study for these modifications were just finished when the German Ministry for Research and Development decided to stop the project because of financial reasons.

Konecny together with DLR made various attempts to refligh the Metric Camera on other missions, e.g. on the German D-3 mission and on the Russian MIR-station, but got not the support of the Ministry of Research and Technology.

The only calibrated mapping camera which has been flown after the Metric Camera was the American Large Format Camera, which was operated on a Space Shuttle Flight in October 1984 on the initiative of F. Doyle. This camera was equipped with a forward motion compensation and a large image size of 46 cm x 23 cm with long size in flight direction to improve the stereoscopic effect. It could be shown that from these images point accuracies for all three coordinates of better than 10 m could be obtained and that compiling and revision of topographic maps at a scale of 1:50 000 and larger was possible. Konecny and his co-workers at the Institute for Photogrammetry and Surveying participated in these investigations.

Up to now no further space missions with large format calibrated cameras have been carried out. One can wonder why. In 1990 on the occasion of Konecny's 60th birthday F. Doyle tried to give an answer. He said: "There is clearly no technical reason why we could not have mapped the whole Earth by this time. Why have we failed? Largely, I think, because we know what we want to do and how to do it. As a consequence we are considered operators – not scientists".

3. MOMS – THE FIRST ALONG TRACK STEREO CAMERA IN SPACE

MOMS (Modular Optoelectronic Multispectral Stereo Scanner) was a German spaceborne push broom scanner for high resolution (HR), multispectral (MS) and threefold along-track stereoscopic imaging (Schroeder et al., 2000). The initiative for the development of the camera and its operation in space came from Johannes Bodechtel, University of Munich, and Franz Lanzl, DLR-Institute of Optoelectronics. The stereo-module of the camera consisted of the HR nadir looking lens with a focal length of 660 mm and two inclined lenses with 237 mm focal length. Thus, the Earth's surface was imaged three times from three different directions within approximately 40 seconds only, corresponding to an orbit distance of approximately 300 km. This along-track stereo principle is highly advantageous for image correlation in the data evaluation process, since all three image strips are recorded under more or less the same imaging conditions. The stereo angle of 21.4° results in a base/height ratio of approximately 0.8. The spectral bandwidth of all three channels was 520-760 mm. The multispectral-module consisted of two lenses with 220 mm focal length. Both focal planes contained two linear CCD-arrays each with different spectral filter glasses for imaging in the following four bands: 440-505 nm (blue), 530-575 nm (green), 645-680 nm (red), 770-810 nm (NIR).

The camera, called MOMS-02, was first flown during the German Spacelab mission D2 (STS55) in spring 1993. Within 11 days, 48 image strips were taken from a 300 km orbit with 28.5° inclination. Four hundred processed scenes are available. The ground pixel size was 13.5 m for the MS- and the inclined stereo-channels and 4.5 m for the HR-channel. For the first time, the along track stereo principle was successfully used for the generation of high quality digital elevation models (DEM) from space.

After the shuttle mission the camera system was refurbished for a second flight onboard the PRIRODA module of the Russian space station MIR. The camera, renamed MOMS-2P, was launched on May 5th, 1996 from Baikonur (Kasakstan) and mounted to the outside wall of PRIRODA in an extravehicular activity by the crew on May 30th, 1996. MOMS-2P was additionally equipped with a navigation package consisting of a GPS receiver and two redundant gyro subsystems. Post processing of these data delivered an absolute orbit accuracy of less than 5 m and relative attitude accuracy (non-linearities) of approximately 10" for typically 5-minute operation cycles. For the MIR orbit altitude of 400 km the ground pixel size was 18 m and 6 m (HR). The inclination of 51,6° allowed for imaging of industrialized as well as developing countries.

MOMS-2P was jointly operated and controlled by the Russian Space Agency (RKA) and the German Aerospace Center (DLR). The MOMS-2P data were recorded on an onboard tape recorder located inside the PRIRODA module. Due to its limited data rate of 100 Mbit/sec, only subsets of all seven channels could be recorded simultaneously. For MOMS-2P/PRIRODA four operation modes were defined:

Mode A: HR nadir and the two inclined stereo channels for DEM generation.

Mode B: Four MS channels for thematic analysis and classification

Mode C: Three MS channels and HR channel for thematic analysis and classification

Mode D: Two MS channels and the two inclined stereo channels for DEM generation and thematic analysis.

The swath width depended on the operation mode. It was 50 km for mode A, 100 km for modes B and D and 58 km (HR: 36 km) for mode C. The maximum tape recorder capacity corresponded to 80 minutes operation time. Full tapes were returned to Earth by Sojus- and Space Shuttle flights. During the mission 19 tapes have been completed. Operation of the camera was terminated August 16, 1999. For data quality analysis sample data were directly down linked to a receiving station in Germany. In March 1997 technical problems occurred with the HR channel. Since that time only operation modes B and D were used and D was given the highest priority.

The data takes mainly covered Europe, North-East Africa, the Middle East, and South America, but selected image strips from other parts of the world also are available. In total, approximately 65 million km^2 of the land mass were recorded and processed. The processing of the MOMS data was accomplished by a science team of several German university institutes and was coordinated by DLR. The "thematic users" were coordinated by J. Bodechtel, University Munich, and H. Kaufmann, Geo Research Center Potsdam, and the "topographic users" were coordinated by F. Ackermann and D. Fritsch, University Stuttgart.

The entire mission was coordinated and scientifically supervised at DLR's Institute of Optoelectronics (F. Lanzl). The tasks comprised the selection and commanding of data takes on request of national and international scientific and commercial users, the radiometric and geometric calibration, quality checks as well as thematic and stereoscopic data evaluation. For the latter task a digital photogrammetric workstation (DPWS) has been established at DLR in cooperation with photogrammetric university institutes in Munich, Hannover, and Stuttgart.

The contribution of the cooperation partners to the DPWS were as follows:

- Automatic Image Matching: University Stuttgart (F. Ackermann) and DLR-Institute of Optoelectronics (M. Lehner)
- Photogrammetric Bundle Block Adjustment: Technical University Munich (H. Ebner)
- Digital Elevation Models: University Stuttgart (G. Konecny)
- Interactive Digital Stereo Point measurements: University Hannover (G. Konecny) and DLR-Institute of Optoelectronics

On the DPWS the entire photogrammetric processing chain is realized in order to produce high quality DEMs and orthoimages. Up to now MOMS data covering an area of more than 400.000 km^2 have been processed to DEMs and orthoimages by DLR.

Accuracy analysis using independent ground control led to point accuracies of 12 m in planimetry and 5 m in height for MOMS-02/D2 data (Lake Nash, Australia). Although the planimetric accuracy was expected to be much better, it could not be verified due to poor checkpoint identification in the imagery of the (desert) area. For MOMS-2P/PRIRODA 8 m accuracy was achieved in X, Y and Z for test sites in Germany.

With the MOMS missions the "along track" stereo imaging principle was successfully demonstrated and paved the way for similar missions by France, India and Japan.

4. SPOT-5

With the missions Metric Camera and MOMS for more than a decade valuable technical and scientific experience in space photogrammetry were gained in Germany. A logical programmatic consequence would have been to continue on this line with a national operational satellite mission equipped with a high resolution stereo camera system. But in the second half of the nineties there was no chance to get the governmental support for such a mission because most of the Earth Observation's budget was spent for Shuttle Radar missions.

A new glimpse of hope occurred at the horizon when the French Space Agency (CNES) offered to DLR to fly a German Stereo Camera on their SPOT-5 mission. The originators of this idea were F. Lanzl on DLR-side and M. Arnaud on CNES-side. A CNES/DLR study team was set up which investigated for more than a year technical aspects of a camera concept, the distribution of data including the data receiving at DLR's Neustrelitz ground station and a business plan.

The study team consisted of: M. Arnaud, C. Fratter, H. Baudoin (all CNES), Ph. Munier (Spot Image) and F. Lanzl, P. Seige, M. Schroeder, R. Sandau, R. Pischel (all DLR) with G. Konecny (University Hannover) as photogrammetric adviser.

As G. Konecny had insider knowledge of both sides his role as catalysator and moderator of these bilateral talks was very helpful and important.

Because of the fixed time schedule for the running SPOT-5 project a decision on the stereo camera had to be made in September 1997. At this time the concentration and merging of the European space industry was under way and the German space agency DARA was integrated into DLR at the same time. Under this circumstance a positive decision on the German side could not be accomplished. One of many reasons was that the German space industry was not willing to spend own money in the development of the stereo camera. The company that came out of the industrial merging process was EADS. But instead by the German branch of this company the camera was finally realized and financed via the French branch of the company as pure French stereo camera on SPOT-5.

For the German side remained the satisfaction that their along track stereo imaging principle was international accepted.

SPOT-5 with the high resolution stereo camera (HRS) was finally launched in May 2002. The camera delivers stereoscopic images of 10 m ground resolution and 100 km swath width.

In 2003 CNES and SPOT Image provided original images to the science community in the framework of the ISPRS/CNES HRS-Scientific Assessment program (Baudoin et al., 2004). Results of this program were presented at the ISPRS Istanbul Congress in June 2004. From Germany DLR's Remote Sensing Technology Institute and the Hannover Institute of Photogrammetry and Geo Information participated in this program.

It could be shown that a stereoscopic evaluation of SPOT5-HRS data, only using anciallary data delivered by the image provider and not using ground control points, leads to an absolute accuracy of terrain heights in the order of 5 to 9 m (bias), with a standard deviation of 2 to 4 m for single points and 4 to 7 m for the interpolated DEM in comparison to a reference DEM of superior quality. With only one to two ground control points the bias error could be reduced to 0 to 1 m.

5. HRSC-MARS EXPRESS

The development of the High Resolution Stereo Camera (HRSC) has its origin at DLR's Institute of Optoelectronics and is based on the technical experience obtained with MEOSS and MOMS. MEOSS stands for Monocular Electro Optical Stereo Scanner and was a compact three line push broom camera using only one single lens. MEOSS was foreseen to fly on an Indian satellite, but due to two launch failures this camera never became operational in space. Like MEOSS the HRSC has only one lens, but different to MEOSS it uses nine CCD-lines in the image plane.

The HRSC was originally planned to fly on the Russian mission MARS 96, but this mission failed shortly after launch due to a failure of the upper stage of the launch vehicle.

A redesigned HRSC, reduced to a mass of only 19.6 kg was accepted by ESA to fly on their mission Mars Express, which was launched in 2003. The camera started to take pictures of the Mars surface on 9 January 2004.

Of the nine CCD-lines five are used for stereoscopic viewing: one is looking nadir, two are looking forward in different directions and two backward in the same manner; the other four lines are used for multispectral imaging in blue, green, red and infrared.

With a focal length of 175 mm and an orbit altitude at the perihel of 265 km the maximum ground resolution is about 10 m. The objective of the HRSC mission is to produce a topographic image map with a ground resolution of 20 to 40 m of the whole Mars surface of 145 Mio. km^2.

The initiator and coordinator of the HRSC development was Gerhard Neukum. He and his team moved at the beginning of the nineties from the Institute of Optoelectrics in Oberpfaffenhofen to Berlin, where DLR had founded a new Institute of Planetary Research. This institute is now responsible for controlling and operating the camera and for processing of all raw data to scientific image products. G. Neukum, who is now with the Free University of Berlin, is the Principal Investigator of the HRSC-experiment and coordinates all scientific activities. For the mapping tasks the following German photogrammetrists are members of the HRSC science team: J. Albertz, TU-Berlin; M. Buchroithner, TU-Dresden; E. Dorrer and H. Mayer, University Bundeswehr München; H. Ebner and U. Stilla, TU-München; Ch. Heipke, University Hannover; F. Scholten, DLR-Berlin.

6. SHUTTLE RADAR TOPOGRAPHY MISSION (SRTM)

SRTM used the principle of interferometric synthetic aperture radar (In SAR) for DEM generation from orbit altitude (Rabus et al., 2003). For the first time this mission provided a nearly global high-quality DEM with a grid point distance of 1 and 3 arc sec. The SRTM-DEM covers the earth between latitudes 60° N and 57° S, it was acquired with the same sensor in a single mission and was produced with a single technique-synthetic aperture radar (SAR) interferometry. All data were acquired within 11 days because the radar system used was actively scanning the earth's surface independent of darkness or cloud cover. Between 2000 February 11 and 22, two antenna pairs operating in C- and X-bands were simultaneously illuminating and recording radar signals onboard the Shuttle Endeavour. SRTM was jointly performed by NASA, the German Aerospace Center (DLR) and the Italian Space Agency (ASI). The C-band data covering an area of 119 million km^2 were processed by NASA-JPL. DLR was responsible for the X-SAR system, this included the instrument design, the mission planning, calibration, as well as the development and operation of the processing and archiving system. The X-band data that covered approximately 58 million km^2 were processed to DEMs and orthophotos; the processing of all X-band data was completed in 2004 and these data are now available to the users from DLR's remote sensing data archive.

The X-band DEM is provided in geographic coordinates. The horizontal spacing is 1 arc sec; the elevation value is given in meters. WGS84 is used as horizontal and vertical datum. This means that ellipsoidal heights are provided. The DEM accuracy is ±16 m absolute und ±6 m relative vertical accuracy.

A height error mask (HEM) is provided with the DEM that annotates the quality of each individual pixel. The interferometric DEM allows to produce ortho-rectified versions of all SAR image products.

The configuration used for DEM generation is the so-called across-track interferometer. This resembles a stereo arrangement: two SARs fly on (ideally) parallel tracks and view the earth's surface from slightly different directions at the same time. This SAR observation technique is called single pass interferometry. SRTM was the first and till today the only single-pass interferometer in space.

The SRTM instrumentation reused hardware components from the two 1994 Shuttle Radar Laboratory Missions. Two single-pass interferometers were built and operated in parallel, the US C-band (5.6 cm) system and a German/Italian X-band (3.1 cm) system X-SAR. The master channels (transmit and receive) of both interferometers used the original components in the shuttle cargo bay. The secondary (receive-only) antennas were mounted at the tip of a 60-m long lightweight mast. During lift-off and landing, the mast was stowed away in a 3-m long canister. Once in orbit, the mast was unfolded by a smart mechanical construction.

The X-SAR swath width was in the order of 45 km leading to gaps in the mapping pattern. However, the X-band interferograms and the derived DEMs are of higher quality than those from the C-band. The height accuracy of the X-band data is superior to the C-band data by a factor of approximately 2. During the mission, 366 so-called data takes, spanning from ocean over land to ocean, were acquired in X-band and 398 in C-band.

The SRTM X-SAR processing system was developed by DLR based on experience from the 1994 SIR-C/X-SAR mission and from ERS tandem interferometric processing. Processing of interferometric SAR data to DEMs can be split up into the SAR data processing part and the geocoding part. The SAR processing part deals mainly with problems of digital signal processing. The geocoding and mosaicking steps deal with precise geometric transformations from sensor domain to map coordinate space, as well as regridding and data fusion methods.

In the process of initiating and preparation of SRTM as well as in the processing of the data the German photogrammetrist were not involved. They came into the play after the data were distributed as scientific users for evaluating the accuracy of the delivered DEMs.

The whole X-band SRTM mission was mainly carried out by DLR. The key persons were

- for instrument development, calibration and operation: W. Keydel, A. Moreira, M. Werner (DLR-Institute of High Frequency Techniques)
- and for processing R. Bamler, M. Eineder (DLR-Remote Sensing Technology Institute) and A. Roth (DLR-German Remote Sensing Data Center)
- The project manager was R. Werninghaus, Project Directorate Space Management - Earth Observation

7. CONCLUSIONS

What is the future of Space Photogrammetry?

Space missions with photogrammetric cameras with large film format for stereoscopic imaging are out since 1984. Instead of them the along track stereo imaging principle introduced by the German MOMS mission was accepted as a reliable method and will be used in various photogrammetric space missions:

- SPOT-5/High Resolution Stereo Camera (HRS) was launched in May 2002. But the original stereo data are not available to the photogrammetric users. Spot Image, the data distributor, offers only the derived DEM products.
- ALOS/Prism is a Japanese mission with a three line stereo camera (Prism) with 2.5 m ground resolution and swath width of 35 km. This mission is scheduled for launch in 2005.
- Cartosat 1 is an Indian satellite with a stereo camera with forward and backward look directions. The ground resolution is 2.5 m and the swath width 27 km. Launch is probably in 2006.

In Germany no photogrammetric mission with an optical imaging instrument is planned. But there is a good chance that the experience gained with interferometric SAR method during the SRTM mission can be reused in the TanDEM-X mission. This mission foresees two SAR-satellites flying close together in a so called tandem configuration, presently analysed in a phase A study. The objective of the new mission would be to generate a global DEM with approximately 3 m height accuracy. The launch is planned for 2008/09.

To get an optimal benefit from the running and upcoming photogrammetric space missions an international cooperation of the mapping scientists and professionals is necessary. Gottfried Konecny has always in his professional life underlined the need for mapping in all countries and has always shown innovative technologies to accomplish it. With the upcoming space missions we may have the tools to complete the tasks of global mapping in medium to small scales. I am sure that Gottfried Konecny, also after his 75th birthday, will continue to use his many international contacts to establish networks of cooperation to fulfil the task of global mapping.

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