

DIGITAL 3D PHOTOGRAPHS FOR CARTOGRAPHIC HERITAGE

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Abstract

This paper promotes the obtaining of objective (“quasi real”) 3D object information in general, based on 3D photographs. In particular here 3D photographs are used for recording and documentation as well as for protection and reconstruction purposes of Heritage monuments, including Cartographic Heritage objects. In addition 3D photographs are used as quasi ground truth for terrestrial as well as for aerial and even for space photography to benefit Cartography. Historic Heritage stereo views are one key to “the spatial past”, a real treasure, still waiting for a rediscovery. To submit an idea of its brilliance and outstanding documentary value, samples of masterpieces of existing historic as well as of current international stereo views are presented in an introduction. The samples concentrate on Cartographic Heritage, including birds-eye or near birds-eye views.

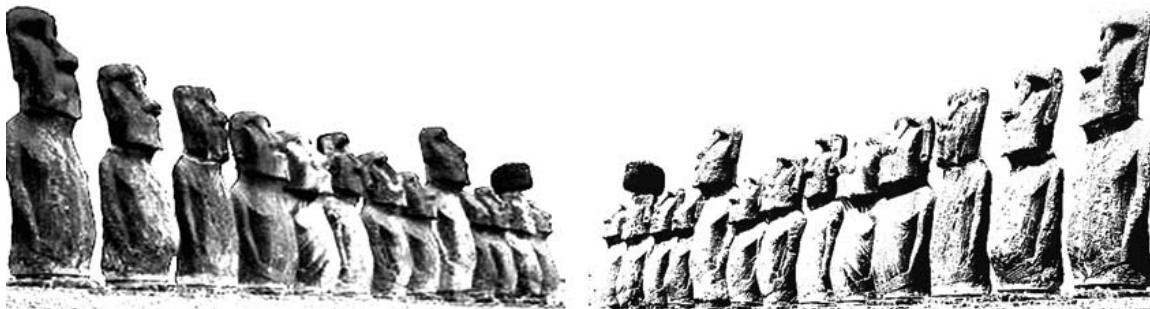


Figure 1. 3 D photograph of Statues of the Easter Island (in pigeon 3D-presentation)

The demonstrated masterpieces represent a huge amount of international collections of Heritage stereo views, too. Therefore this paper also deals with information on International Archives of importance for Heritage stereo views.

Regarding cartographic heritage, the IGN-Archive of France and the Keystone-Mast collection of the USA shall be named. However, due to different reasons, like restrictions by the owners, critical conditions of the originals etc., sometimes there is no or limited access only to archives of Heritage stereo views. It is estimated, at least one

Million analogue 3D photographs, suited for cartographic heritage wait for digitization and in this respect this paper also recommends optimum digitization rates for analogue 3D photographs.

This contribution is also on exposing new stereo views of, e.g., objects of Cartographic Heritage. For this purpose receipts are stated, including approaches, e.g., to calculate the optimum base length for 3D photographs. As a matter of fact, for Heritage objects, mainly exposing of stereo views with single lens cameras is sufficient. It is liked to emphasize, the 10m X-Lite telescope staff camera, as just introduced in Europe and on the African continent, promises a great future for extremely large scale digital mapping purposes, including quasi ground truth.

In addition rare samples of international 3D photographs are presented.

To stimulate further activities in the field of applying International digital 3D photographs for Cartographic Heritage, partly rare samples are demonstrated. In addition this is backed up by an updated list of the methods for virtual 3D visualization, claiming completeness.

As another future aspect, Heritage objects will be projected by the FELIX Solid state 3D screen, which promises a great future for advanced 3D cartographic products in general as well as possibly even for a new 3D-PC (screen) generation, succeeding 2D-PCs.

In a final outlook the authors, who, in close cooperation with Professor Lee Jin Duk, chair the CIPA task group on 3D photographs in Cultural Heritage, like to point to their non-commercial website 3dsite.icomos.org, as carried out by Kim, Seung Sun.

1. Introduction: Masterpieces of international 3D photographs

As homage to the International ICC congress in Santiago de CHILE in 2009, within this introduction masterpieces of rare international Heritage stereo views are presented, including historic Heritage stereo views of particular regions of the host country, as well as a queue of 5 stereo mates of South America on a historic globe, see Fig. 2 until Fig. 5. These samples give an idea of the brilliance as well as of the outstanding documentary value of Heritage 3D photographs, see also [7].



Figure 2. Digital 3D photographs for Cartographic Heritage:
presentation of a historic globe



Figure 3. Laguna de INCA, Andes, CHILE according to Keystone No. 322/21861



Figure 4. Homage to ICC 2009:
Plaza de Armas with Catholic Church, Santiago, CHILE, 1910

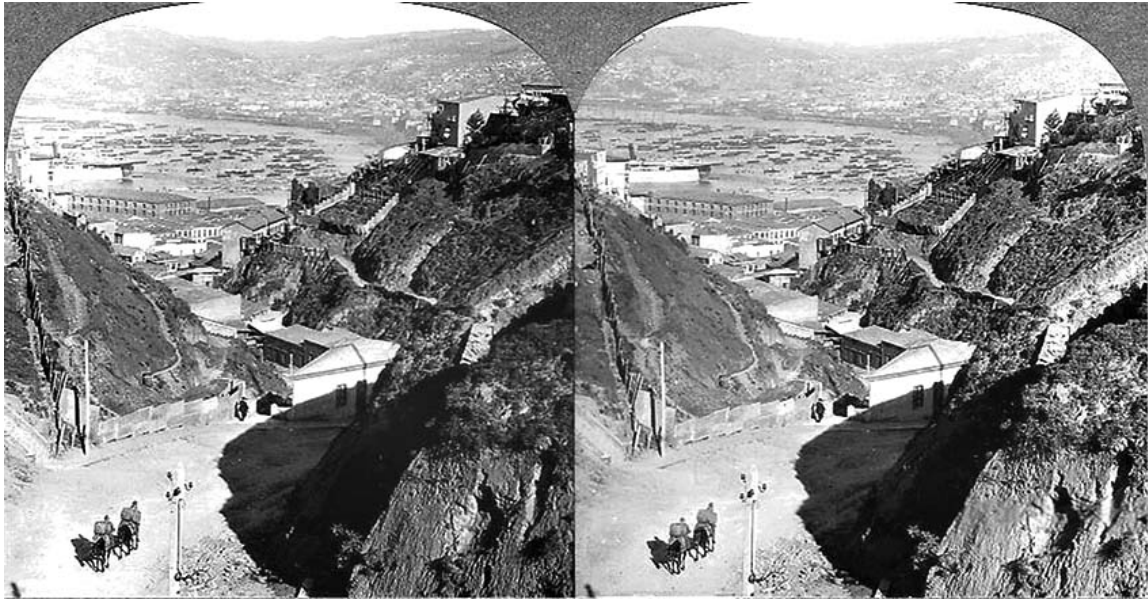


Figure 5. Valparaiso, CHILE (Keystone stereo view approx. 1910)

2. International Collections of 3D photographs

A complete overview of existing Collections of international stereo views is more than overdue. The most important source in this respect is the International Stereoscopic Union (ISU) with approximately 900 members from about 32 states, compare also [1]. Regarding cartographic heritage, the IGN-Archive of France shall also be named. There is no doubt, the most important international Archive for stereo views is the Keystone-Mast collection, which is maintained by the CMP (California Museum of Photography), situated in Los Angeles (USA) and holds more than 350000 (analogue) stereo views of, e.g., the former Keystone Company, of Underwood and Underwood and of H.C.White etc., dating from 1892 to 1963. The current digitization rate is approximately 10%.

The HAN 3D archive in Seoul (South Korea) is another sample of a very important archive for unique specimen of National stereo views.

In this context it is also liked to remember the famous historic German Photogrammetrist Meydenbauer, whose archive is still maintained as a part of the Conservation Institute of the province Brandenburg in Germany. It consists of more than 10000 stereo views on super sized glass, showing important monuments mainly of Germany. These authentic historic stereo views in many cases very successfully have been applied for rebuilding and restoration purposes.

Keeping also in mind global archives of satellite and aerial photography, it is estimated, currently easy at least some million historic analog stereo views still remain for digitization, representing a real cultural treasure, waiting for “excavation” and

applications for modern spatial data presentation, for restoration and comparison purposes.

Due to different reasons, like restrictions by the owners, critical conditions of the originals etc., sometimes there is no or limited access only to archives of Heritage stereo views.

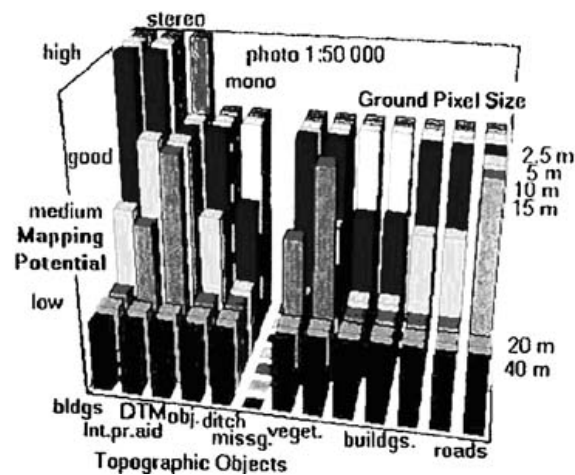


Figure 6. Results of advantages from spatial (“stereo”) image data interpretation

To define an optimum digitization rate for the analog stereo images, as a first result in Figure 6 is illustrated, the empiric stereo ability of a stereo pair, digitized with 500 dots per inch, which means 2,5 m ground pixel size in 1:50000, is similar as high as the stereo ability of the original photographs of the same scale. This result for the test site Hannover was achieved by A. Elmhorst. Therefore it is highly recommended, to digitize the available handed down stereo views systematically at least with 500 dots per inch digitization rate and to use a modern storage medium, like Hard Disk, CD-ROM, DVD etc.. Thus for daily applications the digital data and print of such images can be used, while the original is protected and kept for exclusive operations only.

Beside their documentary value stereo views contain important detailed 3D geometric and radiometric information. The quality of the original 3D images can even improve from digital removing of speckles and scratches etc. and by increasing the radiometric appearance of the (now digital) stereo views.

3. Exposing 3D photographs

As a matter of fact, the benefit of a complete additional dimension from systematic 3D photography for documentation purposes is still underestimated and even doubted. But due to their objective documentary value (“near real”), nowadays for objective 3D object documentation 3D photography should be applied, while subjective interpreted manual sketches become obsolete.

3D images often are not directly available or show lack in resolution. To overcome this problem, extremely high resolution low altitude aerial (3D) photography from a 15m carbon telescope-rod and from a captive balloon successfully has been exposed. This methodology will more and more become an objective tool for a huge range of documentation purposes, in particular in archaeology. This “3D-niche-photography” is also well suited under expedition constraints and promises a great international future, see also [4].



Figure 7. Exposing for extremely large scale image mapping and for quasi ground truth with a digital X-Lite staff camera on the antique site of Patara (Turkey) (verified study)

The authors also just improved the X-Lite 10m telescope-rod camera from single lenses into a real digital camera, allowing synchronic exposure, see also Fig. 7.

To receive optimum 3D photographs, the base length shall vary depending on the height, respectively on the object distance, see also [6]. Due to different expectations of the customer, e.g. requiring “a 3D perception equal to real” or requiring “an enhanced 3D perception” etc., there is no unique answer after the optimum base length, Therefore it is highly recommended, to expose a queue of 2 by 2 photographs with different base lengths instead of just one stereo pair. As single lenses cameras allow a rather flexible modification of the base length, single lens cameras for 3D photography of static objects even seem superior to old fashioned stereo cameras. Beside its relative low price, the great advantages of single lens cameras are its “travel light nature”, which namely points to the light weight, the easy handling and the flexibility in base length variation.

In another test series the authors just began, to use a water protected 10 m telescope-rod camera for “dry” underwater 3D photography from boots, river banks or bridges etc., without Deeping.

4. On digital 3D photographs for Cartographic Heritage

The well known Behaim globe, as presented as arbitrary 3 D photograph in Fig. 8, even dates back to the ages before the discovering of the “New World” as started with Christopher Colombo, see Fig. 8 and compare [1].

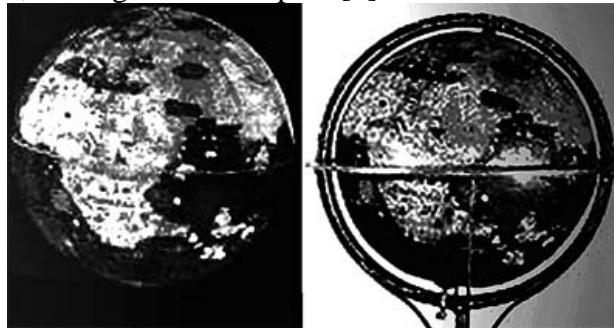


Figure 8. Sample for arbitrary stereo mates of the early globe of Martin Behaim
“before Colombo discovered the New World” (copy)

To submit further ideas of the broad range of applications of 3D photographs in cartographic Heritage, in the following are presented

- a stereo view of a vase crater, showing a historic map like view of the town of Magdeburg, approximately dating back to 1630, is another extremely rare sample for a cartographic document in 3D (compare Fig.10)
- a secret Venetian road mark of the Harz-Mountain is shown in 3D (see Fig.11),as
- as well as a 3D photograph of a relief mainly of the European terrain in Fig.12 and,
- as shown in Fig.13, extraterrestrial cartography in 3D more and more becomes popular, as indicated by a historic stereo view of the moon surface,
- or even by a stereo view of the Pioneer plaque in Fig.14.



Figure 9. Monument of Cristoforo Colombo near the main station of his hometown Genoa (Italy) in 3D



Figure 10. Sample for Cartographic Heritage in 3D: Rare historic map like view of the town of Magdeburg on a crater (approx. 1630; courtesy C. Historic Mus. of Magdeburg)

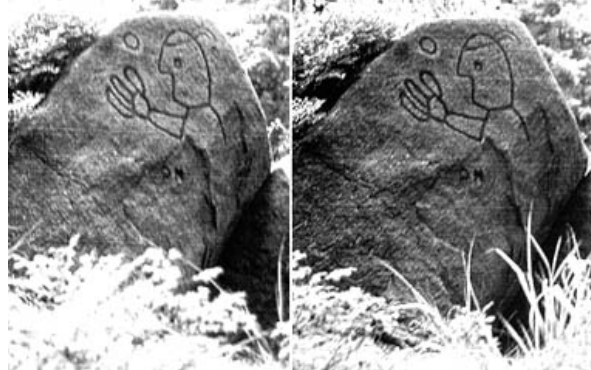


Figure 11. Sample of recent 3D Rock Arts photography related to Cartographic Heritage: The Venetian stone in the Harz-Mountain (Germany), a road mark to secret gold mines

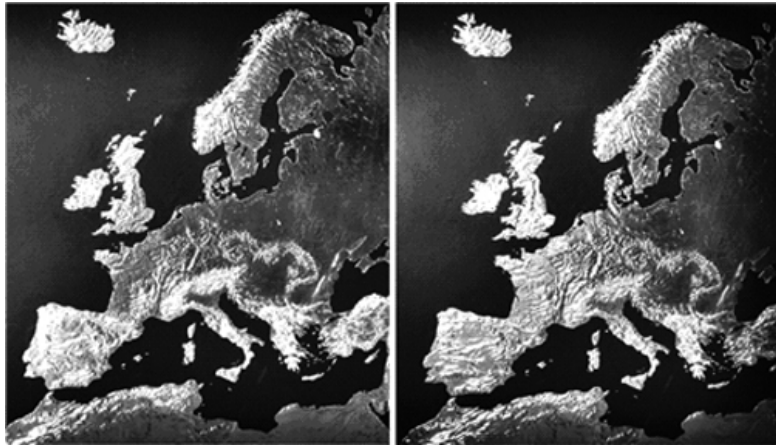


Figure 12. 3 D photography of a terrain relief mainly of the European region



Figure 13. Historic stereo view of the moon according to Keystone, approximately 3 days after the full, but of different constellations, to verify horizontal parallaxes from minimum changes in the relative appearance of the moon surface.

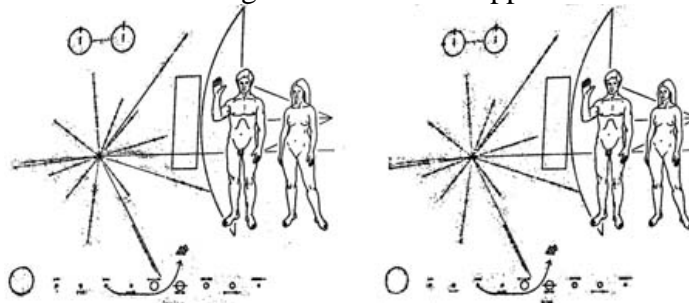


Figure 14. The famous Pioneer plaque in 3D, which moves through the space since the 1970th, indicating the global address of our earth and human beings, “addressed to E.T.”

5. Complete List of the Methodologies for virtual 3D visualization

The stereoscopic perception ability, while viewing on 2 corresponding stereo mates, is part of the human 3D viewing sense. Independent of the nature of the horizontal parallaxes, also known as disparities, an attempt for a systematic investigation of the

complete list of virtually stereo aids according to the state of the art, has been carried out. Constraints are: at least 2 stereo mates of real and/or synthetic origin, showing the same object, as imaged from different positions, approximately perpendicular to a base line with satisfactory parallel imaging directions, compare also [3]. From a consequently dealing with the principals of spatial data perception, even the future of the whole computer industry might change. Here namely the so called FELIX -3D solid-state 3D screen seems to become a real candidate for a new spatial PC generation in order to replace or to complete the 2dimensional screen generation, see [5].

**Table 1. Complete List of the virtual 3D Visualization Methodologies
(status: 2009)**

1. 3D perception of in minimum 2 stereo mates, vertical or horizontal arranged, but “<u>projected without contact</u>”; for "ortho" or "pseudo"as well as for normal and/or cross 3D visualization:
1.1 AUTOSTEREOSCOPIC VIEW of horizontal mounted 3D views, see Fig.2 to 5 and Fig. 8 to 14
1.2 MAGIC EYE / RANDOM DOT
1.3 HEAD MOUNTED DISPLAY
1.4 STEREOSCOPIES:
1.4.1 LENS STEREOSCOPIES , see Fig. 7(left)
1.4.2 MIRROR STEREOSCOPIES with LENSES
1.4.3 Mirror stereoscopes for horizontal arranged stereo mates; vertical mirror (= PIGEON ; see Fig.1)
1.4.4 Mirror stereoscopes for vertical arranged stereo mates; horizontal mirror: = DOWN UNDER
1.4.5 PRISM-STEREOSCOPIES for horizontal mounted stereo mates
1.4.6 Prism-Stereoscopes for vertical arranged stereo mates: KMQ
1.4.7 LENTICULAR LENSES for vertical, horizontal or arbitrary interlaced stereo mates:(e.g., “ 3D POSTCARDS ”) or
1.5 STRIP BARRIER : vertical or horizontal interlaced stereo mates appear related to 1.4.7 but do not use lenses
2. Methods for virtual spatial perception based on stereo mates, “<u>projected in contact</u>”,using alternate projection and/or different color,via
2.1 ANAGLYPHS (complementary) color separation by green/red or blue (magenta)/red or magenta/yellow glasses
2.2 CROMADEPTHS (spectral color separation)
2.3 POLARIZING FILTER Techniques
2.4 (Liquid Crystal-) SHUTTER glasses
2.5 NuOptix 3D Movies for (relative) moving objects for PULFRICH GLASSES , also used in CYBER SPACE
3. 3D perception Techniques using <u>VIRTUAL 3D MODELS</u>:
(3.1 MIRROR)
3.2 moving screen -Rotating Screw Shaped Screen (FELIX) 3D - or up and down Oscillating Screen (BOLLOGRAPH)
3.3 (FELIX)3D SOLID STATE,a new 3D Computer generation?see Fig.15
3.4 HOLOGRAM Technologies

Conclusions

It is liked to emphasize, moving back to basics in spatial data processing shows a surprising potential for advanced practical 3D image application, like, e.g.,

- To convince amateurs and professionals of the still underestimated effect in obtaining a complete additional dimension.
- A survey of existing international 3D image archives, including the archives contents and access is highly recommended.
- Intense dealing with “3D-niche-photography” based on telescope-rod and/or captive-balloon promises a great future.
- A Peer reviewed and definitely complete synopsis of the virtual 3D-visualization Technologies with sufficient information content is still missing!

Summarizing, improvements in 3D image application namely are expected in modeling, software, instrumentation, Analysis and standards.

In a final outlook the authors, who, in close cooperation with Professor Lee Jin Duk, chair the CIPA task group on 3D photographs in Cultural Heritage, like to point to their non-commercial website 3dsite.icomos.org, as carried out by Kim, Seung Sun.



Figure 15. This early result of a 3D globe in crystal supposed to stand on the very beginning of the coming “3D-Computer Age”

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