

3D VISUALIZATION TECHNIQUES IN CARTOGRAPHY

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Abstract

For the 1st time the stated 3D-Visualization-Techniques in Cartography claim for completeness. As shown, 3D-Visualization-Techniques promise a great future for advanced 3D cartographic products as well as for a new solid state 3D-PC(screen)generation.

To stimulate the interest in 3D-presentation, samples of masterpieces of historic and of recent international 3D-photographs, related to Cartography, are presented.

As in this respect some Million analogue 3D-photographs wait for digitization, this paper reports on Archives for 3D-photographs and recommends optimum digitization rates.

In addition this contribution is on exposing digital 3D-photographs for,e.g., Cartographic-Heritage. Here the authors'10m X-Lite telescope-staff-camera promises a great future for extremely large scale mapping purposes, including quasi ground truth.

Finally the authors, who, in cooperation with Professor Lee Jin Duk, chair CIPA task-group3 on 3D-photographs in Cultural-Heritage, maintain the website 3dsite.icomos.org, as carried out by Kim, Seung Sun.

Keywords

3D PC screen, 3D photographs, 3D Visualization Techniques, Cartographic Heritage, Data mining, quasi ground truth, telescope staff camera

1. STIMULATING THE INTEREST IN 3D PRESENTATION

As a homage to the 3rd International Conference on Cartography and GIS in Nessebar (Bulgaria) 2010, within this introduction masterpieces of rare international Heritage stereo views are presented, including historic Heritage stereo views of the host country, e.g., the mausoleum in Pleven (Bulgaria), of approximately the 1920th (see fig. 1) (approx. in 1920).

The latter is a historic 3D masterpiece of the Keystone view company.

Another Homage to Bulgaria is the recent Digital 3D photograph of the ancient Roman Athena of the famous Hildesheim Treasure, possibly carrying a dragon shaped wind-sock of antique Thracian origin in her right hand.



Figure 1. The mausoleum in Pleven (Bulgaria) (approx. in 1920) on a historic 3D masterpiece of the Keystone view company as homage to the ICC Conference 2010 in Nessebar

And last not least coming back to the topic, fig 3 presents a recent Digital 3D photograph of Cartographic Heritage, showing the NE-Asian hemisphere on a historic globe. 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. Recent Digital 3D photograph of the ancient Roman Athena of the Hildesheim Treasure; possibly carry a dragon shaped wind-sock of antique Thracian origin in her right hand

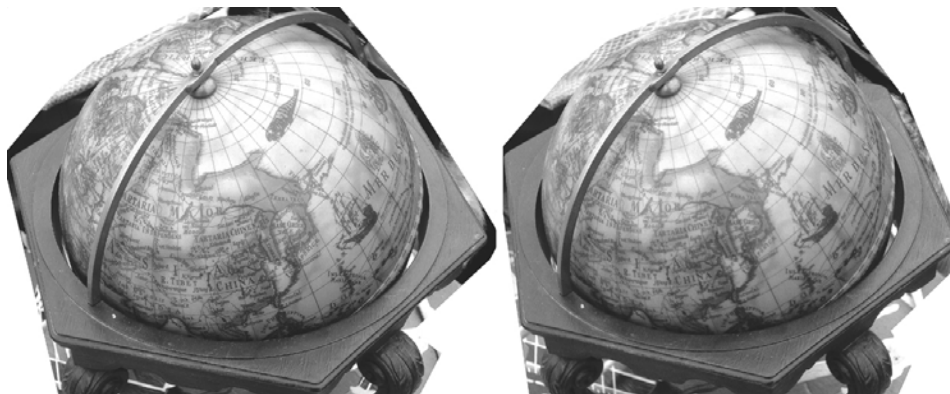


Figure 3. Recent Digital 3D photograph of Cartographic Heritage, showing the NE-Asian hemisphere on a historic globe

2. COMPLETE UPDATED LIST OF VIRTUAL 3D VISUALIZATION PRINCIPLES

A specialty of the human viewing sense is the 3D perception ability not only for real but also for virtual objects. The horizontal parallax, also known as disparities, required to percept in 3D, can be of real as well as of synthetic origin. A sample for the perception of synthetic horizontal parallaxes is the 3D viewing based on stereo pairs. From dealing with this general task, the authors successfully searched for a list of virtual 3D visualization principles, claiming for completeness, according to the state of the art. Nevertheless the authors invite the cartographic community carefully to check on this list and, if possible, kindly to add missing virtual 3D visualization principles, which are not listed. In case the authors would appreciate a (surprising) message via e-mail to Schuhr3D@hotmail.com. Constraints to put virtual 3D visualization principles on the list are at least 2 stereo mates of real and/or of 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]. Of course 3D perception not only succeeds for Cartesian space, but can also represent, e.g., temperature distribution. From a systematic dealing with the principals of spatial data perception, the authors where lucky enough to invent the new “Down Under” method. It is liked to emphasize, 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

Table 1. Complete List of the virtual 3D Visualization Principles (status: 2010)

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.1 to 4 and fig. 6 to 7
1.2 MAGIC EYE / RANDOM DOT
1.3 HEAD MOUNTED DISPLAY
1.4 STEREOSCOPES:
1.4.1 LENS STEREOSCOPES
1.4.2 MIRROR STEREOSCOPES 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-STEREOSCOPES 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 BARRIER STRIP: 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 like in the famous movie AVATAR
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 VIRTUAL 3D MODELS:
(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.5
3.4 HOLOGRAM Technologies

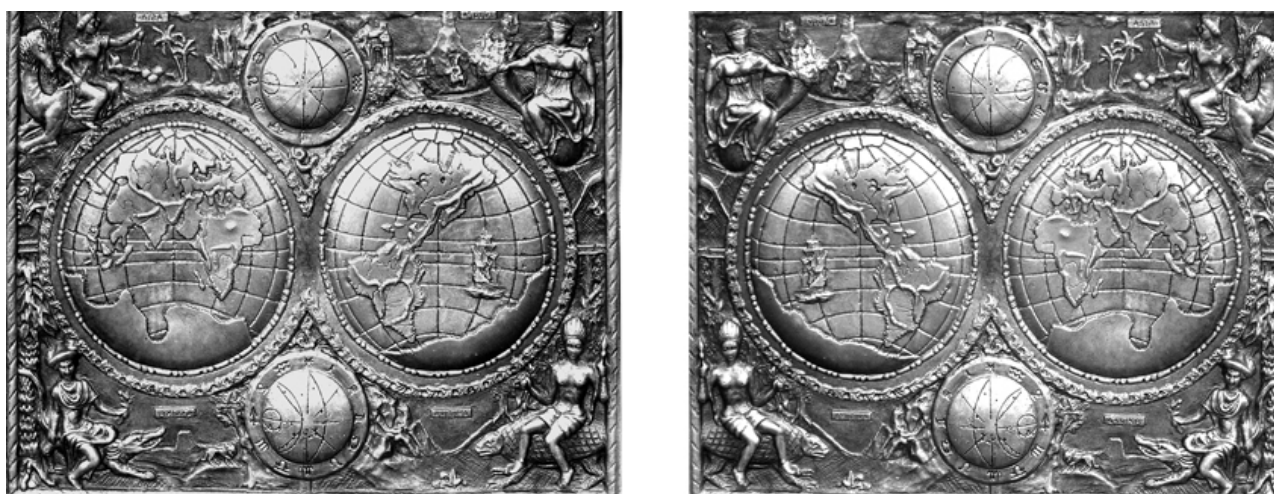


Figure 4. This 3D photography of an antique relief of the earth also is a sample for 3D presentation in the Pigeon mode (see table 1, 1.4.3; for stereoscopic perception use a vertical mirror in between both stereo mates)

become a real candidate for a new spatial PC generation in order to replace or to complete the 2dimensional screen generation, see fig. 5 and [5].

As a matter of fact, beside virtual projections in 3D nowadays the importance of the production of real models for many applications, including Cartography, increases, as highlighted by modern 3D printers (see fig. 6).



Figure 5. This early result of this 3D laser globe in crystal possibly represents the very beginning of the coming “3D-Computer Age in Cartography”



Figure 6. 3D printer of Z-Corporation with produced real (partly cartographic) models on a 3D photograph

3. DATA MINING FOR 3D PHOTOGRAPHS OF CARTOGRAPHIC RELEVANCE

The demonstrated masterpieces represent huge international collections of Heritage stereo views, including Cartographic Heritage too. Therefore this paper also deals with information on International Archives of 3D photography. A complete overview of existing Collections of international stereo views is more than overdue.

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 3D photography.

The most important source in this field is the International Stereoscopic Union (ISU) with approximately 900 members from about 32 states, compare also [1]. Regarding Cartographic Heritage, beside others, the IGN-Archive of France and the Keystone-Mast collection of the USA shall be named.

The Keystone-Mast collection is maintained by the CMP (California Museum of Photography), situated in Los Angeles (USA) and holds more than 350000 (analogue) stereo views, dating from 1892 to 1963, see for instance fig. 1 and 7. The current digitization rate is approximately 10%.

Keeping also in mind global archives of satellite and aerial photography, it is estimated, currently easily 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.

Beside their documentary value stereo views contain important detailed 3D geometric and radiometric information.

The quality of the original 3D images can even virtually improved from digital removing of speckles and scratches etc. and by increasing the radiometric appearance of the (now digital) stereo views.

To define an optimum digitization rate, original conventional analog 3D aerial photographs showing the scale 1:35 000 have been digitized with different pixel sizes.

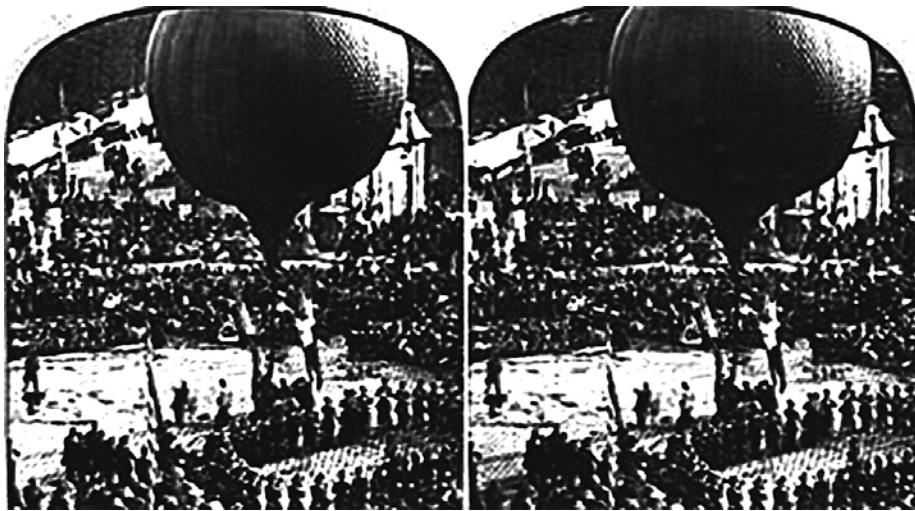


Figure 7. A treasure document of Cartographic Heritage in 3D: Fans attending a Balloon lift off of Nadar, the famous French Pioneer in 3D Photography and Cartography

As a first result, the interpretation of the stereo pairs, digitized with 500 dots per inch, which in this case means 1.8 m ground pixel size, shows approximately the same accuracy in object interpretation as the original 3D photographs, while the interpretation accuracy for images showing larger pixel size decreases, compare fig. 8. Please note, the stereo effect is an important tool, to increase the interpretation quality.

Therefore it is highly recommended, to digitize the available handed down stereo views systematically, using at least 500 dots per inch or more and to use a modern storage medium, like DVD etc.. Thus for daily applications the digital data and prints of such images can be used, while the original is protected and kept for exclusive operations only.

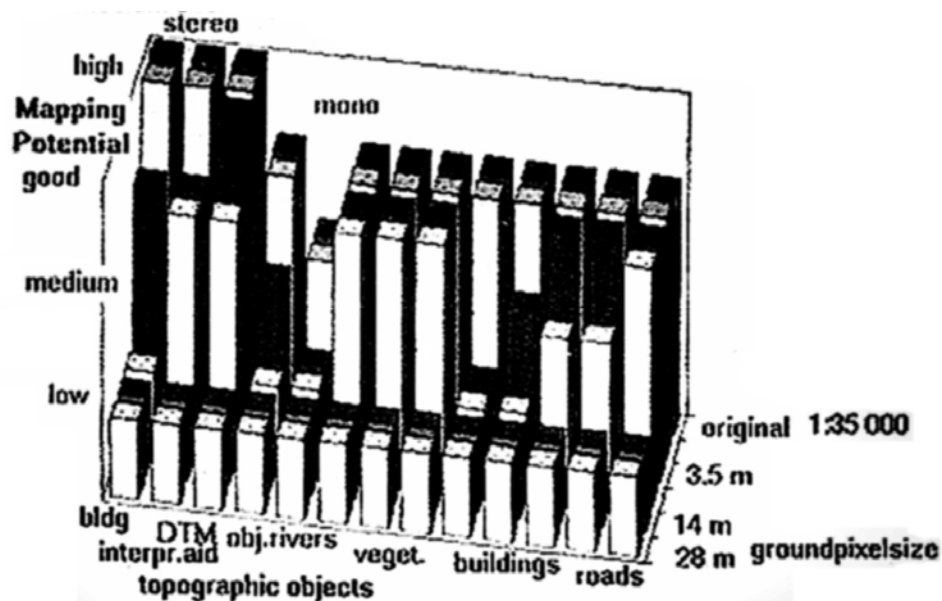


Figure 8. Interpretation results showing advantages from spatial (“stereo”) image data interpretation

4. EXPOSING DIGITAL 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, nowadays even already partly improved by civil drones, will more and more become an objective tool for a huge range of cartographic documentation purposes, including quasi ground truth. This “3D-niche-photography” is also well suited under expedition constraints and promises a great international future, see also [4].



Figure 9. Dipl.-Eng. St. Kiel of the University of Applied Sciences Magdeburg - Faculty of Civil Engineering- demonstrating a single lenses version of his digital 3D staff camera with remote control.

To expose 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.

The authors also just improved the X-Lite 10m telescope-rod camera from single lenses into a real digital 3D camera, allowing synchronic exposure, see also fig. 9.

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

5. CONCLUSION

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 archives of 3D photography showing Cartographic relevance, including the archives contents and access conditions is highly recommended.
- Intense dealing with “3D-niche-photography” based on telescope-rod and/or captive-balloon, Civil drones etc., promises a great future.
- A Peer reviewed and definitely complete synopsis of the virtual 3D-visualization Technologies suited for Cartography, showing sufficient information 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.

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