

VIRTUAL RECONSTRUCTION OF AN ANCIENT PIECE

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Abstract. *Our research topic is to present how to remake the original geometry and the visualization of a 16th century piece in CAD system. This article gives an overview, which introduce a complex method we used to create solid body from a scanned point cloud, on which different virtual simulations can be carried out. For the solution of the task we have developed a method for creating a surface texture, which is capable of displaying photo-realistic virtual models as well. The process itself innovative and novel, which can be used in varied places and it can also facilitate the manual restoration procedure.*

Keywords: geometry reconstruction, texture mapping, visualization method

1. Introduction

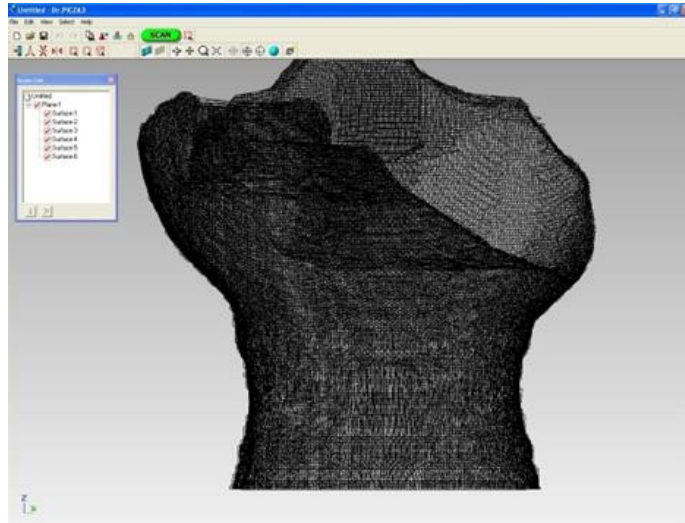
The method we developed is a new and simple reverse engineering technique. The process gives a complex solution to create an accurate CAD model and a perfect visualization from a real object after 3D scanning. The innovation of the method is to combine the remake of these sections in a simple and a realistic manner which haven't been used before in this kind of accuracy. In fact the process is a type of undistorted digitalization technique which more than 3D scanning. The visualization is based on photograph distortions, which also gives a better result than previously used reverse engineering software's color data detection. In the following article the base of the method will introduce. Other automation needed to make the usage of the process suitable for every piece.

2. Recording data

In the beginning of the reconstruction data digitalization was needed. The real object was used as the source of all detected data. We used a 16th century vase to introduce the process. In the beginning a 3D laser scanner scanned the surface of the ancient piece. The inner and the outward faces were scanned in rotary scan type (1. Figure) The density of the points was important in the

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process to evince all the surface finish. The brightness of the coated areas didn't have effect on the final result of the scanning. Extra points were erased from the point cloud.



2. Figure: Point cloud of the 3D laser scanning

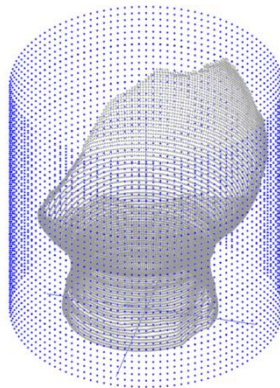
After the scanning process, photographs were made in studio environment. All the setting of the photographing was previously deliberate and fixed. The vase was placed on a turn table which was suitable for precise rotation. The piece was rotate about the axis and photographs were taken in every 10 degree. The target was to get 36 different photographs from the same view with the same light and environment settings. (3. Figure) After having the adjusted photographs pictures were generated on computer from the digital negatives. Subsequent photo corrections were needed to reconstruct the original colors and directions in every digital picture. Absolute gray card was the reference of the original colors to minimize the accidental effects of the camera and the artificial lights.



4. Figure: The photographs in studio environment

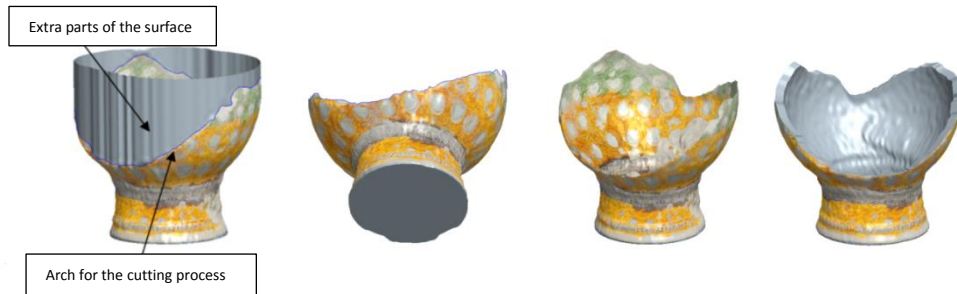
3. Geometry reconstruction

In a parallel way the reconstruction of the real body of the vase was started in CAD software called PTC Creo. In the first step of manipulation of the point cloud was needed along the borders to remove the extra parts. Afterwards cylindrical faces were generated with points on regular arches on previously specified distances. They will lead the narrowing method. The linear texture was suit on the generated surface adapting to the half parts of the model and the scanned geometry. Ultimately the final surface was generated by narrowing the cylindrical surface on the point cloud using as a reference the points on the previously created arches. Than the extra areas of the surface which extends over the border of the point cloud were cut. Solid model was generated by thickening the surface. In this method we didn't use the inner scan data.



5. Figure: The point cloud and the generated points

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6. Figure: Generation of the final surface and the body

All these steps need programming abilities. Homogeneous coordinate transformations were used in the transformation method to find the correct location of the surface point among the scan points in MATLAB.

4. Visualization

To prepare a realistic texture, distortions were needed. This was necessary because the texture was based on the side view of the rotated photographs. In the method we developed, a flat pattern was created with linear matching on the cylindrical surface. Later in the process this cylindrical face will narrow on the previously gained data of the point cloud.

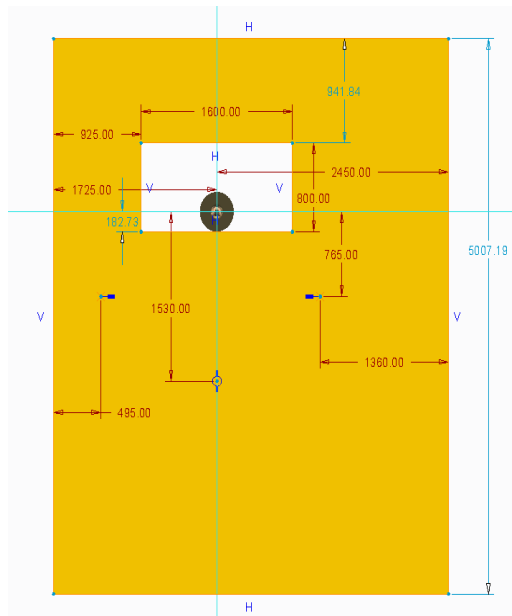
At the first step slices were chopped and distorted in horizontal way from the generated photographs based on the largest diameter of the vase. All of our calculations were based on the pixels of the photographs. The distortion was made on all slices in selected diameters. The lamination was referred to the widest diameter of the vase. Then the slices were merged in panorama maker software in linear merge type. The transparency was set in those places where the cover of the vase was pitted. On those places where the coated areas were missing the original material of the vase was appeared. It was helpful to generate a more realistic visage.

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7. Figure: Distortion of the slices and the flat pattern of the texture

To finish our project the original studio settings were reconstructed in the render module of the PTC Creo called Photolux. (8. Figure) All the previously measured amounts were recreated and the piece was put in the original place as in the studio. In this environment rendered pictures and videos were made from the solid model. All the settings of the material and the lightings were adjusted until we get the same visage as the originally taken picture.



9. Figure: The reconstruction of the photostudio in CAD system

5. Conclusion

Obviously simplifications were made in this representation of our method, but in the future we have plans how to eliminate them to develop the technique for free-form surfaces. It will be useful in industry and medicine as well as restoration.

As a consequence of the method validations were made relative to the CAD model to substantiate our results on the geometry and the texture mapping. (7. Figure) Verifications were created to certify the relations between the scanned point cloud and the solid geometry as well as the photographs with the rendered pictures.



7. Figure: The original and the rendered picture

The usage of the technique is very extensive. The reconstructed pieces can be demonstrated in virtual exhibitions where the user can see the objects placed in original environment beneath a walk through ancient or medieval times.

On the other hand we are able to supplement the missing parts to help and simplify the restorations. We can make exact calculations to create the perfect replacement for the piece.

Computer aided simulations on the virtual models can be detect the weak and critical parts to avoid the further damages.

/Participants of the project: C3D Ltd., Department of Machine and Product Design - BUTE, Technical University of Dresden, Eötvös Lóránd University, University of Óbuda, Department of Polimertechnics - BUTE, Museum of Applied Arts./

REFERENCES

- [1] Montegranario, H., Espinosa, J., C.-A. (2007): A regularization approach for surface reconstruction from point clouds, *Applied Mathematics and Computation* 188 (2007), ELSEVIER, pp.: 583–595, ISSN: 0096-3003
- [2] Liu, S.; Wang, C. C. L. (2010): Orienting unorganized points for surface reconstruction, *Computers & Graphics* 34 (2010), ELSEVIER, pp.: 209–218, ISSN: 0097-8493
- [3] Alberts, C. A. (2004): Surface reconstruction from scan paths, *Future Generation Computer Systems* 20 (2004), ELSEVIER, pp.: 1285–1298, ISSN: 0167-739X [2]
- [4] S. Sotoodeh, A. Gruen, T. Hanusch: Integration of structured light and digital camera image data for the 3d reconstruction of an ancient globe ISPRS Congress Beijing 2008 conference, Beijing, China, 2008. July 3-11., pp.: 367-372
- [5] J. De Reu, G. Plets, G. Verhoeven, M. Bats, D. Herremans, W. D. Clercq (2012): Towards a three-dimensional cost-effective registration of the archaeological heritage, *Journal of Archaeological Science* (2012)
- [6] A. Koutsoudis, G. Pavlidis, F. Arnaoutoglou, D. Tsiafakis, C. Chamzas (2007): Qp: A tool for generating 3D models of ancient Greek pottery *Journal of Archaeological Science* (2009)