3D Object Reconstruction using KONICA MINOLTA V190

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I. Introduction: 3D Reconstruction [2]

3D Reconstruction of objects and scenes is an active research field in computer vision and graphics. 3D reconstruction has various applications, for instance, inspection, visualization, and animation (*Movie: The Adventures of Tintin (2011)*). Their importance recently increased exponentially as this is the fundamental step in digital archiving of cultural heritage. 3D object reconstruction techniques can be divided into contact methods (for example, using coordinate measuring machines, calipers, rulers and/or bearings) and non-contact methods (X-ray, SAR, photogrammetry, laser scanning). This report will only focus on *"Laser Scanning"* as, the objective of this laboratory experiment is to reconstruct 3D objects with texture mapping using (*using KONICA MINOLTA VI-910*), which is designed under the *laser based triangulation* framework. The reconstruction and post image processing was done using programs: *Polygon Editing Tool (PET) and the program RapidForm 2004*.

II. KONICA MINOLTA VI-910: Basic Principle of *Laser Based Triangulation* [1]

KONICA MINOLTA VI-910 captures 3D shapes via laser without touching object. It is very useful in creating CAD models or rapid prototyping, product inspection, and computer-aided dimensional testing (CAT). Konica Minolta VI-910 provides high speed non-touch scanning and powerful software for collecting data for visualized modelling and can be used for high accuracy applications relating design and manufacturing.

The basic principle of VI-910 is based on laser triangulation. Triangulation depends on the projection of a light pattern, for instance, in VI-910 the object is scanned by a laser line which sweeps the field of view. The reflected light from the surface is captured by the CCD camera (*single frame/line*). The distance from object to system can be calculated by trigonometry, as long as a priori distance between the scanning system and the camera is known. The contour of the surface is derived from the shape of the image of each reflected scan line, and then converted to the lattice points. A polygonal-mesh is created with all connectivity information retained, eliminating ambiguities and improving the details.

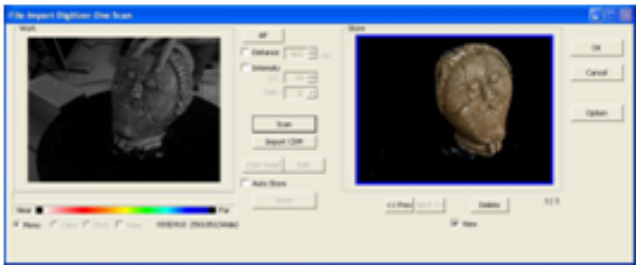
The image acquisition and manual point correspondence was done using *Polygon Editing Tool (PET)*, whereas the object reconstruction was performed in *RapidForm 2004*.

III. Experimentation Procedure

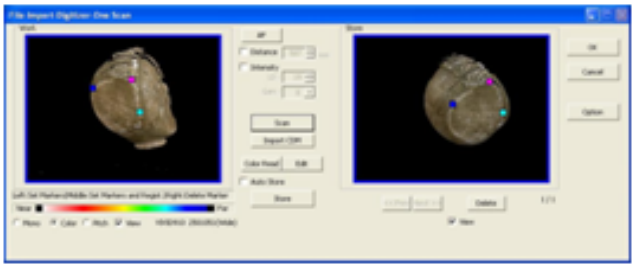
1) `Image Acquisition`: *KONICA MINOLTA VI-910* in conjunction with *Polygon Editing Tool* was used in image acquisition process. Acquisition of all possible surfaces of the object was achieved by manually rotating the object in the roundtable.
2) `Point Correspondence`: Point correspondences between two different object orientation image was done manually in the *Polygon Editing Tool* software. Figure 1(a) shows the scanning process, where some corresponding points from the new capture and the previous capture was selected (*at least three points*). Figure 1(b) shows the registering process. Registration took place after each selection, which fused all previous registration. Figure 1(c) shows the 3D reconstruction of the object.
3) `Post Processing`: Post processing was done in the *RapidForm* software. The steps consisted of refining view registering, merging view, removing extra shell points, filling the holes, and moving the centre of the object to the origin. To reduce computation time, the texture could be removed before doing five steps above. Figure 1(d) shows the post processing result of the previously reconstructed object.

IV. Limitations and Problems

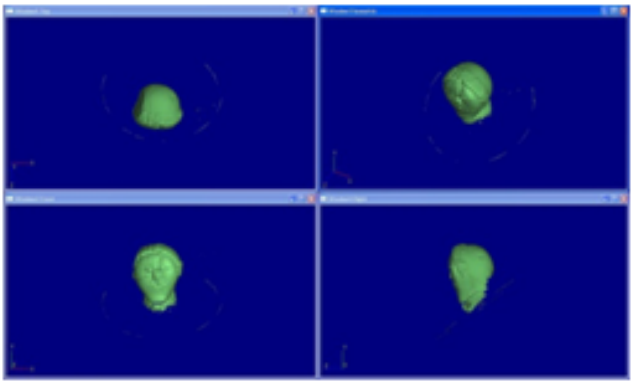
1) The object needs to be rotated manually to gather multiple images. This process increases the accuracy but is laborious, time consuming and sometimes unintentionally redundant. However, this problem can be solve by integrating the automatic motor to the base of the rotation plate. then, we



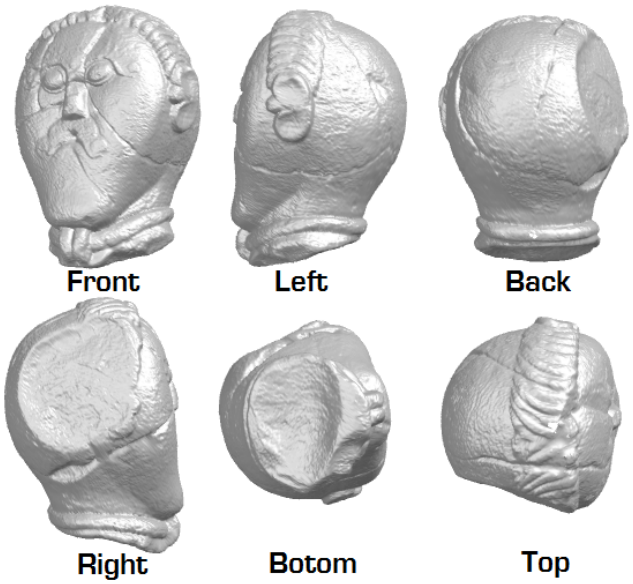
(a) Scanning Process



(b) Registering Process



(c) Unrefined 3D Reconstruction



(d) 3D Reconstruction: Post Processing Results

Fig. 1. 3D Object Reconstruction using KONICA MINOLTA V190

can program the rotation plate very precisely at any angle.

2) The complex object shapes can create trouble, as the laser can not research each part. This makes the post processing vital.
3) The camera has a limitation and needs to work within the range of less than 1 meter to the object position. This leads to scanner drawback between one capture and the other considering inconsistent distance changes.

V. Conclusions

Summarizing, the KONICA MINOLTA V190 is a powerful instrument for performing highly accurate 3D scans of rigid non specular objects. An object can be scanned easily and relatively fast. Furthermore, the powerful post-processing algorithms enable the possibility of removing noise and filling gaps. The application offers also possibilities of exporting the 3D scan in various formats to process the reconstructed objects or view them. A big advantage of the Vi-919 Non Contact Digitizer is its portability and capability of scanning objects of each size. The corresponding software allows to reconstruct objects given a set of views by manually specifying a set of corresponding points. Table I summarizes the advantages and disadvantages of this method.

TABLE I
SUMMARY OF ADVANTAGES / DISADVANTAGES

Advantages
Non-Contact Method
Wide scan range (0.6 to 2.5m)
Portable and versatile
Reverse Engineering
Precise capture of 3-D shapes
Reliability
Measures objects of every size
Outstanding texture mapping
Powerful pre/post-processing

Disadvantages
Large User Input
Object needs to be repositioned
Rigid objects only
Multiple scans from different views

The Vi-919 Non Contact Digitizer offers plenty of applications. A computer based CAD model for almost any object, including texture can be generated using inverse engineering. This is of great advantage when the task is to perform object inspections etc. Other possible applications are related to food production, Cultural Antiquities cataloguing and publishing, Dental and orthodontic appliances and other application to Machine Vision.

There exist many similar products for performing 3D reconstruction. A list of available products can be seen in

$http://www.dirdim.com/prod\_laserscanners.htm$. A direct comparison of the available products is not possible, since a set identical objects would have to be scanned with all the available scanners in order to compare the obtained result.

The Vi-919 Non Contact Digitizer is definitely an excellent product that enables a 3D reconstruction with high accuracy and a relatively short amount of time. The software is easy to use and anyone with some computer skills can learn to use the software within a few hours.

REFERENCES

[1] J.G.D.M. Franca, M.A. Gazziro, A.N. Ide, and J.H. Saito, *"A 3d scanning system based on laser triangulation and variable field of view. In Image Processing",* 2005. ICIP 2005. IEEE International Conference on, volume 1, pp. 1 - 425 - 8, Sept. 2005.

[2] F. Remondino and S. El-Hakim, *" Image- based 3d modeling: A review",* The Photogrammetric Record, 21(115), pp. 269 - 291, 2006.