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A STUDY OF THE APPLICABILITY OF THE KINECT BASED 3D SCANS

BY

OCTAVIAN CIOBANU[1*] and GABRIELA CIOBANU[2]

[1]"Grigore T. Popa" University of Medicine and Pharmacy, Faculty of Medical Bioengineering
[2]"Gheorghe Asachi" Technical University of Iaşi,
Faculty of Chemical Engineering and Environmental Protection

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Abstract. Paper approaches the applicability of the Kinect based 3D scans for low-cost 3D scanning and reconstruction of real objects. The study was made in order to observe the applicability of the Kinect based 3D scans in the case of small objects and in the case of anatomic surfaces. Different objects and anatomic surfaces were scanned and 3D reconstructed using Kinect and specialized software. The results of the study show that the Kinect based 3D scans have some performances in the case of blind holes and surface concavities but finally this technique is not suitable for the case of objects with sharp edges and multiple details. The best results of scanning and reconstruction were obtained for anatomic surfaces. Kinect based scans may have a lot of applications in bioengineering area.

Key words: 3D scanning, Kinect, applicability.

1. Introduction

Any physical object can be digitized using 3D scanning technologies like laser scanners, structured light scanners, photogrammetry etc. Each 3D scanning technology has its advantages, limitations, and costs. The increase of

*Corresponding author; *e-mail*: oct.ciobanu@gmail.com

interest in 3D scanning and in generating 3D reconstructions using Kinect sensors and the increasing capabilities of processing software have expanded the range of domains to which may be applied. This tendency permitted simultaneously the decreasing of the costs of scanning hardware and software.

This paper approaches the scanning with a low-cost device based on structured light. The Kinect depth sensor used in this work was launched by Microsoft on June 2009 and was based on a webcam-type peripheral. Due to the low cost, the Kinect have a lot of applications (Gallo, Placitelli, and Ciampi, 2011), (Henry et all, 2013), (LaBelle, 2011).

2. System Architecture

The Kinect sensor (Fig. 1) uses a structured light technique in order to reconstruct 3D surfaces described by a multitude of point clouds defined by x, y and z coordinates. The depth sensor allows the user to rotate around the object with a radius between 400 and 1000 mm.

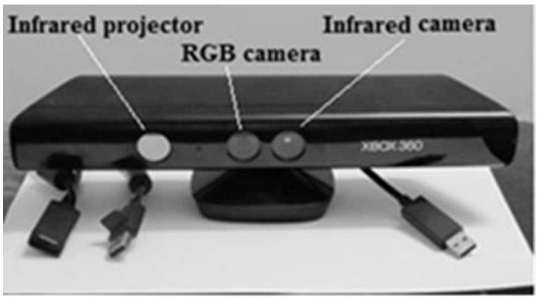

Fig. 1 − The Kinect sensor

Shin had studied the accuracy of the Kinect sensor and found in 2013 that the reconstruction errors were between 2 and 10 mm for human surfaces when sensor was placed between 500 and 2000 mm distance (Shin et al, 2013).

These errors allow the use of Kinect sensor in a lot of bioengineering applications including prosthetics and orthotics. The Kinect for Xbox 360 sensor was designed to be used with Xbox gaming console but any Kinect for Xbox 360 may be connected to a PC according to the scheme from (Fig. 2).

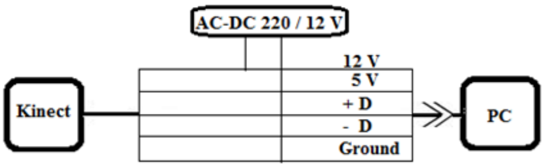

Fig. 2- Kinect to PC adapting scheme

Devices like Asus Xtion and Primesense Carmine have similar characteristics. For rapid 3D reconstruction, a PC needs next requirements: 2 GB RAM, Quad core processor, Windows 7 or later (64 bits), Cuda compatible graphics card with 1 Gb of memory as NVidia GTX 560 or higher (Ciobanu, 2015).

The Kinect sensor works with Windows Software Development Kit (SDK), with Windows 7 compatible PC drivers for the Kinect device. It also enables developers to create applications that support gesture and voice recognition. Also, Kinect needs OpenNI, open-source software that is able to read 3D data from Kinect, and other sensors.

There are several software for 3D reconstruction: Skanect, Kscan3d, Fablitec, ReconstructMe, Blender, etc. Skanect was preferred for this study.

The scanning was performed in day light, when lighting conditions were stable. The possible trajectories or positions of the Kinect sensor during scanning are described in (Fig.3).

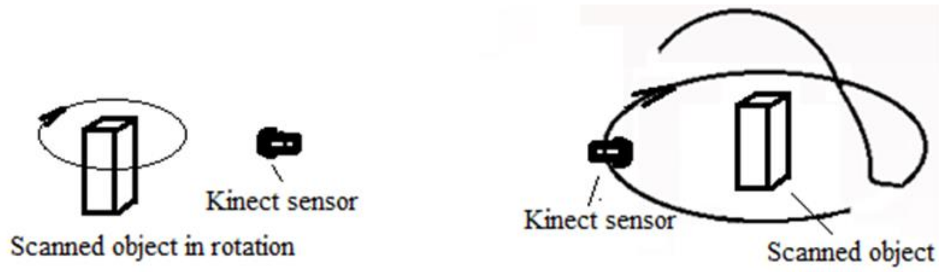

Fig. 3 − Examples of Kinect sensor positions during scanning; rotating object (left) and rotating sensor (right)

The quality of 3D reconstruction depends on reconstruction software and on correct scanning process. Reconstructed objects are discussed and the quality of mesh models are discussed

4. Experimental Results

In the initial phase of 3D reconstruction, Kinect and Skanect produce a 3D mesh model, empty inside. Next types of objects were scanned: box, sphere, vessel and a complex device.

Case 1. Scanning of a box (180x55x35 mm) and visualization of the 3D reconstructed model with MeshLab software. Kinect sensor was fixed and the object was rotated.

MeshLab has functions for 3D mesh modification, including the management of faces number. Different 3D models are presented in (Fig. 4).

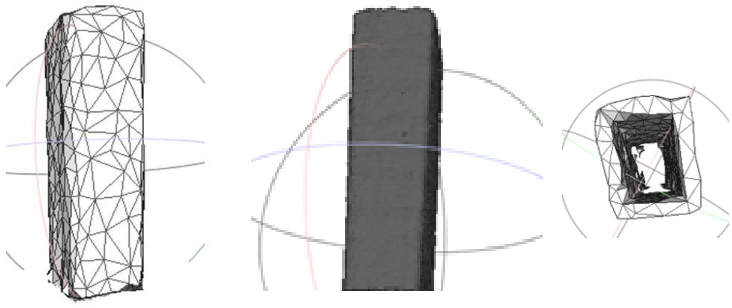

Fig. 4 Results of a box scanning; frontal view with 1049 faces (left) frontal view with 724000 faces and top view (right)

Case 2. Scanning of a sphere (60 mm diameter) and vizualization of the 3D reconstructed model (Fig.5) with MeshLab software. Kinect sensor was fixed and the object was rotated.

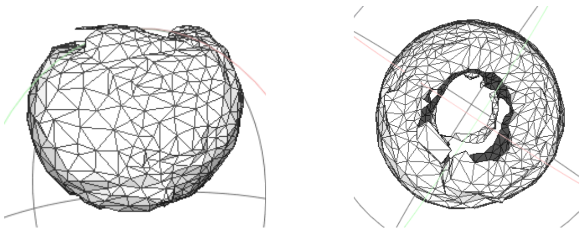

Fig. 5 The 3D model of a sphere; front view (left) and top view (right)

Case 3. Scanning of a cylinder (ϕ10 x 240 mm) and vizualization of the 3D reconstructed model (Fig.6) with MeshLab software. Kinect sensor was fixed and the object was rotated.

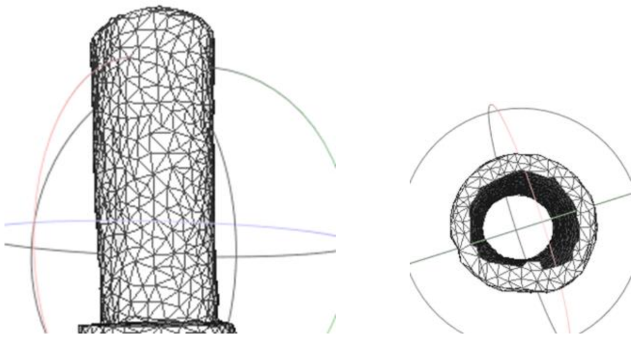

Fig. 6 Result of a cylinder scanning (3100 faces); frontal view (left) and top view (right)

Case 4. Scanning of a vessel and vizualization of the 3D reconstructed model (Fig.7) with Deep Exploration software. Kinect sensor was rotated and the object was still.

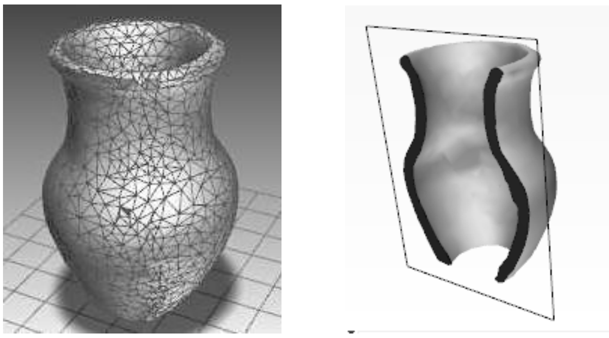

Fig. 7 Reconstructed model of a vessel; front view (left) and section (right)

Case 5. Scanning of human head and vizualization of the 3D reconstructed model with Deep Exploration software. Kinect sensor was rotated and the object was still.

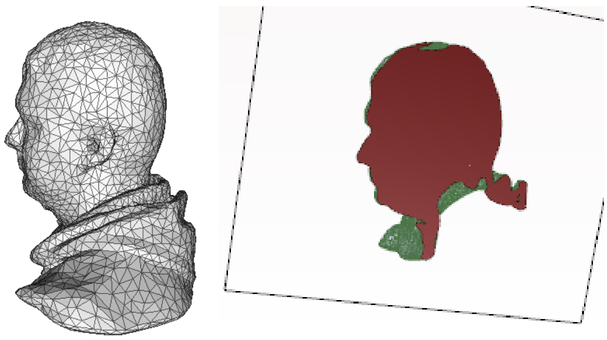

Fig. 8 Reconstructed model of a head; lateral view (left) and section (right).

Observations:
- The quality and the precision of vertical and horizontal edges are inacceptable in (Fig. 4);
- Reconstruction software make thick walls as seen in the top view of (Fig.4);
- Walls of box are not parallel as seen in the top view of (Fig.4);
- Some corners are rounded as seen in the top view of (Fig.4);
- During the scanning with fixed camera, vertical hole may appear in the middle of spheres and cylinders (Fig. 5 and 6);
- Blind holes are partially reconstructed as in (Fig.7);
- Rounded surfaces are well reconstructed as in (Fig.7 and 8).

5. Conclusions

The study showed the results of the use of a Kinect depth sensor in the 3D scanning of different surfaces. The scanning with Kinect sensor produces good performances, for the most part of blind holes and surface concavities but this technique is not suitable for the scanning of small objects with sharp edges and multiple details. The best results are obtained during the scanning of anatomic surfaces.

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STUDIU ASUPRA APLICABILITĂŢII SCANĂRII CU SENZORUL KINECT

(Rezumat)

Lucrarea de faţă prezintă un studiu despre aplicabilitatea sistemelor de scanare bazate pe senzorul Kinect. Rezultatele studiului arată că utilizarea acestui senzor în cazul obiectelor mici cu muchii drepte nu este indicată, ca urmare a unor imprecizii în descrierea suprafeţelor cu astfel de muchii. Sistemul lucrează mai bine în cazul scanării suprafeţelor rotunjite şi din acest motiv aplicaţiile medicale sau bioinginereşti sunt cele mai potrivite.