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APPLICATION OF KINECT FOR REVERSE ENGINEERING: A CASE STUDY

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Abstract

As computer-aided design (CAD) has become more popular, reverse engineering has become a viable method to create a 3D virtual model of an existing physical part. The reverse-engineering process involves measuring an object and then reconstructing it as a 3D model. The physical object can be measured using CMMs, laser scanners, structured light digitizers, or Industrial CT Scanning. Here, in this work, creation of the 3D model is done by scanning the existing physical object with the "KINECT" camera which has the capability to read the object in all the possible directions. For post processing the CAD model, Autodesk's Mesh Mixer software is used and the CAD model is converted into STL file. Then the model is printed on FDM machine. To overcome the errors while reading the physical object a rotary motion table is used.

Keywords: Kinect v2; 3D modeling; 3D Printing;

1. Introduction

Kinect is a line of motion sensing input devices that was produced by Microsoft for Xbox 360 and Xbox One video game consoles and Microsoft Windows PCs. Based around a webcam-style add-on peripheral, it enables users to control and interact with their console/computer without the need for a game controller, through a natural user interface using gestures and spoken commands. Kinect for Xbox One, a new version with significantly expanded hardware capabilities, was released with the Xbox One platform starting in 2013. The corresponding Kinect for Windows v2 hardware was released in 2014, along with a supporting SDK. The 2.0 version of the Windows SDK supported the Kinect for Windows v2 as well as the Kinect for Xbox One hardware.

The updated version of Kinect uses a wide-angle time of flight camera, and processes 2 gigabits of data per second to read its environment. The new Kinect has greater accuracy with three times the fidelity over its predecessor and can track without visible light by using an active IR sensor. The colour camera captures 1080P video that can be displayed in the same resolution as the viewing screen, allowing for a broad range of scenarios. Kinect for Windows v2 is shown in the Fig. 1.

Fig. 1. Kinect for Windows v2

Microsoft's Kinect is now widely used as low-cost device because of its integrated variety of sensors. Some of the important sensors are RGB camera, Infrared sensor, Multi- array microphone.

Kinect has the unique ability to “see” in 3D. Unlike most other computer vision systems, the Kinect system is able to build a “depth map” of the area in front of it. This map is produced entirely within the sensor bar and then transmitted down the USB cable to the host in the same way as a typical camera image would be transferred—except that rather than colour information for each pixel in an image, the sensor transmits distance values. The sensor uses a clever technique consisting of an infrared projector and a camera that can see the tiny dots that the projector produces. The depth sensor consists of an infrared laser projector combined with a monochrome CMOS sensor, which captures video data in 3D under any ambient light conditions. The sensing range of the depth sensor is adjustable.

2. Generation of CAD Model Using Kinect

The software used for scanning the physical object is the Software development kit (SDK) for windows Kinect. The Kinect is connected to the computer (having windows 10 OS) through the adapter and USB 3.0. Then the Kinect is placed corresponding to the target object position. Then the target object is brought into the Kinect’s field of view either by moving the Kinect or moving the object. In SDK, feature called Kinect fusion explorer-WPF is used to read the object. Fig. 2 shows the screenshot of the software environment of Kinect fusion explorer-WPF while reading the object. Here the object considered is the human body. The Fig. 2 showcases different settings in fusion explorer which can be changed according to the target object that is to be read.

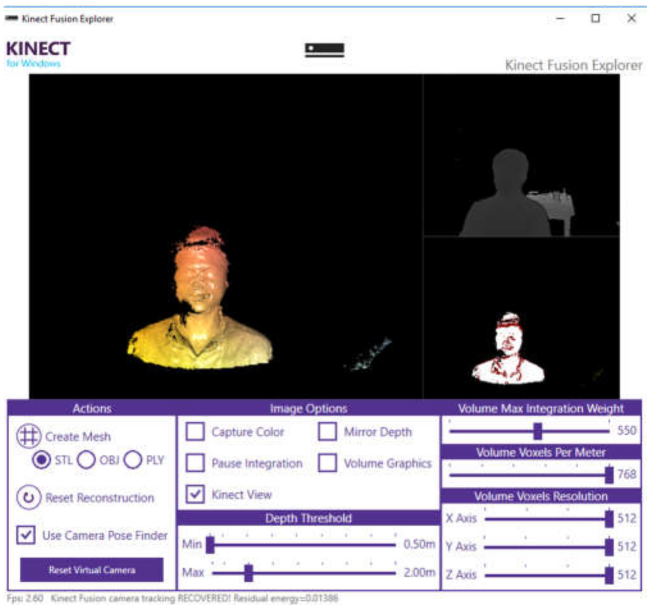

Fig. Environment of Kinect Fusion Explorer-WPF

In the Fig. 2, depth threshold option is used to fix and maintain the distance between Kinect sensor and the target object to avoid reading of any other foreign objects. Volume voxels resolution setting is used to define number of voxels in each axis which changes the resolution of target object. In the image option setting the object can be read either by RGB sensor or depth sensor which are named as ‘capture colour’ and ‘Kinect view’ in the SDK application. Here the Kinect view is used for capturing the 3D data. The object is to be read and saved in STL format because this is the standard format for 3D printing. Now the human completes one revolution before the Kinect camera and it captures the 3D data of the human. After completion of one rotation the Reset Reconstruction option is used to complete the process of creating the CAD model in STL file format. Now this is saved and imported to Mesh Mixture software for post processing. The post processing includes analysing the scanned model, editing it and exporting it to the 3D printer software. In the editing options any errors like holes that are generated while scanning can be eliminated by making the object as solid. After post processing the model is shown in the Fig. 3. Now the modified clean model is saved in STL format.

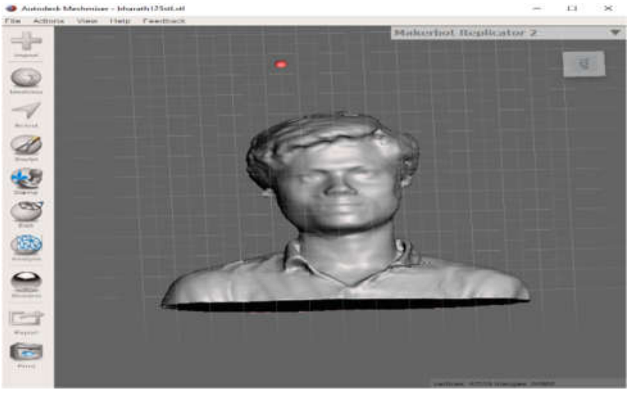

Fig. 3. Processed Model

3. Printing the scanned model:

Ultimaker Cura software is used for preparing the model for 3D printing. The STL file is loaded in the software and the parameters chosen for printing. Various options are available in the software for selection which in turn affects the quality of the print. There is always a trade-off between quality and the time required for a 3D print. Higher resolutions result in smoother surfaces, which take longer to print. Parameters like nozzle diameter, filament diameter, printing speed and temperature are given. The layer thickness is taken as 0.3 mm. After pressing the save option, the toolpath is saved in G and M codes. This data is loaded on the S-300DH fused deposition modelling machine to print the object.

Fig. 4. Rotary Table

For scanning small components, a rotary table is fabricated and that is shown in Fig. 4. The object considered in this case is Axle shaft yoke half. The first step involved in usage of rotary table is placing the target object on the circular plank which is raised above the bottom plank. The transparent material is placed on the circular wooden plank. On top of it, target object is placed. Now, the Kinect is fixed at certain place from the object. Here, the object is in motion and the Kinect is in fixed position. Manually, the shaft is rotated by hand at small speed. By turning the stepped shaft, it creates a rotary motion which in turn rotates the wooden plank which is connected to the shaft. The object then rotates according to the motion of the wooden plank.

Now, the Kinect will read the target object. For better scanning with the Kinect, the angular velocity of the wooden plank is in controlled and maintained at low rpm. Thus, the object is scanned by the Kinect following through rotary motion of the object. The objects that are printed over the S-300DH fused deposition modelling machine are shown in Fig. 5 and Fig.6.

Fig. 5. Printed Human Model

Fig. 6. Printed Mechanical Component

4. Conclusion

In this paper, an attempt is made to scan objects using Kinect. A simple procedure is presented that shows the procedure of reverse engineering process. The process of generation of the CAD model is done at much lower cost compared to the other alternative 3D scanning techniques. The generated model is processed and printed to compare it with the existing part. A fair result is obtained with minimum errors. Because of low cost and user friendly features caught attention and lead to build a 3D model using Kinect.

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