

INTERNATIONAL JOURNAL OF INFORMATION TECHNOLOGIES, ENGINEERING AND MANAGEMENT SCIENCE

Post-processing of 3D scans in laser scanning

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Abstract

This article is focused on post-processing of 3D scanned objects and on the importance of post-processing and identification of problems which may arise during the processing of the data. Creation of 3D shape using special 3D technologies has become main approach for creating digital data of 3D shape which is then processed in various software tools. Despite the increasing of the accuracy most available scanning techniques cause serious scanning irregularities also known as artifacts.

Keywords: 3D, post-processing, 3D scan, filters, artifacts, point cloud.

Introduction

Data digitization as part of reverse engineering affects various industries. In general, digitization can be understood as a transfer of objects into its digital form. Digitization can increase the productivity of enterprises and increase the ability of competitiveness of individual companies. With an increasing demand for real world digitization the geometric complexity of 3D object surfaces has also increased. With the increase of complexity, the processing becomes more difficult. Gathering these data is time consuming and costly. 3D laser scanning devices which can capture real world 3D objects has recently become very popular.

Laser scanning provides high-precision in a recording of real world objects. The result of the scan is a point cloud which represents a three-dimensional image of the scanned objects. This technology is widely used to measure various objects such as buildings, production halls, machines, facilities, engineering networks as well as cultural monuments or sculptures. [1]



Figure 2 – Post-processed scan of building. Done by Laser Scanner

Post-processing of the scanned data is also very important. The output is during the post-processing filtered and reduced by the amount of unnecessary data.

Possible types of scanning irregularities

The quality of the scanning itself often depends on the properties of the materials the objects are made of and depends on the weather effects such as sunlight

and wind (if we consider exterior scanning). Depending on the data collection method used various types of scanning irregularities may occur (Figure 2). Authors [2] describe the following scanning irregularities:

- Physical limitations of the sensor lead to noise in the acquired data set. Sample points can also be corrupted by quantization or motion artifacts. The latter occur when the scanned object moves during the acquisition process, a common problem when scanning humans or animals. Figure 3 shows the movement of people in front of the building,
- Multiple reflections and heavy noise can produce off surface points (outliers). These are points do not exist and have been created when the laser beam passed through the transparent objects such as windows.
- Holes and under-sampling in the model surface occur due to occlusion, critical reflectance properties, constraints in the scanning path, or limited sensor resolution. Holes also occur under the scanner itself.
- Many scanners tend to create ghost geometry when the scanned object is textured. [2]

Authors of this paper were during the 3D laser scanning experiencing very similar irregularities:

- Reflection of objects on the buildings walls,
- Duplicated points,
- Dark Scan points.



Figure 2 – Typical artifacts of raw scanner data. Top Row: Low sampling density due to gracing sensor views, Holes due to sensor restrictions, noise. Bottom Row: low sampling density at delicate surface details and outliers Left: holes due to critical reflectance properties.

Some problems can also occur due to the wrong setting of the 3D scanner itself such as a vertical and horizontal axis shift.

The importance of post-processing

Depending on the required output quality of individual scan objects laser scanning will create several million points (point cloud). These raw scanner data, however, contains the above-mentioned scanning irregularities. These irregularities are not important for the user and can cause considerable problems in the subsequent creation of the 3D models. That is why these points must be reduced and filtered to make a clean scan. Clean scan can be then used to create final 3D scan. There are many software tools on the market that offer methods for removing these unwanted points.

Reduction and filtration of point clouds

In the post-processing, there are several methods to reduce and filter unwanted parts of the point cloud. The authors [3] describe the steps of point cloud extraction methods as follows:

"The detection of object surfaces in point clouds is the first step to extract information from point clouds. Applying to the bare Earth surface from airborne laser data, reverse engineering of industrial sites or the production of 3D urban models depends on the success of this first step. Methods for the extraction of surfaces can be roughly divided into two categories: those that segment a point cloud based on criteria such as the proximity of points and / or similarity of locally estimated surface normal and those that directly estimate surface parameters by clustering and locating maxima in a Parameter space. The latter type of methods is more robust, but can only be used for shapes like planes and cylinders that can be described with a few parameters." [3].

Most today's software tools can extract data from scanning devices. However, there are several ways to extract these data. After the successful extraction, the data can be cleaned and filtered. There are several different filters. The most common include:

- Smooth Filter - this filter is used to smooth out the data you get. Generally, it works by adjusting the measured co-ordinate point to a mean value from its neighborhood. What is important to point is that the filter does

not remove individual points it just adjusts their value to the middle one which leads to smoothing.

- Stray Filter - filter removes points that are outside the selected area and this method is based on defining points distance. The filter is suitable for use near the edges.
- Distance based filter - filter removes all points that do not meet required quality and is based on the minimum and maximum distance.
- Outliers filter - filter removes points that are outside the selected area. It is not recommended to use this filter near the edges.
- Combination of various filters

Per the various filters we can eliminate irregularities which limit user in his/her work which scanned objects. Figure 3 shows raw scanner data which was obtained by extracting the data from the scanning device. The data after the extraction (individual scan file) should be joined together into one file. There was a huge amount of unwanted points in the data. This was caused by mass movement of people in front of the building. Figure 4 presents scan which is cleaned from all unwanted points by applying filters and post-processing.



Figure 3 – Typical artifacts of raw scanner data



Figure 4 – Scan after application of filters, point reduction and cleansing from other scanning irregularities

Conclusion

With an expanding increase in demand for real world representation in digital world, the demands for 3D processing of real world objects are growing. These processes can be costly and time consuming. Nowadays, using 3D scanning devices can reduce costs and processing time during the digitization of real world objects into the 3D models. Although these devices and applications make the 3D digitization much easier the collected data need professional post-processing. To be able professionally post-process data from scanning devices it is necessary to master not only scanning devices and software but also to master scanning techniques and limitations which depend on characteristic of scanned object and surrounding environment.

Acknowledgements

This paper is supported by the following project: University Science Park of the University of Zilina – II. phase (ITMS: 313011D13) supported by the The Operational Programme Research and Innovation funded by the European Regional Development Fund.



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