Generating Simple Polygonal Objects From Point Cloud

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Abstract

We present a software system that allows semi-automatic generating of simple 3D objects from point cloud mesh. Resulting objects should be usable by plant engineering software such as Cadmatic.

Keywords: *Point Cloud, Laser Scanning, Mesh Optimization, Plant Design.*

1. INTRODUCTION

Elomatic Oy offers engineering and consulting services to variety of Finnish companies such as Metso Paper. Since the time, which is required to accomplish a contract, is one of crucial factors in this area, Elomatic has to seek ways to improve its efficiency. Particularly, a replacement of old machinery (e.g. upgrade of old paper machines), consists of several steps:

1. One have to obtain computer plan of the environment, where montage works will be done. Not only plan of the building is required, but also detailed plan of the other machinery in this area, pipes etc. Since in most cases it is difficult to obtain this information, laser scanning of the area have to be done, which leads to second step.
2. From the point cloud, which is obtained by scanning, engineers manually create computer representation of the environment. This task is performed using appropriate software such as IBM's CATIA or Cyra's Cyclone. The resulting data is appropriate for plant design software such as Elomatic's Cadmatic.
3. Engineers performs rest of calculations in plant design software.

Practice shows that second step is most time-consuming and typically requires about two weeks. It consists mostly from manual conversion of point cloud to NURBS surfaces or to CAD software-specific structures (such as pipe that is defined with its type, diameter, position and length). Historically, plant design software works efficiently only with lightweight parametric descriptions of the objects.

Our system is designed to speed up a conversion of point cloud to parametric representation of objects, which plant design software can handle natively.

2. ALGORITHMS OVERVIEW

Several different algorithms are used in conversion process. First, triangle mesh, which is generated by pre-processing software from point cloud, is simplified to obtain approximation with the order of complexity that is suitable for plant design software. If the resulting approximation can be used directly, it can be exported "as is". Otherwise, a segmentation of the mesh must be performed in order to further simplify some of its parts. Then each segment is replaced with an appropriate simple geometric shape.

2.1 Triangle mesh simplification

Triangle surface mesh, which is generated from point-cloud, contains a lot of redundancy due to large number of samples per surface, and typically it can be optimised up to tens times without introducing noticeable error. Since importance of different parts of the mesh can vary, we have decided to give a user higher degree of control by implementing progressive (continuos) level-of-details scheme in order to allow changing LOD interactively and thus visually control quality of the approximation. There are several approaches, which are able to handle uncertain topology of our input mesh. We have chosen vertex clustering [2,4] for our initial testbed as a golden mean. However, progressive simplicial complexes [3], which offer potentially better fidelity at expense of topology restrictions and more processing time [6], will be considered.

2.2 Segmentation and shapes fitting

In order to further simplify input data, some parts of surface geometry can be represented as a simple geometric shapes, e.g. cylinders or parallelepipeds. General or specialized data-fitting algorithms such as non-linear least-squares fitting [1] can be used to perform this task. One should be able to spit source mesh into several parts. Then for each part optimal approximate shape is found. We propose to implement manual segmentation, which requires user's judgement on such criteria:

- If given surface mesh is feasible for direct export to plant design software;
- Which parts of mesh must be fitted.

Further automation of the segmentation task is an interesting continuation of the development.

3. CONCLUSION

Our software system is expected to speedup Elomatic's plant design workflow by improving efficiency of the montage site's plan making.

4. REFERENCES

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