Abstract

The object of the dissertation are the spatial expansions of symmetrical object's point clouds. Presentation of the objects geometry in the form of point clouds is a result of the measurement in laser scanning technology and the processing of recorded observations. The resulting spatial data set is a detailed and accurate numerical representation of the object measured surfaces. Clouds often include millions of points, which causes the occurrence of interpretation difficulties during their visualization. In a special way, this applies to the regular shape of symmetrical objects. In the three-dimensional space of the point cloud in one direction there are points showing separate parts of the object are visible. The aim of the work was to create an alternative form of the point cloud, which maintains the current detail, allows for its more legible presentation and facilitates inference about the geometry of the symmetrical object.

Conducting a point cloud spatial expansion requires determining a regular mathematical primary surface, which approximates the shape of a symmetrical object. This surface may be e.g. a cylinder, sphere, spheroid or hyperboloid. The surface is the reference for measured points in the cloud. The second element necessary to carry out the development is to define the element of symmetry of the primary surface (point or line). To determine the value of geometric parameters defining both surfaces and elements of symmetry, non-robust and robust methods of estimation. Based on the obtained values, parameterization of all points from the cloud is performed, consisting in assigning them the appropriate curvilinear coordinates related to the primary surface. In addition, linear values of separation of points from the surface (depth parameter of the spatial expansion) are determined. As a result, a new way of presenting a symmetrical object point cloud is obtained, based on curvilinear coordinates and the depth parameter.

The dissertation used the theory of surfaces and the theory of cartography. Based on them, functional relationships have been created that adapt and modify known formulas of cartographic projections. These functions transform the primary point cloud into the form of spatial expansions. Both data sets are three-dimensional, which is a significant difference from the classic maps. In the spatial expansion of symmetrical object points clouds, the image of their symmetry elements is the surface. As a result, all points from the created cloud are above the mentioned plane at the height corresponding to the distance of points from the element of symmetry. Thus, interpretation difficulties are largely eliminated, because the points located in the primary point cloud in the same direction, in spatial expansions, are projected in different places. The dissertation also presents distortions that appear due to the use of spatial expansions of point clouds.

Application possibilities of the solution were tested on point clouds obtained from the measurement of four symmetrical objects. Diversified geometrical features of objects enabled presentation of different aspects of spatial expansions. The primary surfaces considered were the cylinder, sphere and prolate spheroid. Obtained datasets based on expansions include spatial configuration analysis of complex multi-module constructions, comparative analysis of objects with similar geometry, shape and deformations analyses of symmetrical objects.

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