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Generating Method for Three-Dimensional Building Model with Mobile Mapping System Data

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In the field of landscape engineering, efficient and probable methods have been researched and developed to generate a digital city which is a city model made from three-dimensional computer graphics. The polygonal prism model, which is generated from the outline and the height of the building determined by the light detection and ranging (LIDAR) data or the number of the buildings stories, is mainly used to represent a building in surroundings. It is very easy to generate the polygonal prism model. However, this model cannot represent details of facades unless the texturing is applied.

In this study, the authors tried to generate a three-dimensional building model with details of facades by using the mobile mapping system (MMS) data as a point cloud. The data are acquired with three-dimensional laser scanners and GPS devices mounted on a vehicle.

The major information used in this study are the MMS data, the tracks of MMS and building outline data. The MMS data are point data. Each one has x, y and z coordinates and the GPS time with four decimal places by the second. The tracks of MMS are line data. Each one has a position of MMS (x, y and z coordinates) and the GPS time with one decimal place by the second. The generating process of three-dimensional building model, which proposed in this study, is as follows:

(1) Creation of regression equation

Using the original MMS data (hereinafter referred to as P_{MMS}), the regression equation between the observation distance (x) and the interval of points (y) is derived through the least-squares method. This equation defines a threshold value. An equation $y<=0.1e^{0.165x}$ (Equation 1) is obtained from the mean values at three flat intersections in this study.

(2) Addition of observation distance

When a P_{MMS} is observed, the MMS vehicle position is estimated by the interpolation of GPS time and the observation distance of each P_{MMS} is obtained.

(3) Creation of lines

Lines are generated by connecting the P_{MMS} at the same GPS time.

(4) Removal of long links

The long line segments that do not satisfy Equation1 are excluded.

(5) Extraction of points from edges of objects

The points of the remaining line segments with the intersecting angles nearly 90 degrees are extracted as the points forming the edge of an object. The end points of lines are extracted as the points, too. It is now called P_{EDGE}.

(6) Input of outer line

It is required for the users to input the position of the outer wall lines referring on both P_{EDGE} and the building outline. The building outline is redefined based on the entered lines. The maximum height of P_{EDGE} around the entered line is temporarily assumed as the height of this building.

(7) Input of parapets lines

It is required for the users to input the line position of the parapet based on both P_{EDGE} and the building outline. The points are extracted again from P_{EDGE} around the end of the line. It is now called P_P.

(8) Presumption of parapet positions

After P_P are collected and sorted in an ascending order, P_P are divided into groups using Equation 1. The maximum and minimum values of the group are the top height and the bottom height of the parapet, respectively.

(9) Generation of surfaces

The surface models of buildings are generated from these data.

Based on the proposed method, the authors have succeeded in developing a system to generate semi-automatically rough three-dimensional computer graphics models of the building facade on GIS. However, the present model cannot be used for a bird's-eye view or a fly-through simulation used frequently in landscape simulation because it cannot reproduce the building roof. It should

be addressed to reproduce the roof in the near future.

Keywords: building model, digital city, facade, MMS, probability