Space-Filling Curve Based Point Clouds Index

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Abstract

Managing large volume points clouds data generated from laser scanner is a challenging problem in Geographic Information System (GIS) and spatial database. Based on analyzing the pros and cons of the existing management methods, this paper presents a method to manage lidar data in databases based on the Hilbert space-filling curve. Each lidar data point (X, Y, and Z) is encoded (indexed) by the 3-D Hilbert curve. Data points are organized together according to their Hilbert codes. The initial encoding level of Hilbert curve is determined by the total number of points and the target record size. The data points are first encoded with this initial level Hilbert curve. After refining and combining processes, the data volume of each group is controlled under the desired size. One record in database represents one data group; the binary blob of the record contains all the data points in one group. Details on constructing 3-D Hilbert curve are discussed. Typical query process "window query" is implemented. Reported in this paper are results based on synthetic and real lidar data collected from ground tripod lidar and airborne lidar equipments.

1. Introduction

LIDAR (Light Detection and Ranging), including both airborne and ground-based laser scanning, is currently a widely used remote sensing technology for fast acquisition of precise and reliable 3-D spatial information. Point clouds generated from laser scanner have been used in many different geo-information areas, such as digital terrain model generation, 3-D modeling of urban environment and landscape analysis (Ackermann, 1999; Palmer and Shan, 2002).

Point clouds data can be represented as multi-dimensional arrays such as 3D (Cartesian coordinates: X, Y, Z) and 4D (Cartesian coordinates and Intensity of returned pulse). Although existing CAD and GIS software can directly import these arrays into main memory as point features, handling millions of data points usually exceeds their computing capacity. The points cloud dataset requires a significant storage capacity, and the loading time of the dataset from files or databases can be unbearable. It is crucial to provide advanced managing and query functions in lidar data handling such that the interest subset of data can be rapidly located and read from the secondary storage. Present database management (DBMS) systems do not provide a simple way to manipulate multi-dimensional arrays; the operations on arrays are very limited and not optimized (Marathe

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