LADAR Data Cloud Assimilation

An Application of Mathematical Learning Theory
to Point Cloud Estimation Using Eigenvalues

IMI Undergraduate Research Project

Problem

Assimilate sensed point clouds of data and construct approximate surfaces using Triangular Irregular Networks (TINs).

Principle Component Algorithm

Local Test Procedure:

Given a point cloud of data within a given cell.
Calculate eigenvalues of points within the cell.
Eigenvalues provide information about the shape of the point cloud within each cell and are used in the test for cell splits, *i.e.*, refinement.

Build Adaptive Piecewise Linear Approximation Using Adaptive Multiresolution:

Subdivide point cloud using a tree algorithm with cell splits determined by a local test.
Use best fitting lines or planes to approximate each subdivided point cloud.
Result is an adaptive local approximation of surface sampled by the point cloud.

Project Researchers

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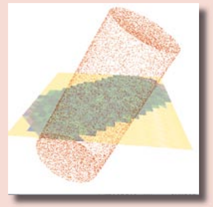
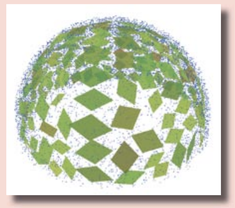
Examples

Point cloud data can be segmented based on a projection of the points onto a TIN. For each subcloud, the ratios of eigenvalues of the covariance, or correlation, matrix are used to analyze the geometric characteristics of the subcloud.



Instead of projecting onto a TIN, the data can be segmented with an adaptive subdivision algorithm. Examples of the subdivision algorithm demonstrate how surface approximations are produced using point clouds generated from the sampling of cylindrical or spherical surfaces. Points are colored based on ratios of eigenvalues. The surface is approximated by using planar segments; the size of these segments is related to the magnitudes of the two largest eigenvalues and the orientation is normal to the eigenvector corresponding to the smallest eigenvalue.

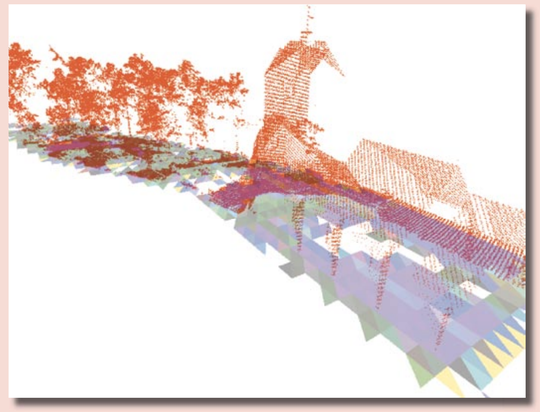


Larger ratios indicate the data is 1-D (*e.g.*, the spiral figure), while smaller ratios indicate 2-D (*e.g.*, the cylinder). Line segments, rather than planar segments, are used for the 1-D case.

Applications

When analyzing terrain data, familiar surfaces and objects such as trees and vehicles may have distinct eigenvalue relationships. Discovering these relationships through adaptive subdivision over triangular meshes can aid in detecting and extracting these objects from point cloud data.

Approximation of point clouds through the tree algorithm facilitates local surface approximations of point cloud data.



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