Nuages de Points et Modélisation 3D (NPM3D) TP2

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1 Question1

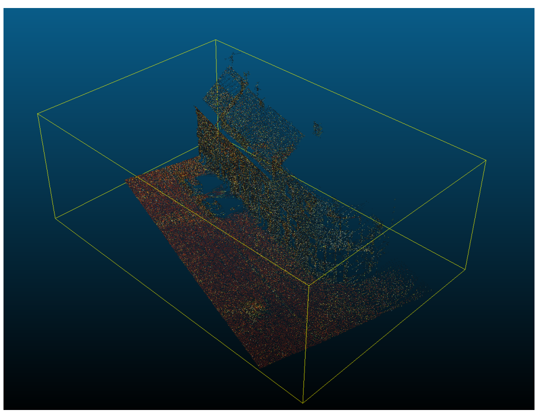

Figure 1: Normals computed with a very small radius of 0.005m

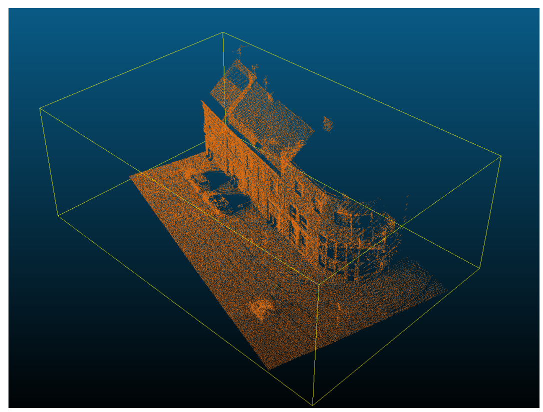

Figure 2: Normals computed with a very large radius of 50m

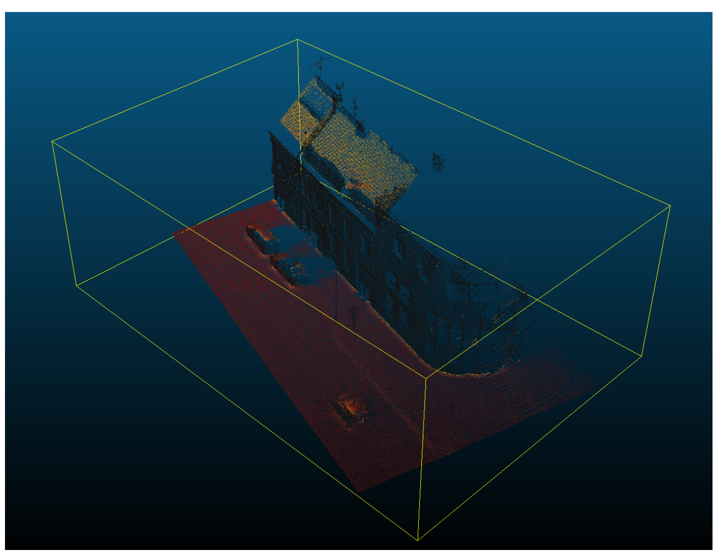

Figure 3: Normals computed with a medium radius of 0.5m

When the radius used to compute normals is too small, as illustrated in Figure 1, the resultant normal vectors can be highly irregular and may not accurately reflect the true orientation of the surface. This is primarily because the computation is influenced by a very limited context that is susceptible to noise and outliers, making the normals appear scattered or noisy. This can lead to an inaccurate representation of the surface's geometry, especially in areas where detail is critical.

Conversely, employing a radius that is excessively large for normal computation can lead to an overgeneralization of the surface features. As shown in Figure 2, the normals are excessively smoothed, resulting in a loss of critical geometric information, particularly at edges or intricate surface details. This uniformity can obscure the distinction between different planes or features, making the surface appear less detailed and more homogenized than it actually is.

2 Question2

We can start with a radius slightly larger than the average distance between points. This helps to reduce noise while preserving detail. Adjustments can be made based on the level of detail required for the task at hand and the computational resources available. The goal is to find a radius that provides the most accurate representation of the surface without unnecessary computation or loss of important geometric information.

3 Question3

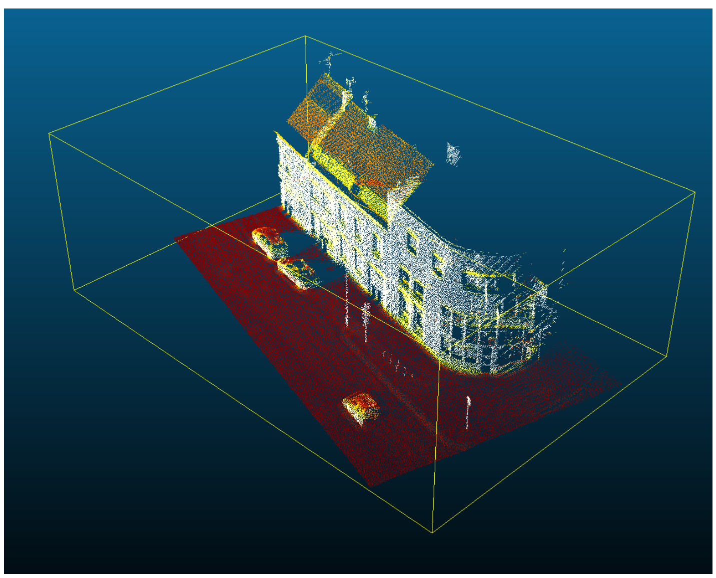

Figure 4: Normals converted as "Dip" scalar field in CloudCompare with radius = 0.50m

4 Question4

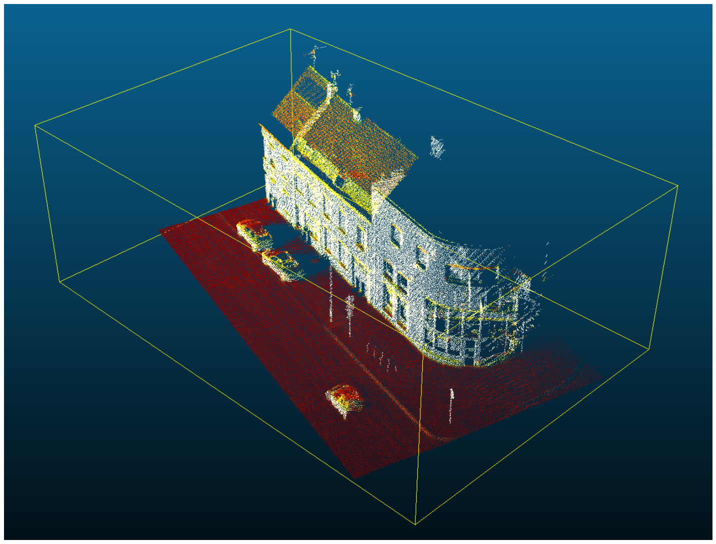

Figure 5: Normals converted as “Dip” scalar field in CloudCompare with k = 30

Differences in normal estimation using a fixed radius versus the k nearest neighbors (k-NN) method stem from their handling of point density:

Radius Method: Normals are influenced by all points within a set distance. This can cause variability, with stable normals in dense regions but potentially inaccurate ones where points are sparse due to insufficient data for reliable calculations.

k-NN Method: This technique maintains a consistent count of contributing points for each normal, ensuring uniformity in normals across regions with differing densities. While it offers more consistency, it can also introduce noise in dense regions as it doesn’t account for the actual spatial spread of points.

5 Question Bonus

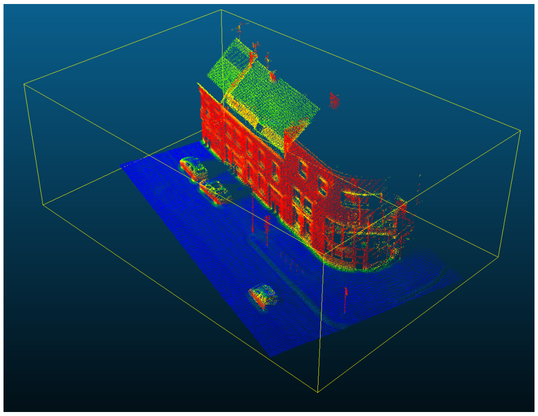

Figure 6: Verticality

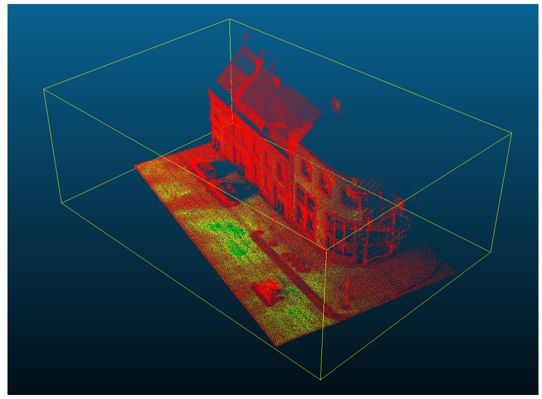

Figure 7: Linearity

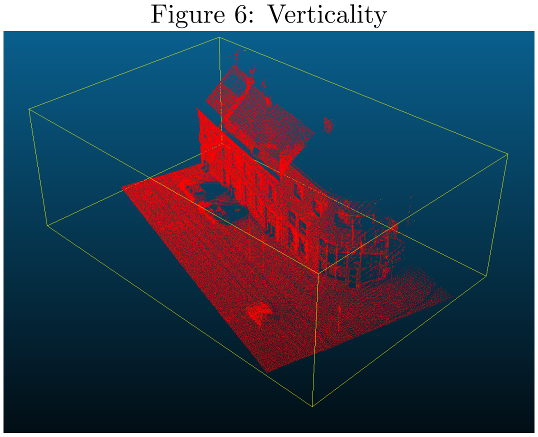

Figure 8: Planarity

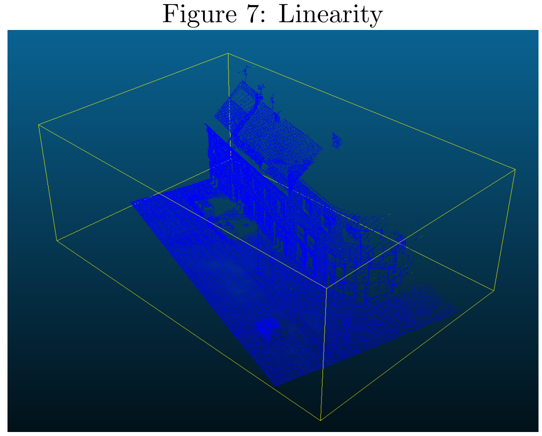

Figure 9: Sphericity

The 4 features as scalar fields of the point cloud(computed with radius = 0.50m)

To briefly explain the last three features:

Linearity: Measures how elongated a distribution of points is along a line. It is high when points are aligned in a line and low when they are not.

Planarity: Measures how much the points lie on a plane. High planarity indicates that the points form a plane-like structure.

Sphericity: Indicates how uniform the points are in all directions, resembling a sphere. Higher sphericity means the distribution of points is more spherical.