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ACCURACY EVALUATION OF THREE POINT CLOUD DOWNSAMPLING CRITERIA

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Background

- ❖ With an increase in the number of acquired points, there is a concurrent rise in both the computational burden and the time needed for point cloud denoising.
- ❖ To integrate non-contact metrological systems on an industrial scale, it is crucial to minimize raw data points while preserving essential surface information.

Objective

Evaluation of the accuracy and repeatability of three usual point cloud downsampling algorithms.

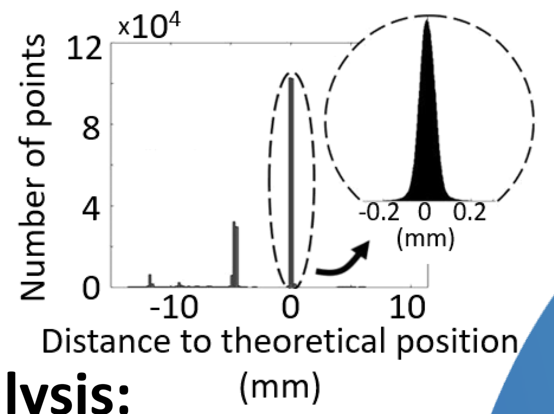
Methodology

Pre-Processing

Identify the Surface to be cleaned and remove the outliers

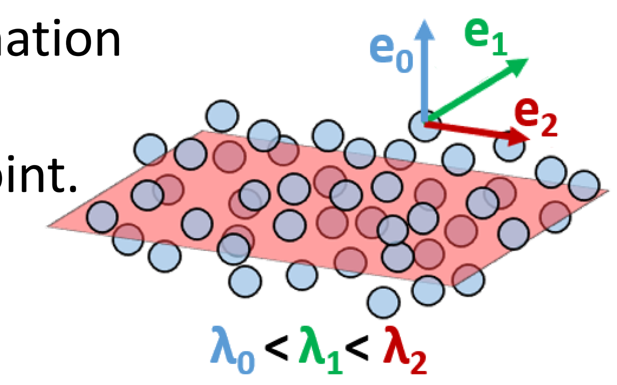
❖ Identify The Objective Surface:

From the theoretical surface position towards its local normal vector, identify the highest density areas.



❖ Principal Component Analysis:

For local normal estimation in order to compute the curvature of each point.



❖ Point Classification

Classify each point based on its similarities with its *K*-nearest neighbours.

Similar?

YES → **Median Filter** $p_{new} = p + p_m \cdot \overline{e_o}$

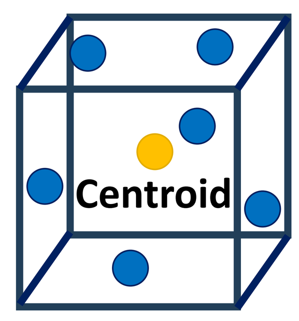
NO → **Bilateral Filter** $p_{new} = p + \alpha \cdot \overline{e_o}$

Downsampling

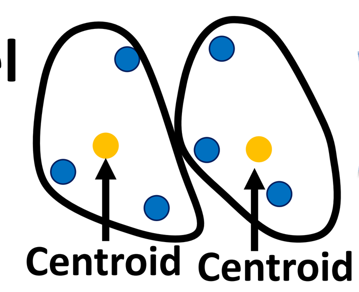
Reduce the number of points without loosing information

1. Uniform Cubic Voxelization

Voxelize the bounding-box and generate a new point cloud by means of the centroid of each voxel.

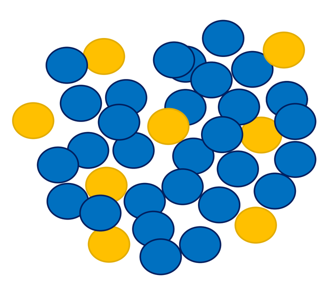


2. Similar Point Per Voxel Rate Voxelization



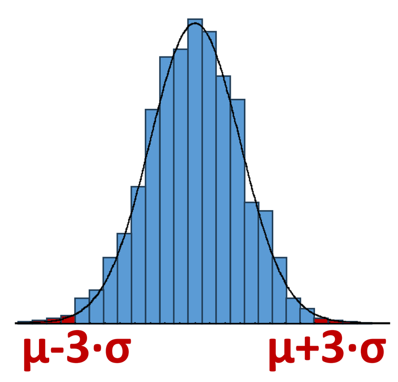
3. Random Removal

Randomly delete a percentage of the points to ensure that all the three methods have a similar number of points.

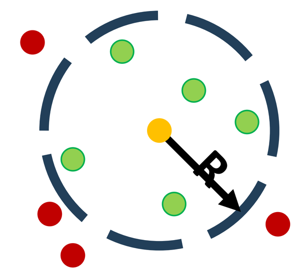


Post-Processing

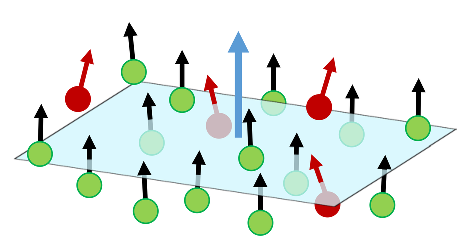
Remove the noise



Statistical Analysis

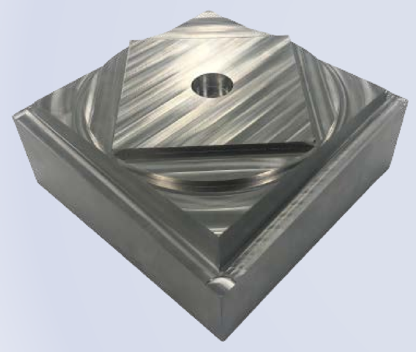


K-Nearest Neighbours



Local Normal Comparison

Materials



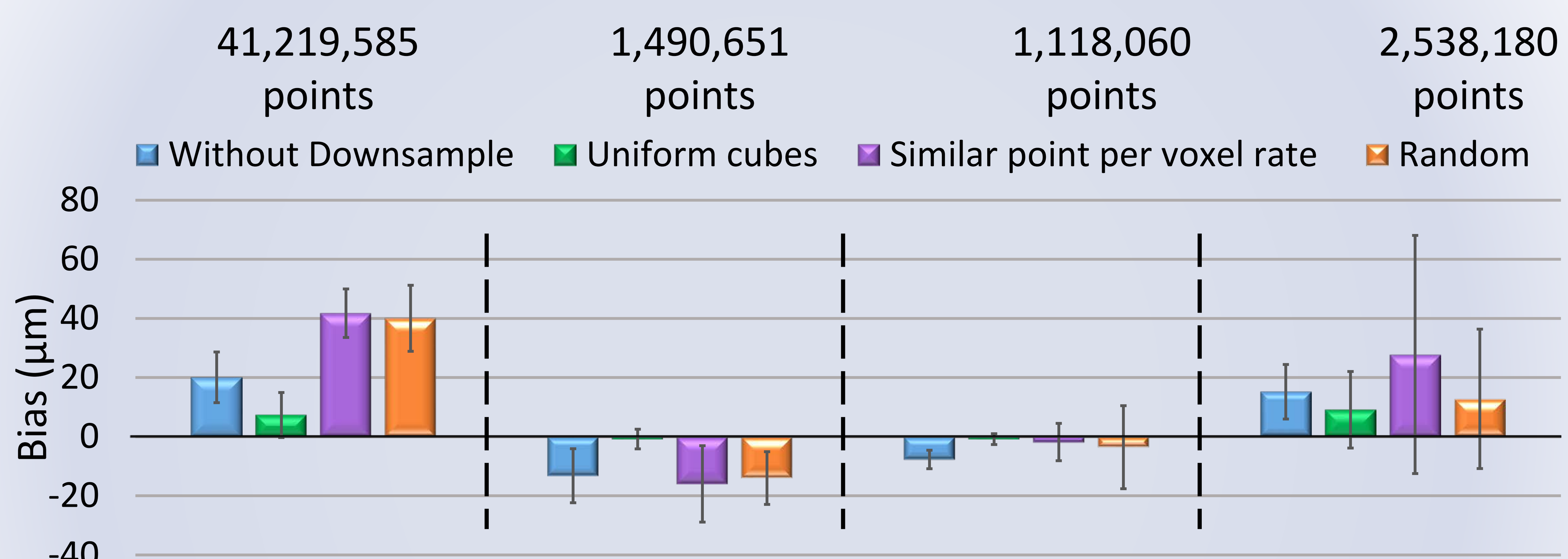
Milled NAS 979 circle-diamond-square workpiece made of AISI 304L stainless steel.
(200 mm x 200 mm x 90 mm)

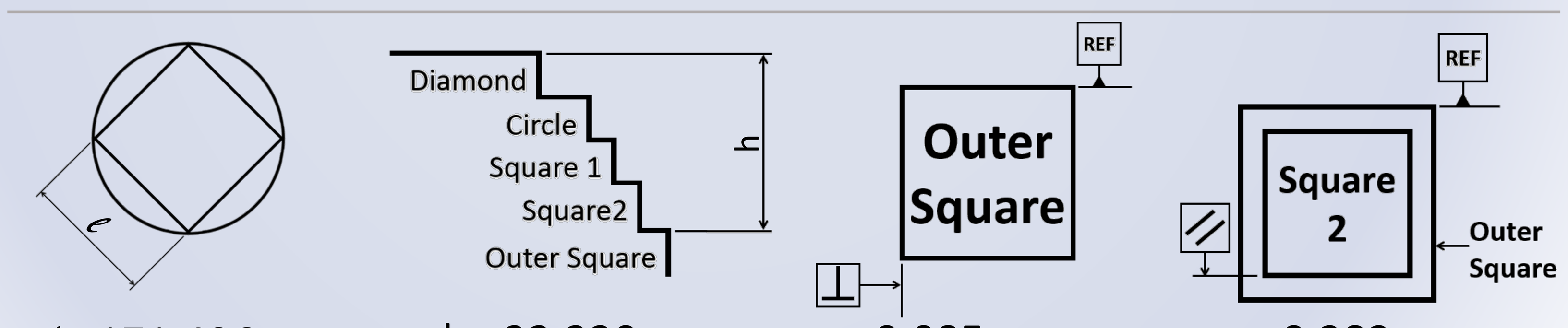
Conclusions

The uniform cubic voxelization method has proven to be the most suitable algorithm in terms of:

- ❖ Bias (72 % less than original)
- ❖ Standard deviation (19% less than the original)
- ❖ Number of points (96 % less than the original)

Results





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