Point Clouds and 3D Modelisation

TP2: Iterative Closest Points algorithm for point cloud registration

Thibaud Ardoin
Alain Riou

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Question 1 ICP performs quite almost perfectly on the perturbed bunny point cloud, but returns a quite irrelevant result with the returned bunny. In fact, since the matching algorithm takes into account the distance between points of the point clouds, the matching is in that case irrelevant.

In Notre Dame example, it seems relevant that the reference point cloud is the one which covers a larger zone (`Notre_Dame_des_Champs_2.ply`). In fact, an error in the computed rotation matrix induces a bigger error in the position of points if the point cloud is wider.

Moreover, the widest point cloud is more likely to be aligned with a third point cloud, and the error of the two point clouds with this reference point cloud would be smaller than the cumulated errors of one point cloud aligned with another which is itself aligned with a third one.

Question 2 Table 1 indicates the RMS error reached with the two perturbed point clouds.

This algorithm works better than CloudCompare ICP because it assumes that points are ordered, thus there is no

For Notre-Dame images, the algorithm cannot be run since reference and perturbed point clouds are expected to have the same number of points.

Reference point cloud	**Perturbed point cloud**	**RMS**
`bunny_original.ply`	`bunny_perturbed.ply`	9.841×10^{-9}
`bunny_original.ply`	`bunny_returned.ply`	1.751×10^{-8}

Table 1: RMS error obtained with different point clouds.

Question 3 RMS error for both point clouds is plotted on figure 1.

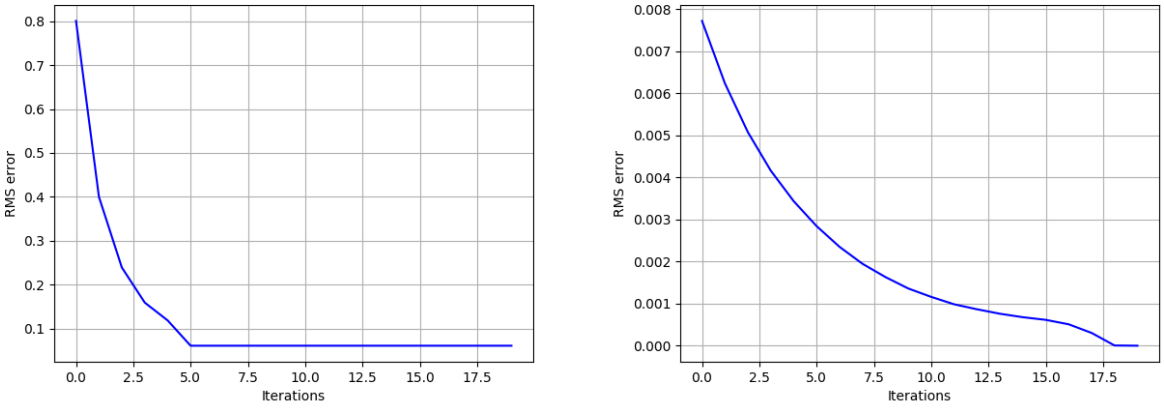

Figure 1: RMS error convergence during ICP algorithm. Left: 2D reference point clouds. Right: bunny point clouds.

Question 4 Figure 2 shows the RMS error obtained with different sampling limits. Compared to previous point clouds, error seems very high, but alignment is in practice quite accurate. It seems that increasing the number of points reduces the variance of the RMS error, however it does not diminish the error itself.

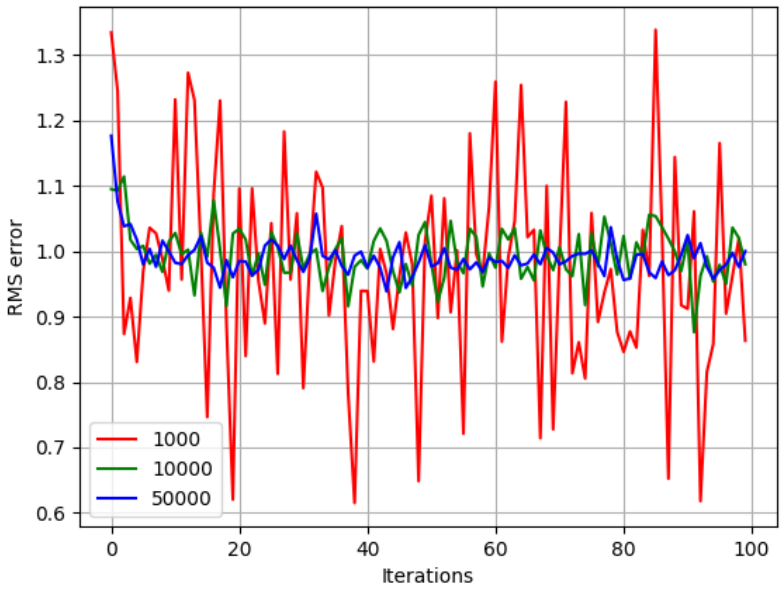

Figure 2: RMS error reached during stochastic ICP algorithm, with different sampling limits.

Question 5 Looking at CloudCompare representation of the two point clouds, it seems that farthest points correspond to regions that are present only in one point cloud over two. Therefore, trying to align all points is doomed to failure since exists non corresponding points.

Similarly, RMS error on the whole point cloud is a quite irrelevant indicator of ICP performance, since non-matching points are *a priori* far one from the other, and that even an ideal alignment algorithm could not reach a RMS error of 0.