TP2 Iterative closest point algorithm for point cloud registration

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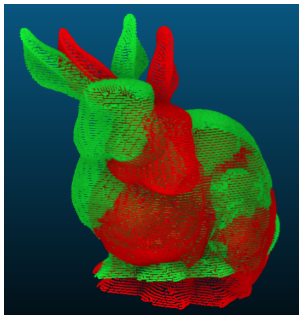
January 2025

1 Answer 1

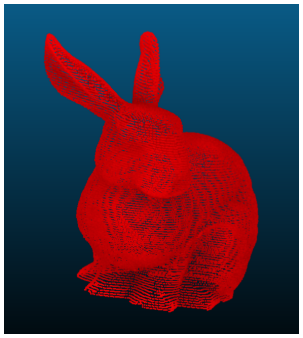
ICP performs really well on the bunny and perturbed bunny point clouds as you wan see in Figure 1. This is because ICP is a local matching algorithm (It works well for close point clouds).

However, we can see that it doesn't work that well on Figure 2 where we tried to match the original bunny with a reversed bunny. As mentionned in the last course, ICP doesn't perform well when the point cloud has been rotated by more than 90 degrees.

For the Notre-dame-des-champs point clouds, I think Notre_Dame_Des_Champs_1 should be the reference, because it's the largest point clouds, and Notre_Dame_Des_Champs_2 is a simple subset of this point cloud that has been slightly perturbed. Figure 3 shows what has been obtained, the algorithm didn't work for this problem.



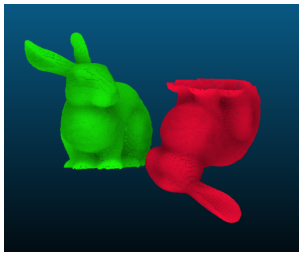
(a) Bunny original and bunny perturbed.



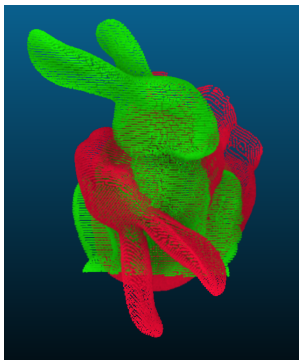
(b) Bunny original and bunny perturbed after rigid icp.

Figure 1: Comparison of the bunnies before and after ICP. Original bunny is showed in green, and the perturbed bunny is showed in red. I choose the perturbed bunny as reference.

[h]

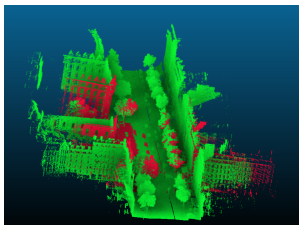


(a) Bunny original and bunny reversed.

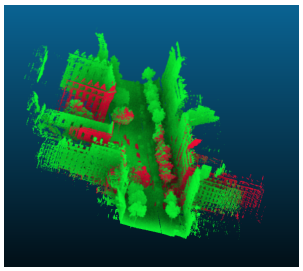


(b) Bunny original and bunny reversed after icp.

Figure 2: Comparison of the bunnies before and after ICP. Original bunny is showed in green, and the perturbed bunny is showed in red.



(a) The two Notre-dame-des-champs.



(b) The two Notre-dame-des-champs after rigid transformation.

Figure 3: Comparison of the Notre-dame-des-champs before and after ICP. Notre_Dame_Des_Champs_1 is shown in green, and Notre_Dame_Des_Champs_2 is shown in green in red.

2 Answer 2

In Figure 4, we remark that reversed bunny is exactly aligned with original bunny. My hypothesis of why my algorithm works better than clouds compare's is because we suppose we begin with the points already matched (perfect matching) while clouds compare computes nearest neighbors, which is misleading since the bunny is reversed. Thus, we can deduce that this function will not align Notre dame des champs since the two point clouds are not matched by construction (they are not even the same size).

We would need many iterations of rigid transformation to reach a satisfying alignment for this problem.

- The RMS score before ICP is 0.161.
- The RMS score after ICP is 0.000.

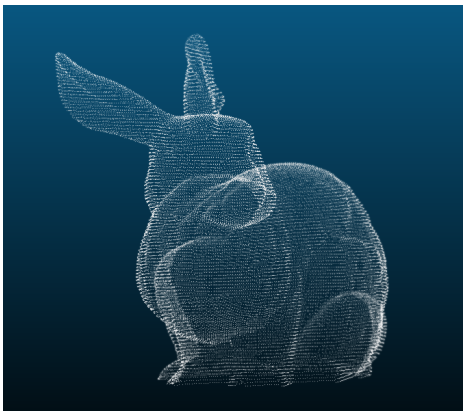
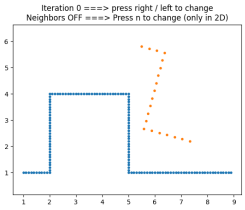


Figure 4: Original bunny and reversed bunny after rigid transformation.

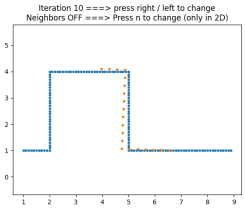
3 Answer 3 & 4

Figures 5 6 show us what the algorithm did.

Figure 7 shows us the evolution of the RMS score for the two point clouds. We can see that the curve problem starts with a higher RMS than the bunny problem, it's due to the fact that the bunnies start very close to each other, whereas the curves are very different at iteration 0. Otherwise, the evolution of RMS is normal, and seems to present slower convergence for bunny problem (which is normal since there a lot of points).



(a) At the start of the algorithm.

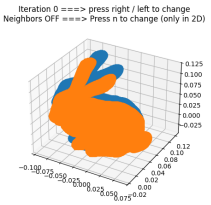


(b) At the end of the algorithm.

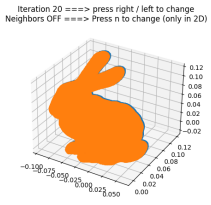
Figure 5: Comparison of the curves between the start and the end of the algorithm.

4 Bonus question

Figure 8 shows the RMS evolution according to the size of the dataset considered at each iteration. We can see that the more the size grows, the more stable is the evolution of the RMS. Figure 9 shows the result obtained for size 100k.

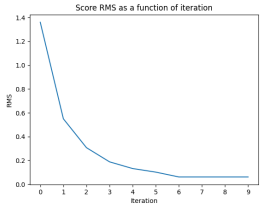


(a) At the start of the algorithm.

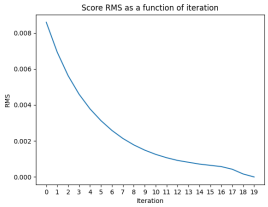


(b) At the end of the algorithm.

Figure 6: Comparison of the bunnies between the start and the end of the algorithm.

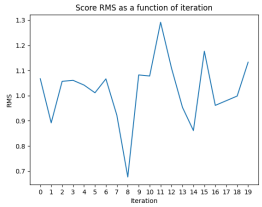


(a) Evolution of RMS for toy problem (plateau curve).

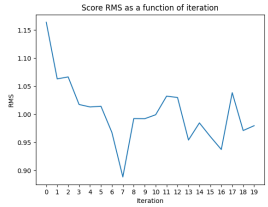


(b) RMS score for bunny problem.

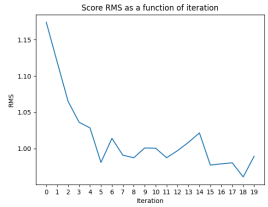
Figure 7: Curves of RMS score as function of the number of iterations for ICP



(a) RMS score for size 1000.



(b) MS score for size 10k.



(c) MS score for size 100k.

Figure 8: Comparison of the curves between the start and the end of the algorithm.

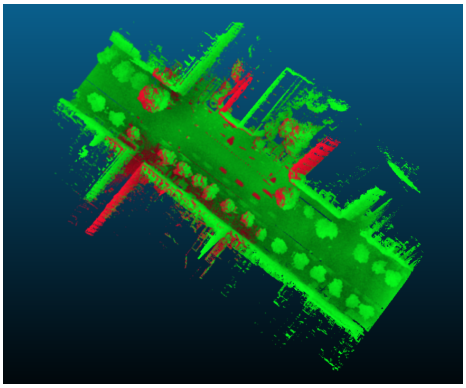


Figure 9: Notre dame des champs after ICP considering 100k for neighborhood