Sampling Relevant Points for Surface Registration

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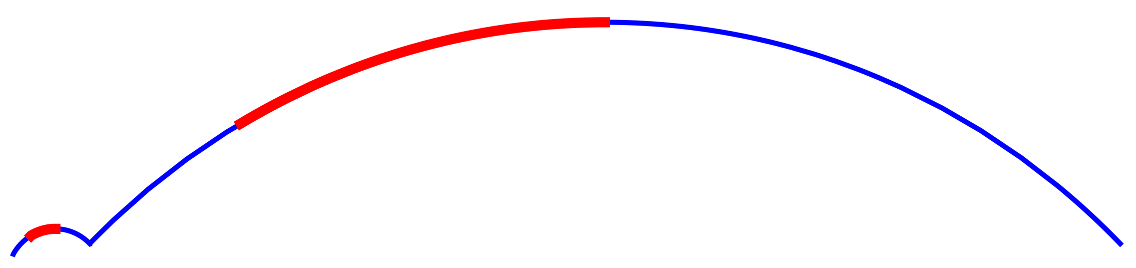
Addressed Problem

The selection of relevant points is a very important issue for any implementation of the ICP algorithm.

The **Uniform sampling** strategy does not properly account for surface features.

The **Normal-Space sampling** technique tries to introduce some constraints to the registration algorithm by selecting points from a wide range of orientations.

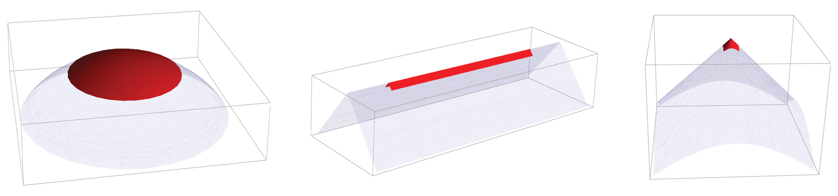
Still, both these methods are unable to distinguish between large areas of uniform curvature and small, distinctive patches that are more likely to help ICP in avoiding translational and rotational drifting.



Relevance-Based Sampling

In our approach the relevance of a point *p* is related to how many similar points are around it. Specifically, we associate to *p* the region:

$$A_p = \{q \in S | N_p^T N_q > T \text{ and } p \sim q\}$$



where N_p and N_q are the normals of the surface *S* at points *p* and *q*, and $p \sim q$ means that the points are connected by a path. *T* is a threshold parameter of the approach that can be used to modulate the spreading of the similarity region.

The distinctiveness of a particular point can be computed as a function of the area of the similarity region:

$$\hat{f}(p) = |A_p|^{-k}$$

where *k* is an equalization parameter that modulates the relative weight of "common" and "distinctive" points.

Actual sampling happens over the cumulative distribution built on any ordering of the points :

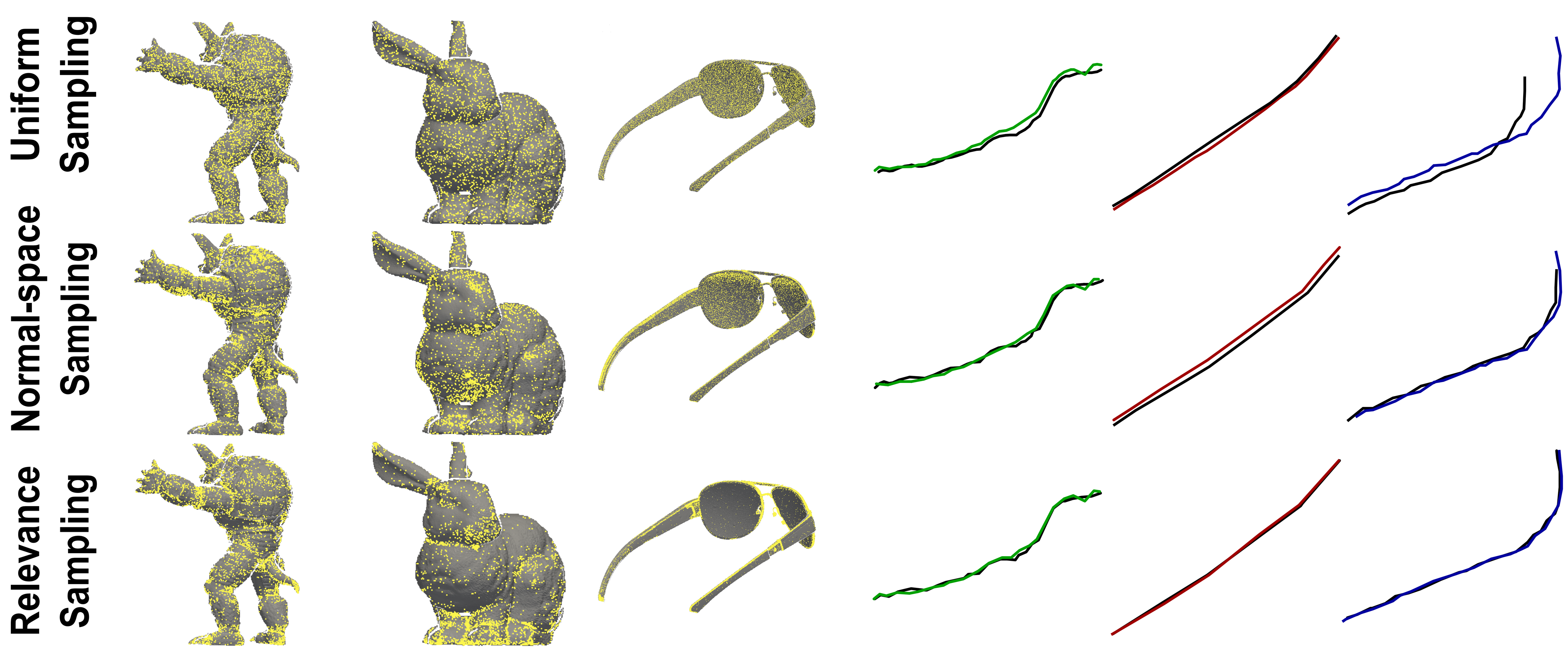
$$\hat{F}(p_i) = \sum_{j=1}^{i} \hat{f}(j)$$

Qualitative Experimental Results

All the experiments have been performed on synthetic range images produced by using a virtual range sensor on objects from the Stanford 3D scanning repository, subject to different levels of positional Gaussian noise.

Qualitative tests show that the proposed sampling method is able to achieve better pairwise registrations than both uniform sampling and normal-space sampling.

Selected points | **Slices of registered range images**



Quantitative Experimental Results

Quantitative experiments are evaluated by assessing translational and rotational errors with respect to the ground-truth. The study of the sensitivity of the threshold *T* shows that the best value is around 10 degrees. The best value for the equalization parameter *k* seems to be a bit below 1.0

The enhanced performance of the proposed method with respect to other widely used techniques is confirmed also by quantitative comparisons.