A test bench to improve registration using RGB-D sensors

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Depth cameras (RGB-D) can provide dense 3D point clouds at a high frequency. Using the ICP algorithm, these point clouds can be matched to deduce the transformation between them and consequently the 6 degrees-of-freedom motion of the camera. This allows to build a tracker that can be used, for instance, as a front-end to a SLAM system.

However, as shown by the large amount of papers recently published on ICP, this algorithm has many variations, each of them depending on several parameters. To explore this large possibility space, we provide two contributions:

- A real-time tracker of the pose of a RGB-D sensor[1]. The latter takes as input a stream of point clouds and outputs an estimation of the 3D pose of the sensor. To avoid drift due to the high frame rate of the input (30 Hz), this tracker holds a single reference and matches every incoming point cloud against it. If the ratio of matching points drops below a pre-defined threshold, the tracker creates a new reference with the current cloud.

  ICP consists of performing several sequential steps, both inside and outside a main iteration loop. For each step, there exist several strategies, and each strategy demands specific parameters. Current works provide no easy way to compare these strategies. To enable such a comparison, the tracker employs a modular ICP chain, which is fully configurable through text-based parameters[2].

- A dataset of 27 runs containing point clouds produced by a Kinect along ground truth from a Vicon[3]. These runs cover 3 environments of increasing complexity. For each complexity, an operator performs 3 types of motion: translations on the three axis, rotations on the three axis and a free fly motion over the scene. For each environment, the operator performs each type of motion at 3 different speeds.

We expect these contributions to enable the community to improve the understanding of what are the critical parameters to produce a precise and fast tracking using RGB-D sensors[4].

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[1]The tracker is available from `http://www.ros.org/wiki/modular_cloud_matcher`

[2]The ICP-chain library is available at `http://github.com/ethz-asl/libpointmatcher`

[3]This dataset is available at `http://www.asl.ethz.ch/research/datasets`

[4]A video of our work is available at `http://www.youtube.com/watch?v=McxpJGOZTPs`