The HILTI SLAM Challenge
NPM3D Team: CT-ICP elastic LiDAR Odometry

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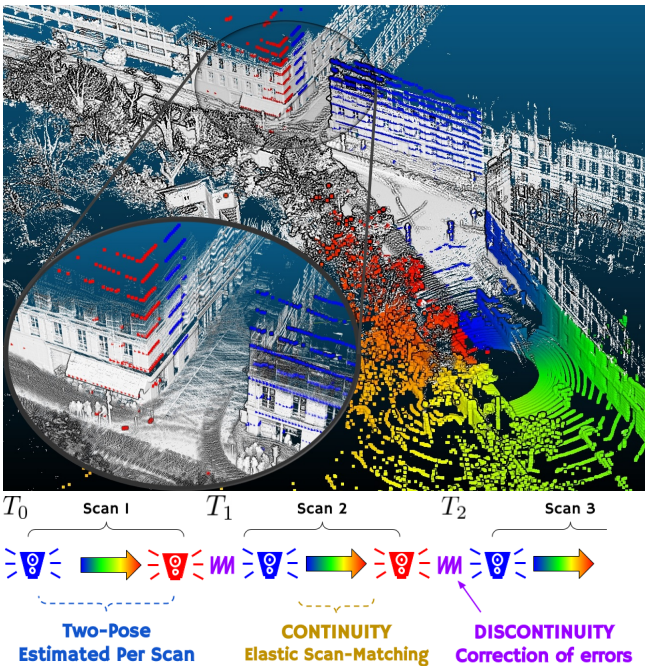

Figure 1: *Top, in color, one LiDAR scan; the color depends on the timestamp of each point (from the oldest in blue to newest in red). The scan is deformed elastically to align with the map (white points) by the joint optimization of two poses at the start and end of the scan and interpolation according to the timestamp, hence creating a continuous-time scan-to-map odometry. Below, the formulation of our trajectory with a continuity of poses intra-scan and discontinuity between scans.*

Here is a report for our participation in the HILTI SLAM Challenge of the IROS2021 workshop "Perception and Navigation for Autonomous Robotics in Unstructured and Dynamic Environments".

This is a work from the NPM3D team of the Center of Robotics at MINES ParisTech - PSL University.

We used an odometry method called CT-ICP based only on LiDAR data from Ouster OS0-64.

Here are some details on the method used:

- This is a scan-to-map based registration method. The principle of CT-ICP is to use an elastic formulation of the trajectory, with a continuity of poses intra-scan and discontinuity between scans, to be more robust to high frequencies in the movements of the sensor.
- The method is causal, i.e. it only uses past information. With each new scan, we try to optimize the current trajectory with the map in the form of a point cloud from the previous scans stored in a sparse voxel type structure.
- There is no Bundle Adjustment, nor Loop Closure. We have the possibility of doing loop closures (using elevation images from the scans) but in our experiments, this improves the trajectory only during long driving sequences as in KITTI or KITTI-360.
- The processing time is approximately 500 ms per scan, which gives a method 5 times slower than real time. It is possible to speed up the calculations and have a real-time method by reducing the number of samples taken in each scan (at the cost of a small loss in the precision of the trajectory).
- The same parameters were used for all sequences.

A publication of the CT-ICP method is in progress with a code in C++ which will be available online in open source: https://github.com/jedeschaud/ct_icp, as well as a pyLiDAR-SLAM framework in Python with loop closure already available at: https://github.com/Kitware/pyLiDAR-SLAM.