Basalt Performance Evaluation on 2020 FPV Drone Racing VIO Dataset

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I. System Overview

We use the Basalt [2] system developed by our group. Basalt focuses on providing the tools for visual-intertial calibration, odometry and mapping. The proposed system is optimization based, casual and performs sliding-window bundle adjustment. For the submitted results loop closures were not used. It uses the stereo images and IMU to determine the trajectory.

The code is available open-source. For more details please check:

https://vision.in.tum.de/research/vslam/basalt

II. Calibration

Before using Basalt for estimating the trajectory we run the calibration using the sequences from the dataset (Basalt calibration documentation). We use the double-sphere camera model [1] for camera intrinsics. We estimate parameters of the model together with camera-to-IMU extrinsics, IMU biases, IMU scaling and IMU axis skew. We also estimate a constant time offset between IMU and camera timestamps based on the calibration sequence.

III. Timing

We evaluate our system on a desktop PC with an Intel Core i7-8700K CPU running at 3.70GHz, 32 GB of memory and an SSD. The system runs on Ubuntu 20.04 without GPU acceleration. Our system is well parallelized and uses all available CPU cores. The timing for the processed sequences is provided in Table II.

Sequence	Timing [s]
indoor_forward_11	13.7
indoor_forward_12	10.3
indoor_45_3	13.2
indoor_45_16	7.3
outdoor_forward_9	17.3
outdoor_forward_10	21.9

TABLE I
PROCESSING TIME FOR EACH OF THE SEQUENCES.

IV. Parameters

The calibration parameters are not optimized online and are fixed for all corresponding sequences. We constrain our sliding window to operate on 7 keyframes and 3 temporal frames. For visual observations we use Huber norm with the threshold of 1 pixel. To initialize new keypoints we run the FAST detector inside a 30×30 pixel grid cell on the image if it does not contain a keypoint from the previous frames. This ensures even distribution of keypoints in the image.

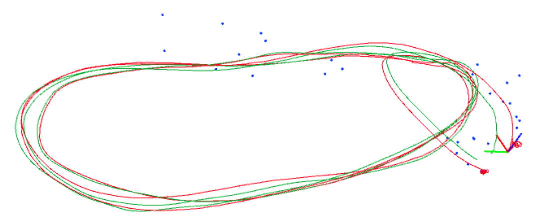

Fig. 1. Ground truth (green) and estimated (red) trajectory on the *indoor_45_4* sequence using the proposed method.

For the IMU we use the following parameters:

Parameter Name	Value
acc. white noise	0.1
acc. random walk	0.002
gyro. white noise	0.05
gyro. random walk	0.00004

TABLE II
IMU PARAMETERS.

References

[1] Vladyslav Usenko, Nikolaus Demmel, and Daniel Cremers. The double sphere camera model. *2018 International Conference on 3D Vision (3DV)*, Sep 2018.

[2] Vladyslav Usenko, Nikolaus Demmel, David Schubert, Jorg Stuckler, and Daniel Cremers. Visual-inertial mapping with non-linear factor recovery. *IEEE Robotics and Automation Letters*, 5(2):422–429, Apr 2020.