Benchmarking at Metaio

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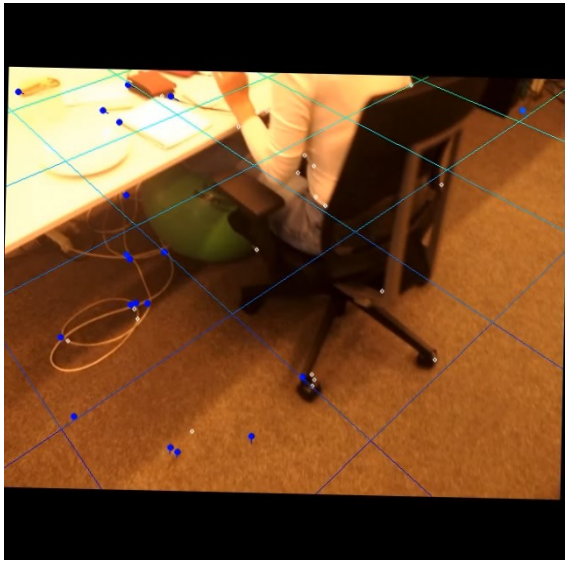
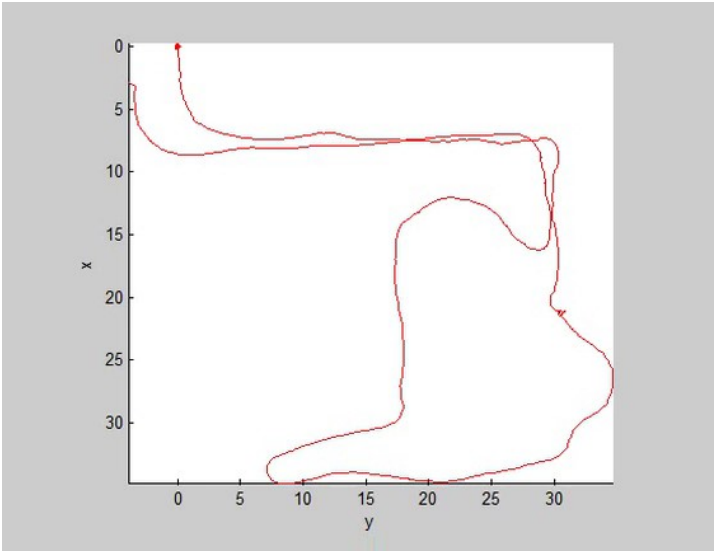
Metaio SDK

- SDK for developers to create augmented reality apps
- Supports iOS, Android, Windows, Unity
- Provides efficient implementations for
  - Marker-based 3D tracking
  - Template-based 3D tracking
  - Sparse visual odometry
  - Sparse SLAM (feature-based, local+global bundle adjustment, relocalization, uses depth if available)
  - Edge-based tracking (known CAD model)
  - Dense visual odometry
  - Visual inertial sparse odometry

Sparse inertial visual odometry (SIVO)

- Kalman filter-based approach
  - IMU is used in prediction step
  - Feature tracks are used in correction step
- Very robust, efficient, metrically correct





This Talk

- How do we evaluate these algorithms at Metaio?
- How do we track and compare their performance?

Public Datasets

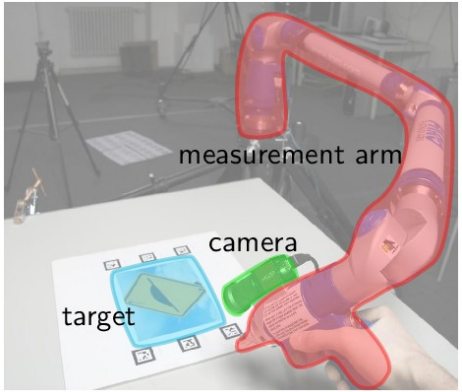
- Dataset for template-based methods
  [Lieberknecht et al., ISMAR 2009]

- Outdoor dataset for 3D camera localization
  [Kurz et al., ISMAR 2013]

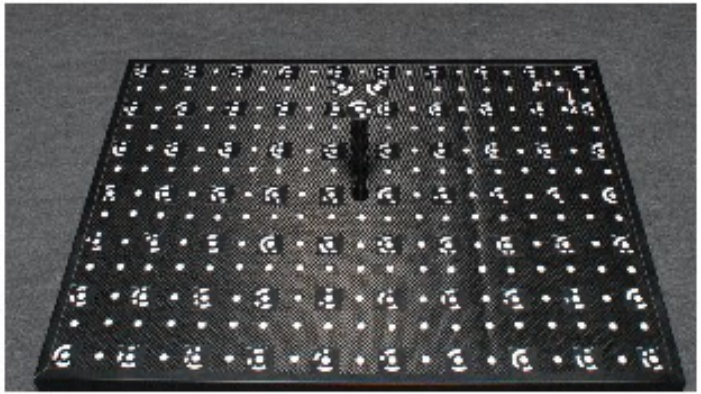
- TUM RGB-D benchmark for visual odometry and SLAM
  [Sturm et al., IROS 2012]

Dataset for template-based methods [Lieberknecht et al., ISMAR 2009]

- Color images acquired by a AVT Guppy camera, 640x480, 40Hz
- Camera pose from Faro Arm, 250Hz, 0.013mm precision
- Calibration
  - Luhmann camera model (pre-rectified), 0.065px residual
  - Hand-eye calibration and time synchronization from visual markers



Setup



Luhmann camera calibration

Template with visual markers

Dataset for template-based methods [Lieberknecht et al., ISMAR 2009]

- Textures: low, repetitive, normal, high textured targets
- Five different camera motions, 40x1200 images + poses
- Available at http://metaio.com/research

Outdoor dataset for 3D camera localization [Kurz et al., ISMAR 2013]

- High quality 3D scan from Faro laser scanner
- Images+IMU+GPS recorded using iPhone at 25 Hz
- Calibration
  - 3D position estimated by geo-referencing
  - High-quality edge-based registration with 3D scan to obtain 3D orientation

3D scan

data acquisition

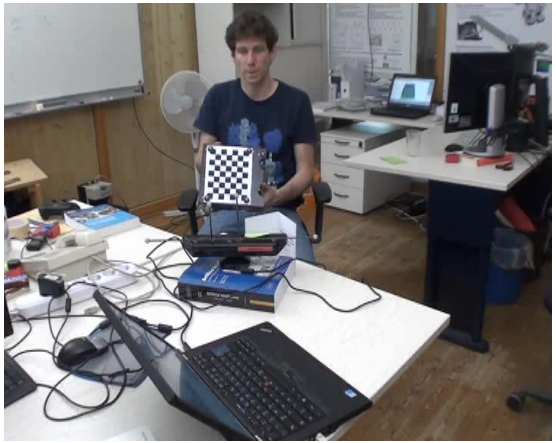
registration

TUM RGB-D benchmark [Sturm et al., IROS 2012]

- Ground truth from motion capture system at 300 Hz
- RGB-D frames from Kinect camera at 30 Hz
- Calibration: intrinsic, extrinsic, time synchronization

Camera with markers

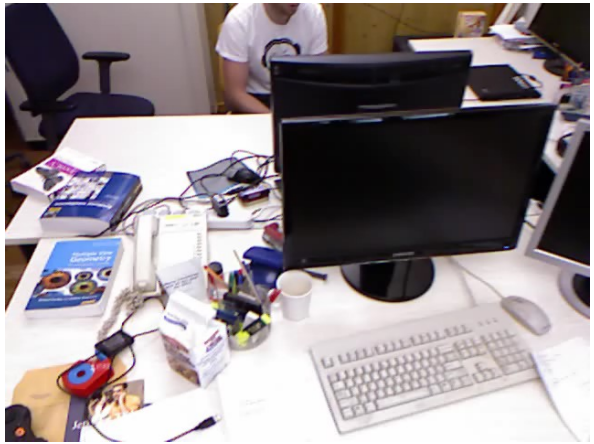
Mocap calibration



Camera calibration

TUM RGB-D benchmark [Sturm et al., IROS 2012]

- 52 sequences
- Variation in camera speed/scenes/illumination/…
- Evaluation tools (Python scripts)
- Available at http://vision.in.tum.de/data/datasets/rgbd-dataset

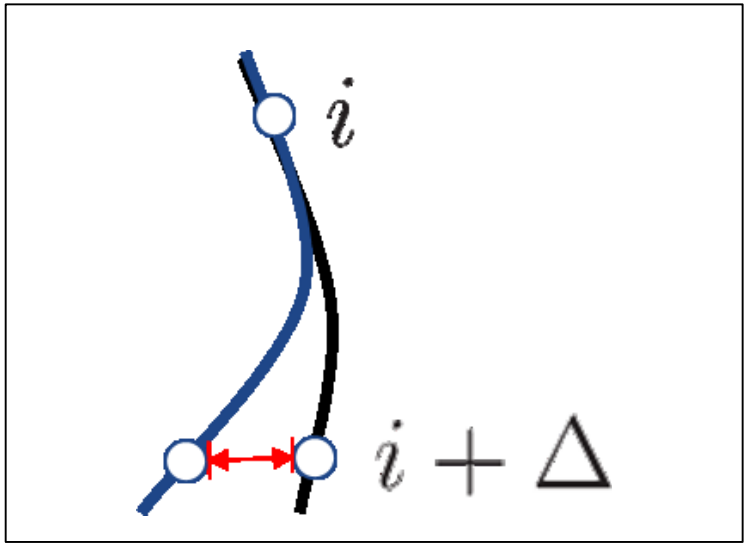


Sequence fr1/xyz

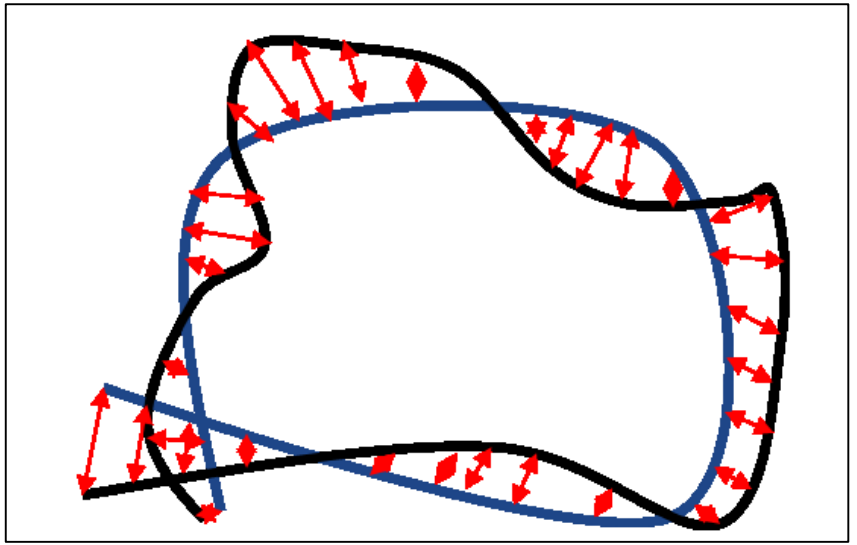
Sequence fr3/long_office

Evaluation Metrics

- Drift [m/s]
- Absolute trajectory error [m]
- Computation time per frame

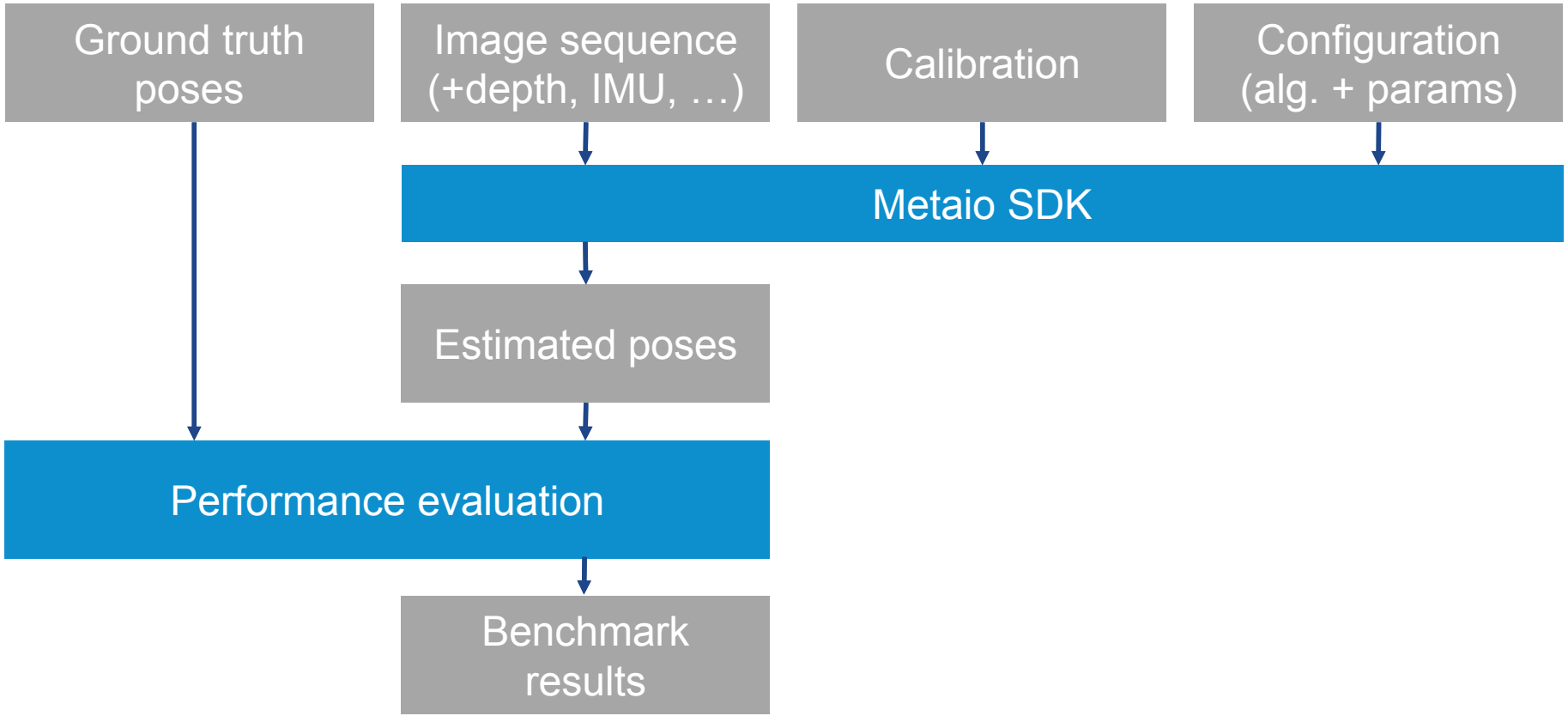


Drift



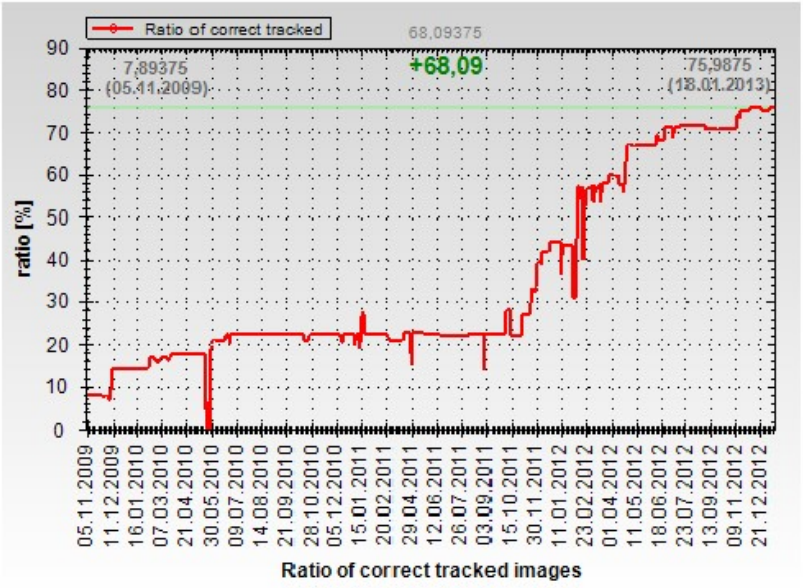
Absolute trajectory error

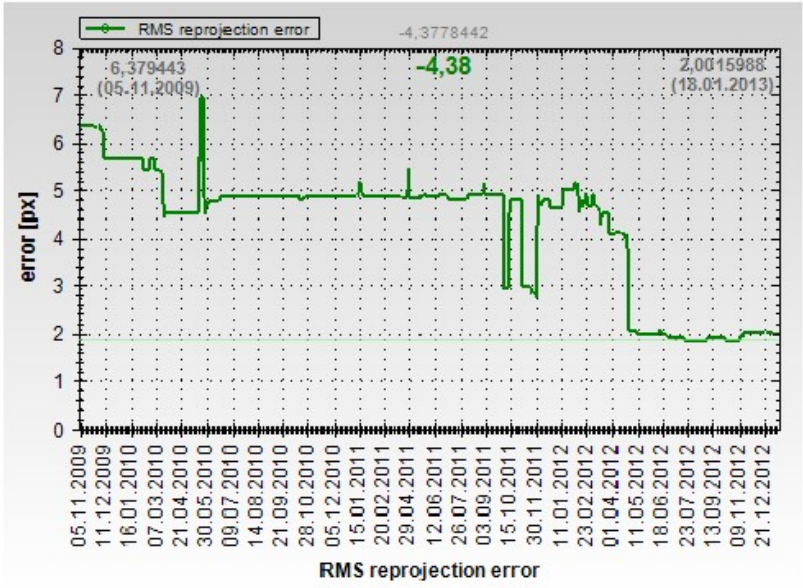
Evaluation Pipeline at Metaio



Benchmarking at Metaio

- Daily automatic evaluation of our algorithms on build farm
- Performance database, interactive plots, web interface (internal)
- Weekly quality meetings to discuss evaluation results (+other metrics)





Conclusion

- Benchmarking is key at Metaio to deliver a high quality vision product
  - Datasets
  - Evaluation metrics
  - Benchmarking
- Public datasets ease performance comparison
- Novel algorithms/sensors typically require new datasets
- Evaluation metrics sometimes application dependent (need standardization)

Metaio supports the community by providing suitable datasets and benchmark procedures.

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