



Visual SLAM

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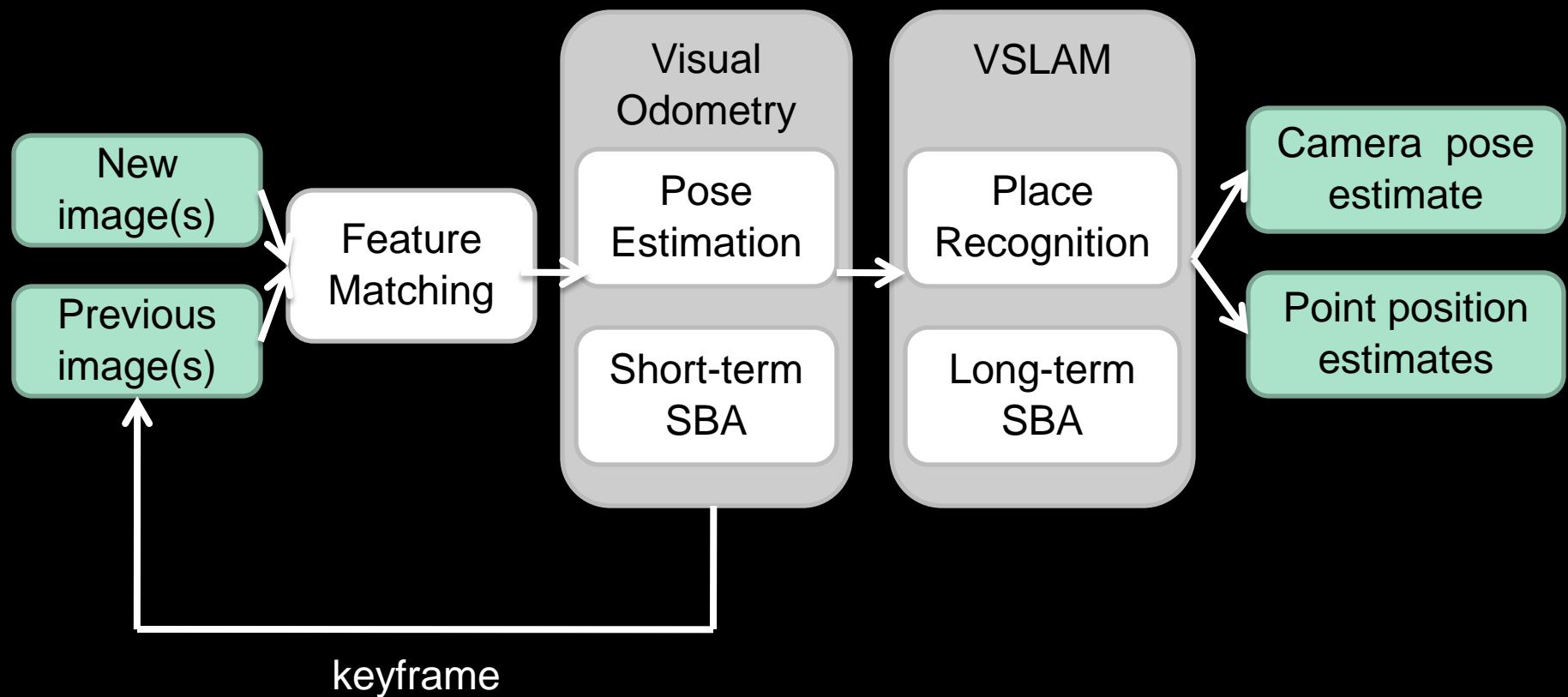
What is Visual SLAM?

- SLAM
 - Simultaneous localization and mapping
 - Create a map of environment while localizing within that map
- VSLAM vs. GSLAM
 - 3D instead of 2D
 - Images instead of laser scans

Components

- Feature detection/matching
 - Find keypoints in image
 - Match to keypoints in other images
- Visual odometry
 - Pose estimation from matched features between images
- Sparse bundle adjustment (SBA)
 - Large-scale optimization on 3D point positions and camera poses
- Place recognition
 - Finding matches between current frame and a set of previous frames
 - Loop closure

System Overview



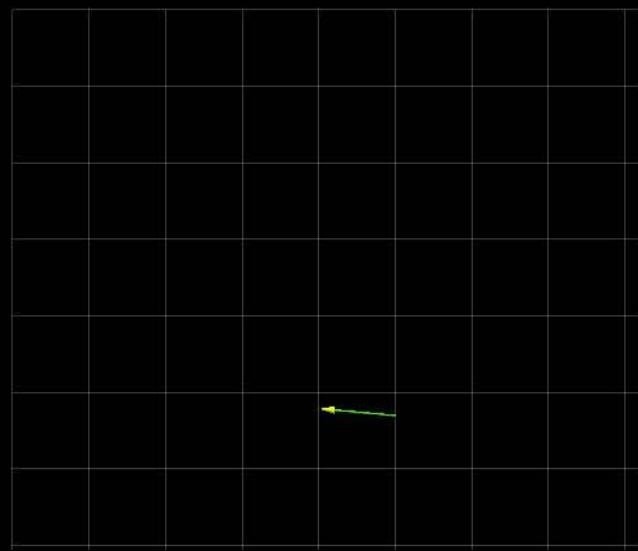
What I Did This Summer

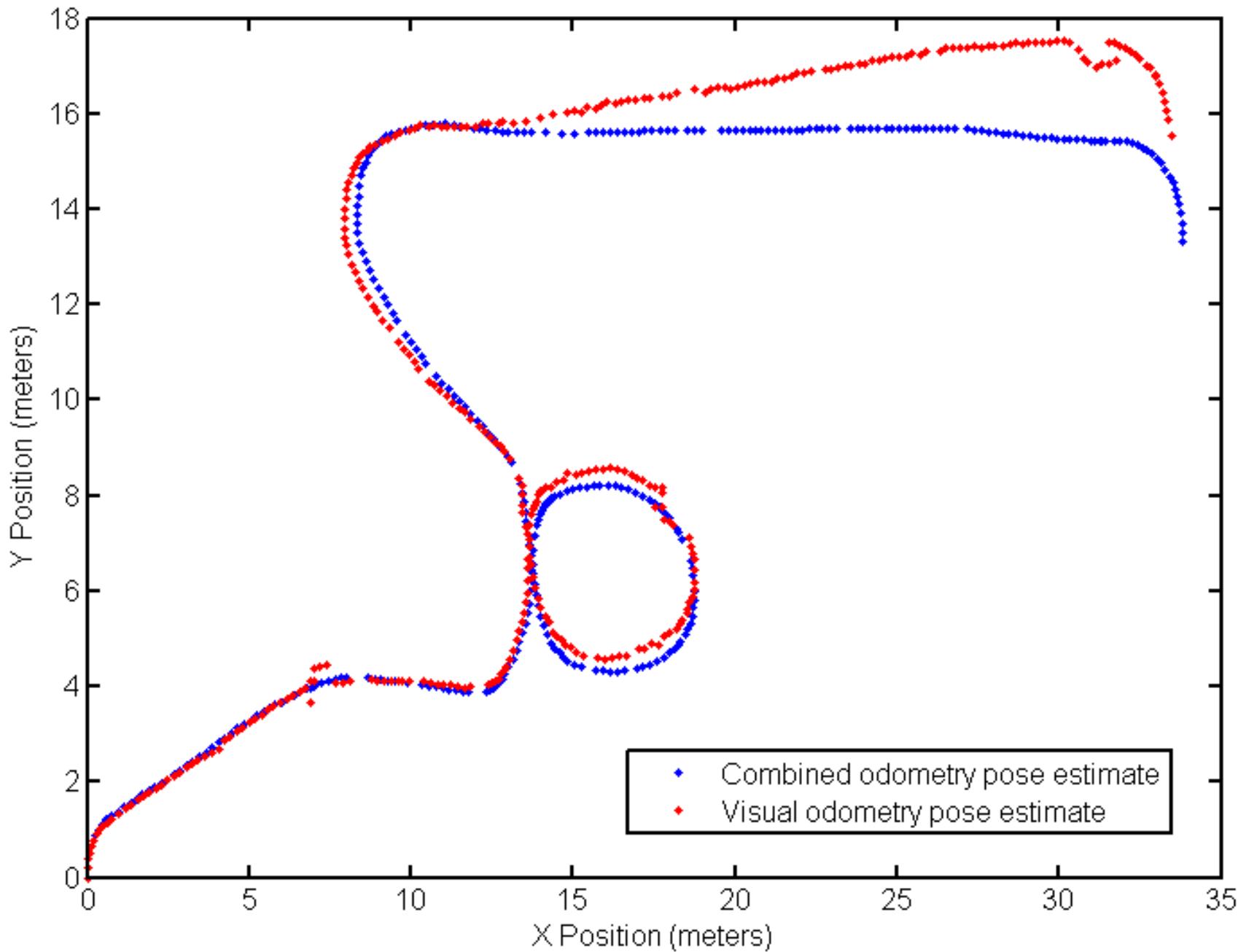
- Learned about SBA, VSLAM, ROS, etc.
- API Revisions
 - Library-level design
 - Indexing structure
 - Representation of projections within SBA
- Documentation
- Released vslam stack to 0.1

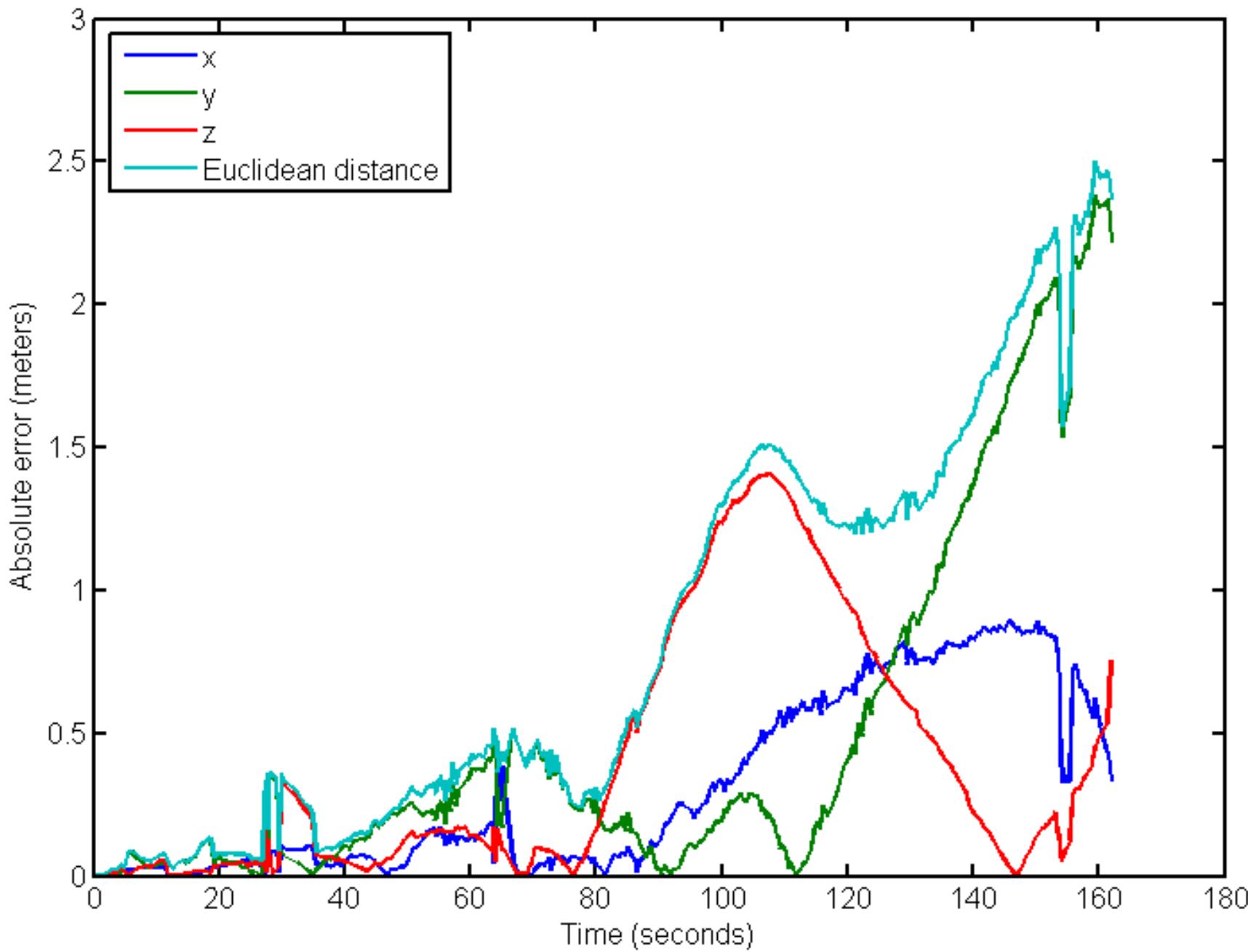
What I Did This Summer

- ROS Integration
 - Standalone nodes
 - SBA
 - Stereo VSLAM
 - Visual Odometry
 - Integration with navigation stack
 - Publish odometry to robot_pose_ekf
 - Publish TF
- Pointcloud data integration

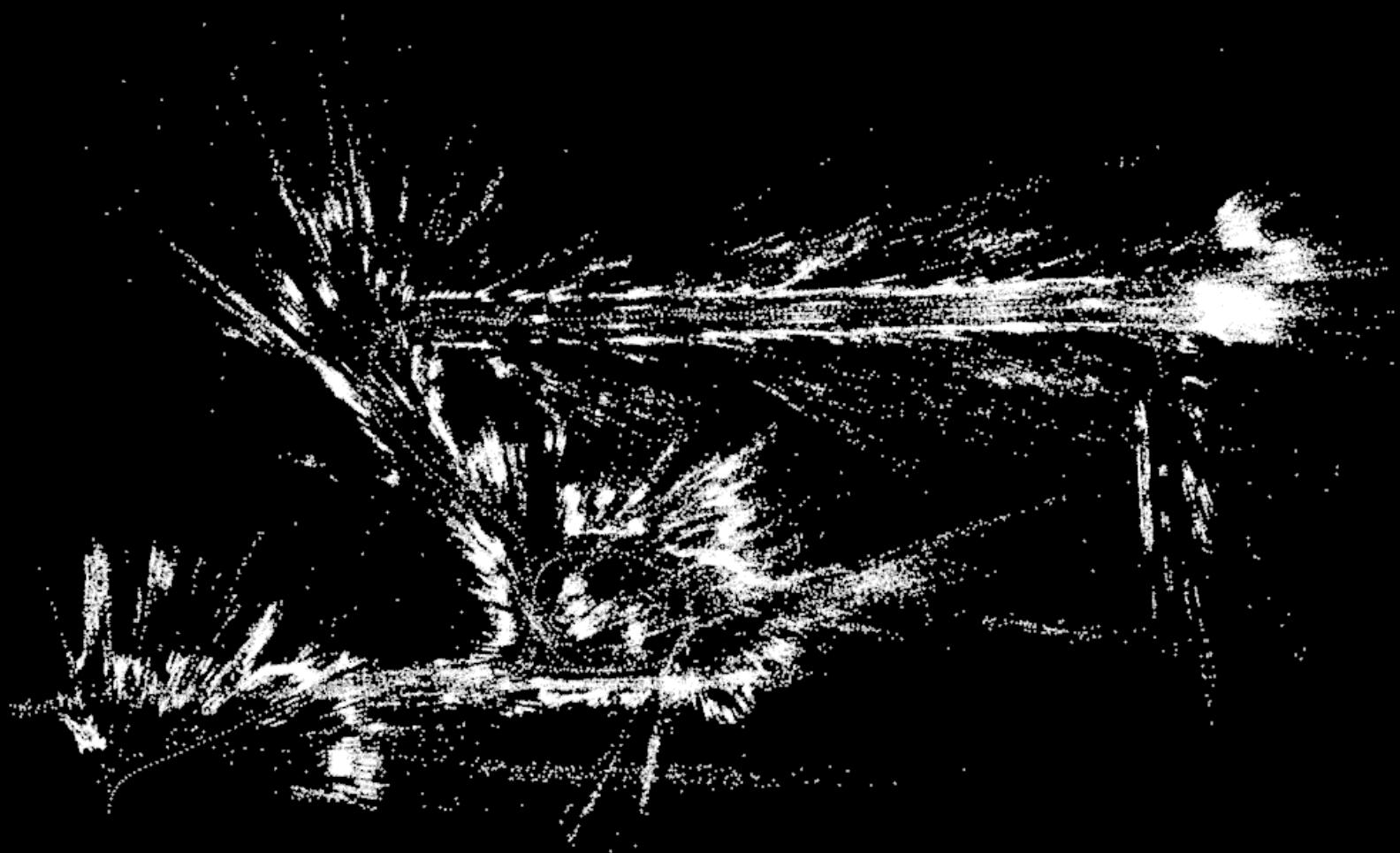
Results



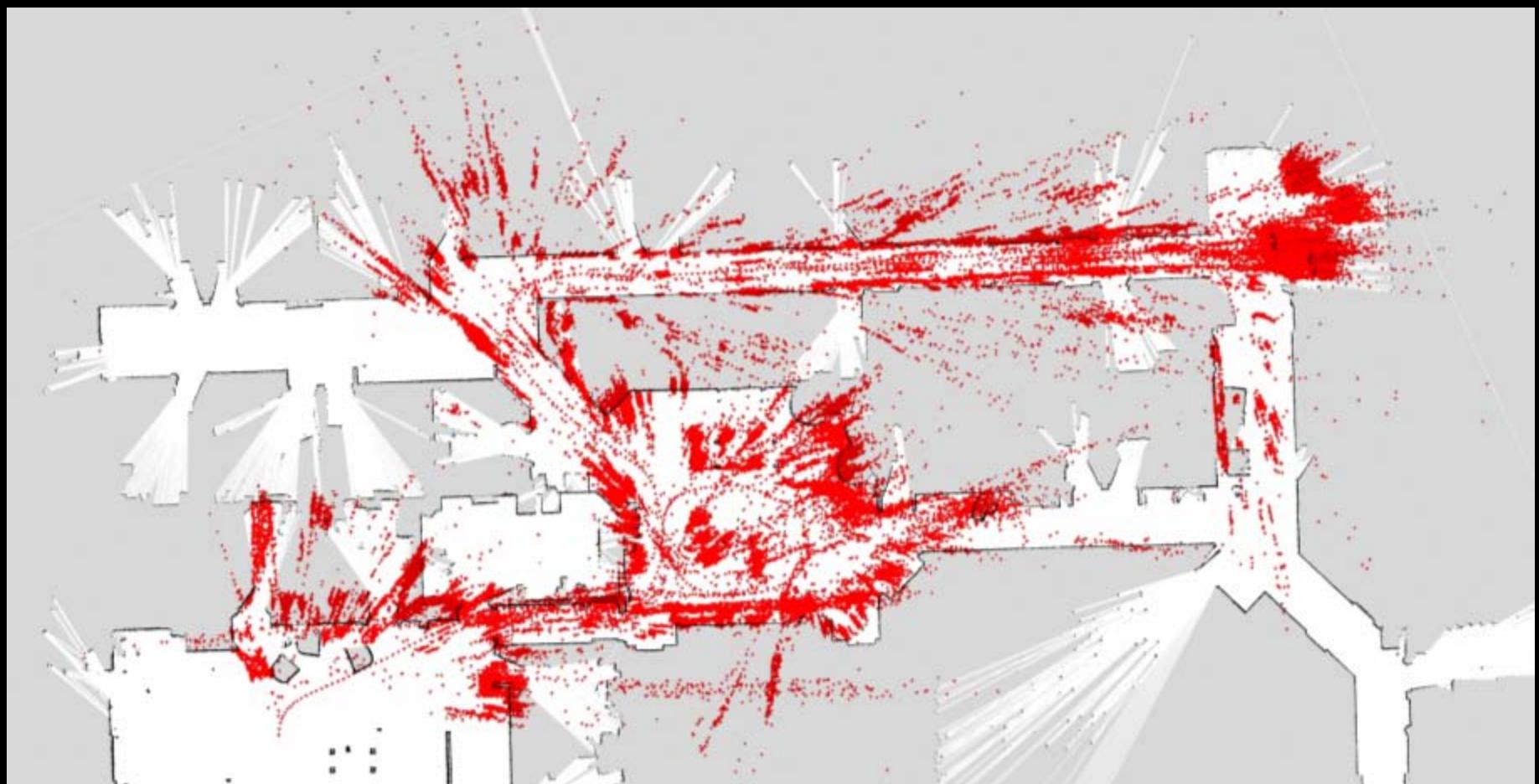




Mapping



Mapping



Integrating Pointcloud Data

- Different sensors
 - LIDAR
 - SwissRanger
 - PrimeSense
- Multi-sensor fusion
 - Use pose estimates and constraints from different sensors

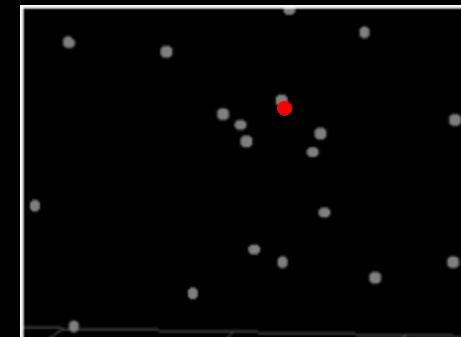
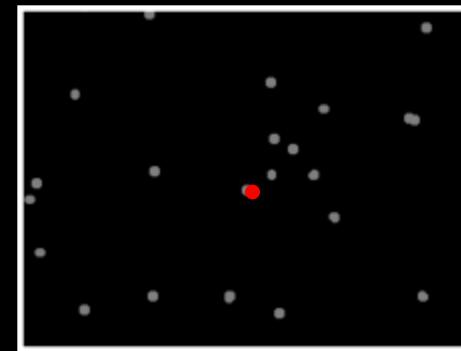
Point-to-point

- Matches between keypoints in images
 - Exact correspondence



Point-to-plane

- Matches between pointclouds
 - Points aren't exact matches



Implementation

- Point-to-point matches
 - Cost measurement is reprojection error
- Point-to-plane matches
 - Consider only error in direction of the point's normal
 - Allows the points to move freely within the plane
 - Requires that point matches be locally planar
 - Filter matches based on curvature
- Use thin covariance matrix with error calculation
 - Rotate covariance matrix
 - Easy implementation within existing system

Applications

- 3D odometry, localization, and mapping
- Model building
 - For small objects, use stereo views from different angles
 - For large objects, like rooms, use image and laser scan data
 - Pointcloud matching

Future Work

- Persistent map
- Pose-to-pose constraints
 - Use odometry estimates
- Whole-room registration
- Monocular pose estimation
- Release vslam stack to 0.2

Thank you!