Visual odometry for Corobots

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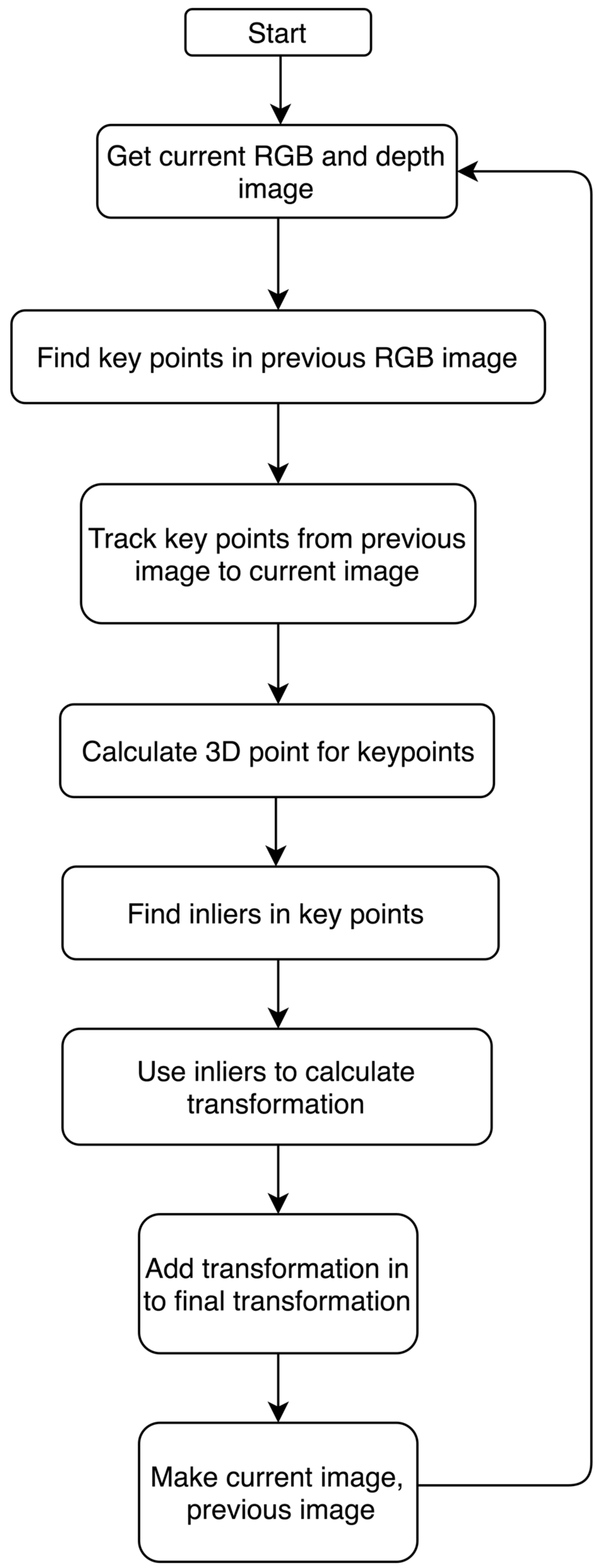
INTRODUCATION

- The goal of this project is to use visual odometry technique on corobots using Kinect depth and RGB camera.
- Currently corobots uses encoders which face precision problems, due to wheel slips and slide.

BACKGROUND

- Visual odometry is process of determining position of robot using associated camera images.
- Corobots have Kinect sensor which provides RGB and depth images.
- Using consecutive images transformation, change in camera position. is calculated in terms of rotation matrix and translation vector.
- Visual odometry computation is done either using images or 3D point cloud.
- Use of monocular camera lacks scale information while operations on 3D point cloud is computationally heavy.
- Proposed approach combines use of 2D images and selected 3D points to estimate transformation with faster computation time than traditional point cloud methods.

ARCHITECTURE



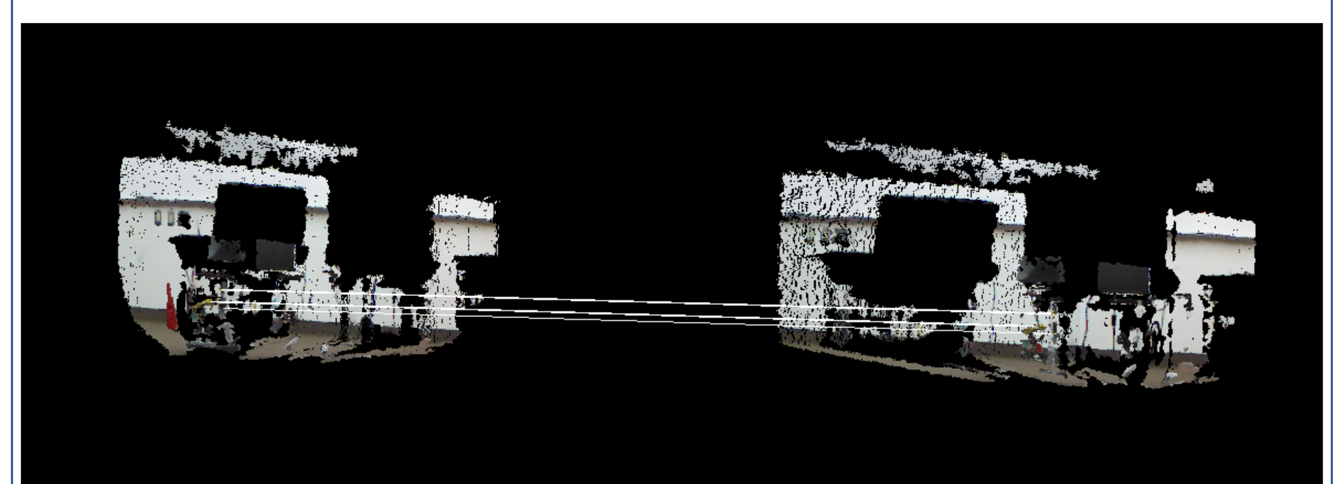
ALGORITHM

Finding and tracking Key points

- Key points are points which are distinctive, easier to track in consecutive images. FAST corner detector was used in this approach.
- Tracking is method of finding corresponding points from first image in to second. Kanade–Lucas–Tomasi feature tracker which uses optical flow was used in this approach.

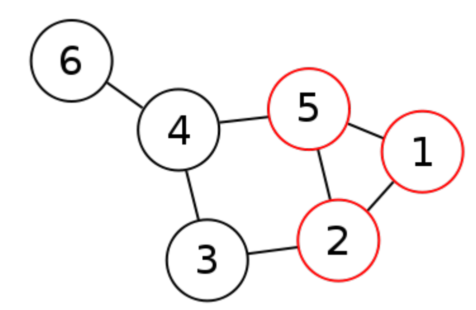
3D Key point estimation

The points in images are converted to real world 3D points using depth data and intrinsic camera parameters obtained from calibration.



Inlier Detection

All 3D point coordinates and correspondences might not be accurate. This was solved by constructing 3D point graph by connecting stable points and finding maximum clique sub-graph.



Transformation estimation

Transformation matrix between scenes consists of relative rotational matrix and translation vector. RANSAC based approach was used.

RESULTS

Method	Average Time
Monocular	0.21 Sec
3D Point Cloud	4.89 Sec
Our Approach	1.02 Sec

Method	Accuracy with features > 100
Monocular	N. A.
3D Point Cloud	+- 5%
Our Approach	+- 5%

Place	Number of features	Inlier Features
Hallway	5 - 30	0 - 5
Lab	40-250	30 - 150

CONCLUSION

- Finding and tracking features in 2D images is faster, accurate and requires much less computational time than 3D point cloud.
- Visual odometry performs better than encoders when view has good lightning, enough features to track and accurate depth values.
- Places like hallways where light is inconsistent, surface is plain and only side walls can be tracked, visual odometry fails.

References

- http://www.ros.org/ http://www.pointclouds.org/
- Fusing points and lines for high performance tracking, Edward Rosten and Tom Drummond
- An Iterative Image Registration Technique with an Application to Stereo Vision, Bruce D. Lucas and Takeo Kanade.
- Registration with the Point Cloud Library PCL A Modular Framework for Aligning 3D Point Clouds Dirk Holz, Alexandru E. Ichim, Federico Tombari, Radu B. Rusu and Sven Behnke