Project Report

Visual Odometry Pipeline

Marius Grimm, Amadeus Oertel, Toni Rosiñol

Titus Cieslewski, Henri Rebecq

Adviser

Prof. Dr. Davide Scaramuzza

Professor

Robotics and Perception Group
University of Zurich & Swiss Federal Institute of Technology Zurich (ETH)

2017-01

**Universität
Zürich**UZH

ROBOTICS &
PERCEPTION
GROUP

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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Abstract

very short and juicy summary of topic and main points

Figure 1: 2D-2D correspondences with KLT.

1 Introduction

2 Initialisation

2.1 Stereo Initialisation

2.2 Monocular Initialisation

The monocular initialisation is a key module in the Visual-Odometry pipeline. It is ordered in the follwoing way:

1. Find the 2D-2D correspondences between the the chosen first two images

2. Apply the 8-point Algorithm to estimate the Fundamental matrix combined with running RANSAC.

3. Check the validity of the estimated Fundamental matrix by either comparing the reprojection error or the distance to the epipolar line.

4. RANSAC return a set of inlier of the current 2D-2D correspondences.

5. With the new set of inlier we can re-evaluate the final Essential Matrix E estimate.

6. The Essential Matrix E can then be decomposed into two rotation and two translation hypotheses for the pose of the first camera frame. This gives in total a set of four camera motion possibilities.

7. These hypotheses have to be disambiguated to choose the right camera rotation and translation.

We have implemented two different approaches for finding the 2D-2D correspondences:

1. Exercise implementation of Harris descriptor and detector.

2. Implementation of the Kanade-Lucas Tracker (KLT).

An examplary output of the 2D-2D module can be seen in Figure **??**. The correspondences between two images are indicated.

Due to efficiency reasons we decided to use the epipolar line distance as a measure to validate the estimated Fundamental Matrices. In theory the reprojection error would have yielded better results (sacrificing efficiency); however, in our case the differences were neglectable.

3 Continous Operation

3.1 KLT

4 Bonus Features

4.1 Plotting

4.2 Automatic Selection of Frames for Initialisation

4.3 Relocalisation

4.4 Full Bundle Adjustment

4.5 Calibrated Smartphone Camera and own Dataset

4.6 Quantitative Analysis

4.6.1 Keypoint Tracking via Block Matching versus KLT

4.7 Monocular Initialisation Harris Detector via Matlab versus Exercise Harris Detector

5 Conclusion

Main conclusions and final remarks.

References

[1] J.-L. Blanco, F.-A. Moreno, and J. González-Jiménez. The málaga urban dataset: High-rate stereo and lidars in a realistic urban scenario. *International Journal of Robotics Research*, 33(2):207–214, 2014.

[2] A. Geiger, P. Lenz, C. Stiller, and R. Urtasun. Vision meets robotics: The kitti dataset. *International Journal of Robotics Research (IJRR)*, 2013.

[3] D. Scaramuzza and F. Fraundorfer. Visual odometry: Part i - the first 30 years and fundamentals. *IEEE Robotics and Automation Magazine*, 18(4), 2011.

[4] D. Scaramuzza and F. Fraundorfer. Visual odometry: Part ii - matching, robustness, optimization, and applications. *IEEE Robotics and Automation Magazine*, 19(2), 2012.

A   Appendix

Additional material such as long mathematical derivations.

B Examples

This appendix provides some additional hints and examples for the layout and style of the thesis. It is worthwhile to look at the source file `Examples.tex` for this appendix to understand how it was created.

B.1 Tables

Tables are left justified and the caption appears on top as seen in Table 1.

Table 1: Translations.

English	German
cell phone	Handy
Diet Coke	Coca Cola light

B.2 Figures

Figure 2 shows a simple figure with a single picture and Figure 3 shows a more complex figure containing subfigures.

Figure 2: IRIS logo.

(a) ETH logo   (b) IRIS logo

Figure 3: Two pictures as part of a single figure through the magic of the subfigure package.

B.3 Units

The SIUnits package provides nice spacing for units as demonstrated in Table 2. Use of the package also makes it easy to change the style or even the unit text in the future.

Table 2: Spacing for units.

Output	Command
42m	42m
42 m	\unit{42}{\metre}
42 m	42 m

B.4   Miscellany

Capitalization. When referring to a named table (such as in the previous section), the word *table* is capitalized. The same is true for figures, chapters and sections.

Naming of structural elements. Refer to a \section in LaTeX as a chapter and call a \subsection section. (I don't like the way \chapters are rendered in the report document class. Hence the suboptimal markup/naming correspondence.)

Bibliography. Use bibtex to make your life easier and to produce consistently formatted entries.

Contractions. Avoid contractions. For instance, use "do not" rather than "don't."

Captions. A brief version of a caption can be provided for the list of figures and tables as demonstrated with the caption of Figure 3. The mechanism can also be used to get rid of the final period of a caption in the lists.