Evaluation of stand-of-the-art monocular visual simultanious and mapping approaches

Masterarbeit

zur Erlangung des akademischen Grades

Master of Science in Engineering (M.Sc.)

Eingereicht bei:

Fachhochschule Kufstein Tirol Bildungs GmbH

Data Science & Intelligent Analytics

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Ich erkläre hiermit, dass ich die vorliegende Masterarbeit selbständig und ohne fremde Hilfe verfasst und in der Bearbeitung und Abfassung keine anderen als die angegebenen Quellen oder Hilfsmittel benutzt sowie wörtliche und sinngemäße Zitate als solche gekennzeichnet habe. Die vorliegende Masterarbeit wurde noch nicht anderweitig für Prüfungszwecke vorgelegt.

Kufstein, 06. July 2020

Julian Bialas, BSc

Sperrvermerk

Ich habe die Sperrung meiner Masterarbeit beantragt, welche von der Studiengangsleitung genehmigt wurde.

Kufstein, 06. July 2020

Julian Bialas, BSc

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HTML HyperText Markup Language

JS JavaScript

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06. July 2020

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Data Science & Intelligent Analytics

Kurzfassung der Masterarbeit: **Evaluation of stand-of-the-art monocular visual simultanious and mapping approaches**

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06. July 2020

1. Introduction

1.1 Related Work

2. Methods

2.1 vSLAM Algorithms

2.1.1 ORB-SLAM

2.1.2 DSM-SLAM

2.1.3 DSO-SLAM

2.2 Calculations

2.2.1 Trajectory Alignment

In order to compare the evaluated position of the camera at a given time with the ground truth of the position, the trajectories need to be aligned. This is because most SLAM Algorithms innitilize the origin of their coordinate system with the camera position from the first frame. Whereas the ground truth of the trajectory uses a different origin. As a consequence, evaluated points $\{\widehat{p_i}\}_{i=0}^{N-1}$ can not be compared to the ground truth points $\{p_i\}_{i=0}^{N-1}$ Also, as described in the vSLAM Algorithms section, the minority of the existing vSLAM algorithms are recognizing the true scale of the coordinate system. For those two reasons, the target is to find $S = \{R, t, s\}$, while R being a rotation matrix, t a translation vector and s a scaling factor, such that

$$S = \underset{S'=\{R',t',s'\}}{\arg\min} \sum_{i=0}^{N-1} \left\| p_i - s'R'\widehat{p_i} - t' \right\|^2$$

.

In other words, the evaluated points are rotated, translated and scaled in a way, that the sum squared error over the point distances is minimized. The upper expresssion is calculated by using the method of Umeyama [2].

2.3 Datasets

2.3.1 EuRoC Dataset

For the evaluation of the vSLAM Algorithms, the EuRoC dataset [1] was used. The dataset contains eleven video sequences, recorded with a micro aerial vehicle at 20 frames per second. For each Sequence, RGB images from two cameras exist. However, since the evaluation focuses on monocular SLAM methods, only the left camera was considered. Also the available inertial and camera pose data was not taken in consideration. The first five sequences were recorded in the machine hall at ETH Zürich, and the other six were recorded in a room, that was provided with additional obsticals. For the latter six sequences, the groundtruth of the environment exists as a dense pointcloud, as can be seen in figure 1.

Finally the true position of the camera is known at a high frequency of over 200 points per second. An overview of the sequences is shown in table 1.

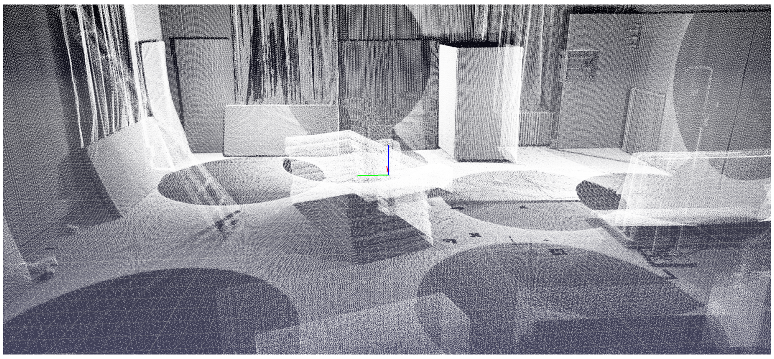

Figure 1: Pointcloud ground truth of sequence V1_01_easy visualized with python package pptk

2.4 Setup and Environment

2.4.1 Evaluation

The entire evaluation is run on a virtual machine. The host system is a lenovo yoga with eight GB of RAM and the basic model (8250U CPU @1.6 GHz 1.80GHz) of an eight core i5. The operating system of the host machine is Windows 10 Home. The virtual machine is given 5 GB of Ram and 4 cores. The operating system of the virtual machine is Ubuntu 18.04. All further setup information can be extracted from the github repository.

2.4.2 Flight Path Planning

Table 1: Overview of the sequences included in the EuRoC Dataset

Sequence Name	Duration in s	Average Velocity in ms^{-1}	Pointcloud available
MH_01_easy	182	0.44	No
MH_02_easy	150	0.49	No
MH_03_medium	132	0.99	No
MH_04_difficult	99	0.93	No
MH_05_difficult	111	0.88	No
V1_01_easy	144	0.41	Yes
V1_02_medium	83.5	0.91	Yes
V1_03_difficult	105	0.75	Yes
V2_01_easy	112	0.33	Yes
V2_02_medium	115	0.72	Yes
V2_03_difficult	115	0.75	Yes

3. Results

4. Discussion

Bibliography

[1] M. Burri. The euroc micro aerial vehicle datasets. *The International Journal of Robotics Research*, 2016.

[2] S. Umeyama. Least-squares estimation of transformation parameters between two point patterns. *IEEE Trans. Pattern Anal. Mach. Intell.*, 1991.