Vision-Aided Navigation (086761) - Fall 2019
Project

General

The purpose of this project is to get the student(s) closely familiar with state of the art approaches on one of the topics covered in (or related to) the course.

Note: The project is an excellent opportunity to investigate a potential topic/direction for research thesis. Those interested are encouraged to get in touch with the lecturer ***before*** choosing the project topic.

Guidelines and Requirements

1. Choose a topic from the table below.
   Doodle poll: Specify your preference [**link to poll**]
   Deadline: by lecture #5 (*November 24th 2019*, no extensions), better to decide earlier
2. Tasks (more details below)
   (a) Choose a topic and read paper(s) from the chosen topic.
   (b) (Partial) implementation is encouraged and **required** to get full credit.
   (c) We also encourage relevant online demonstrations using real sensors and robots. In some cases, students will be able to use robots from the Autonomous Navigation and Perception Lab (ANPL). If interested, contact us for more details.
   (d) Oral presentation of the topic: 20 minutes, unless otherwise mentioned.
   (e) Submit a report that summarizes the paper(s) presented in class.
   Deadline: Submission is due last lecture

Written Report:

The report should summarize the material, as you comprehend it. The summary should highlight what you consider to be the main contribution of the paper(s), but should not be a "copy-paste" from the original paper(s). The basic structure of the report should typically be as follows:

1. *Introduction and overview*: Introduce the paper(s) topic. Describe how the paper fits in with the contents of this course, provide a brief background (literature review) and explain why the problem is important.
2. *Preliminary material and problem formulation*: Present a description of relevant notations and definitions, define mathematically the problem addressed by the paper(s), and summarize any preliminary mathematical material used in the paper(s).
3. *Main contribution*: A detailed discussion of the main results of the paper(s). This should include both a qualitative discussion and a mathematical presentation (i.e. show proofs, preferably in your own style).
4. *Implementation*: Demonstrate the main results of the paper(s) using simulation and/or real-world experiments. You are free to choose the programming language as well as using open source software. This also includes testing the approaches under different conditions than those originally assumed in the paper(s), as well as extending approaches to unsupported settings/scenarios.

5. *Discussion and Conclusions*: Summarize the report and provide some criticism: identify weak points, unrealistic assumptions or aspects that could be improved and suggest possible directions (or extensions) for future research.

The report **should not exceed 10 pages** in length. If submitted electronically, please convert to .pdf format. The usage of LaTex is highly recommended for writing the report.

Oral Presentation:

The oral presentation is complementary to the written report. The presentation should be in a "lecture" style format; i.e., you will present this in front of the class with the goal of "teaching" the main points of the paper(s). It is therefore should be well organized such that participants can easily understand the key concepts. Unless otherwise mentioned, the presentation should be around **20 minutes long**, with additional time allocated for questions (up to 5 minutes). The general format of the talk should mirror the structure of the written report. All team members should take **active** part in the presentation, e.g. for teams of two members, each member should talk about 10 minutes.

Topics & Papers

#	Topic & Papers	Assigned to	Presentation date
1	SLAM review: [1]	Adi & Yelena	19/01
2	Qualitative mapping: [10]	Maxim & Gilad	19/01
3	Multi-Robot SLAM: [8]	Kai & Guy	19/01
4	Communication Planning for multi-robot SLAM: [4]	Omer & Doron	19/01
5	Distributed (object-level) Mapping: [2]	Ariel & Oren	19/01
6	BSP and active SLAM: [6]	Guy & Shahar	19/01
7	Active exploration + object detection: [14, 13]	Shai and Amnon	26/01
8	Efficient BSP via sparsification: [5, 3]	Daniela & Or	26/01
9	DL based camera localization & inference: [7, 9]	Areej & Lucas	26/01
10	Deep semantic localization & odometry: [11]	Noam & Eyal	26/01
11	Limitations of CNN-based Pose Regression: [12]	Ori & Joanne	26/01

Table 1: Reading material sorted by topic.

References

[1] Cesar Cadena, Luca Carlone, Henry Carrillo, Yasir Latif, Davide Scaramuzza, Jose Neira, Ian D Reid, and John J Leonard. Simultaneous localization and mapping: Present, future, and the robust-perception age. *arXiv preprint arXiv:1606.05830*, 2016.

[2] Siddharth Choudhary, Luca Carlone, Carlos Nieto, John Rogers, Henrik I Christensen, and Frank Dellaert. Distributed mapping with privacy and communication constraints: Lightweight algorithms and object-based models. *Intl. J. of Robotics Research*, 36(12):1286–1311, 2017.

[3] K. Elimelech and V. Indelman. Efficient decision making and belief space planning using sparse approximations. *arXiv preprint arXiv:1909.00885*, 2018.

[4] Matthew Giamou, Kasra Khosoussi, and Jonathan P How. Talk resource-efficiently to me: Optimal communication planning for distributed loop closure detection. In *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, pages 1–9, 2018.

[5] V. Indelman. No correlations involved: Decision making under uncertainty in a conservative sparse information space. *IEEE Robotics and Automation Letters (RA-L)*, 1(1):407–414, 2016.

[6] V. Indelman, L. Carlone, and F. Dellaert. Planning in the continuous domain: a generalized belief space approach for autonomous navigation in unknown environments. *Intl. J. of Robotics Research*, 34(7):849–882, 2015.

[7] Alex Kendall, Matthew Grimes, and Roberto Cipolla. Posenet: Convolutional networks for real-time 6-dof camera relocalization. In *Intl. Conf. on Computer Vision (ICCV)*, 2015.

[8] B. Kim, M. Kaess, L. Fletcher, J. Leonard, A. Bachrach, N. Roy, and S. Teller. Multiple relative pose graphs for robust cooperative mapping. In *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, pages 3185–3192, Anchorage, Alaska, May 2010.

[9] D. Kopitkov and V. Indelman. Robot localization through information recovered from cnn classificators. In *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*. IEEE, October 2018.

[10] Jennifer Padgett and Mark Campbell. Probabilistic qualitative mapping for robots. *Robotics and Autonomous Systems*, 98:292–306, 2017.

[11] N. Radwan, Valada A., and Burgard W. Vlocnet++: Deep multitask learning for semantic visual localization and odometry. *IEEE Robotics and Automation Letters (RA-L)*, 2018.

[12] Torsten Sattler, Qunjie Zhou, Marc Pollefeys, and Laura Leal-Taixe. Understanding the limitations of cnn-based absolute camera pose regression. In *IEEE Conf. on Computer Vision and Pattern Recognition (CVPR)*, pages 3302–3312, 2019.

[13] WT Teacy, Simon J Julier, Renzo De Nardi, Alex Rogers, and Nicholas R Jennings. Observation modelling for vision-based target search by unmanned aerial vehicles. In *Intl. Conf. on Autonomous Agents and Multiagent Systems (AAMAS)*, pages 1607–1614, 2015.

[14] Javier Velez, Garrett Hemann, Albert S Huang, Ingmar Posner, and Nicholas Roy. Modelling observation correlations for active exploration and robust object detection. *J. of Artificial Intelligence Research*, 2012.