Master's Thesis / Semester Project:
Efficient Semantic Line Detection on Embedded Platforms.

Computer Vision Lab, D-ITET

Description

In the Robocup Soccer Standard Platform League (SPL), self-localization is one of the most important tasks. The Robots have to be able to do this using only onboard sensors, i.e. the two cameras and the IMU. Since the dimensions of the field and the disposition of the lines are known a-priori, self-localization can be mapped to a state estimation problem. In this, detections of lines (both straight and circular) and intersections (L-intersections, T-intersections, X-intersections) are used as observations to update a particle filter approximating a distribution over the possible positions of the robot on the field. Hence, a robust line detector is the most important component used for this task.

Common approaches to field line detection in the SPL rely on color classification heuristics, image gradients, and handcrafted features. These methods, however, tend to perform poorly in presence of occlusions and do not generalize well to realistic conditions encountered in natural lit fields.

In recent years, deep learning has enabled the development of robust line detection models. These are often used to tackle tasks related to scene understanding, such as wireframe parsing. In this project, we aim to use similar approaches to develop an end-to-end deep robot soccer field line detector capable of real-time inference on an embedded CPU.

Goal

The goal of this project is to develop a deep line detection model for real-time line detection on the CPU of the NAO V6. The project will follow the following tentative roadmap:

1. Training and evaluation of the performance of a state-of-the-art line detection model such SOLD2 [1] for the task of field line detection.
2. Reduction of the size and runtime of a large line detection model to make it amenable to real-time inference on edge devices, or design a novel lightweight architecture for this purpose.
3. Deployment and on-hardware testing.
4. Integration in the robot soccer framework of team NomadZ.

The research aspects of this project include line detection and compact and efficient networks.

Requirements

- Knowledge of deep learning fundamentals.
- Practical experience with PyTorch.
- Basic experience with C++.

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References

[1] Rémi Pautrat, Juan-Ting Lin, Viktor Larsson, Martin R. Oswald, and Marc Pollefeys. Sold2: Self-supervised occlusion-aware line description and detection. *2021 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 11363–11373, 2021.