Proposal

Rationale

Autonomous robots have a great variation of tasks. Most of these require detecting objects in their environment with optical sensors. Examples for those objectives are exploration and recovery. In most objectives additional information about the environment are helpful to estimate threats or even improve cooperation by recognizing other systems. Additionally, it could enable the system to transport specific objects in its environment. The given SoC-board limits the range of methods drastically considering their local performance needs.

Rationale

Joffman[1] uses HSV, feature and shape detection with the TurtleBot2 to detect objects and compares these methods. These methods of objection detection can be applied on low-end hardware.

The YOLO: Real-Time Object Detection project[2] uses a different approach for object detection. It applies a single neural network to the full image. This divides the image into regions and estimates bounding boxes. These are weighted by previously predicted probabilities for detected objects. The SpyPy project[3] uses a similar approach like YOLO, but limits the framerate to 1 per minute and uses minimalized weights to perform decent on a Raspberry Pi. Additionally, input frames are downsized to way smaller resolutions.

Another approach is done by the SSD MobileNet project[4], which is an object recognition and classification framework. Unfortunately, it is relatively performance intensive, too. Although attempts[5] to outsource computation by adding an Intel Movidius Neural Compute Stick are done. Results with a Raspberry Pi 3 B and a NCS promise a framerate of approximately 4 FPS.

One way to face the limited local resources of the system is to outsource computationally intensive tasks to a service like Google Cloud Vision[6]. Its API offers the option to upload frames and get detected objects and their position in the frame based on a pre-trained neural network in Google's cloud. One core requirement is therefore a network connection.

[1] https://github.com/joffman/ros_object_recognition
[2] https://pjreddie.com/darknet/yolo/
[3] https://github.com/breeko/spypy
[4] https://github.com/movidius/ncappzoo/tree/master/caffe/SSD_MobileNet
[5] https://www.pyimagesearch.com/2018/02/19/real-time-object-detection-on-the-raspberry-pi-with-the-movidius-ncs/
[6] https://cloud.google.com/vision/

Outline

Firstly, requirements for an object detection method for the TurtleBot3 Waffle will be determined. Most limitations are set by the platform. Secondly, available methods will be checked whether they match these requirements. Thirdly, object detection methods will be implemented into ROS. Finally, implemented methods will be evaluated and compared based on similar inputs.

Goal

The goal of this project is to determine an acceptable method to detect objects with the TurtleBot3 Waffle using its camera module. This would enable the TurtleBot3 to generate more information about its environment and improove its interaction with it. Additionally, introducing object detection would widen the variety of tasks the system can fulfill.

Preliminary table of contents

The bachelor thesis matching this project should be structured as following:

1. Introduction
2. Literature review
3. Basics
4. Methods
    a) Requirement analysis
    b) Implementation
5. Evaluation
6. Discussion