Using Monocular Vision for Maze Navigation

Project proposal

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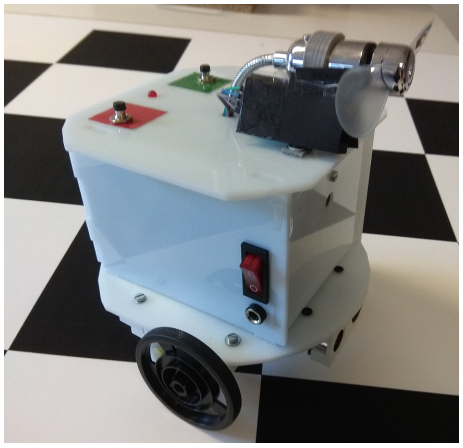
1 Goals

Monocular vision is a challenging approach for obtaining depth information from a scene since one has to collect indirect queues such as several images captured from different viewpoints of the scene, use shadows, motion or shade to infer the geometry of the scene and so on. An ideal approach to understanding the geometry of a scene would be to take advantage of a 3D sensor, but for some applications, this is not possible.

In this project, we want to make a small robot, based on a Raspberry Pi 2, navigate a maze using only a single 2D camera. This requires that the robot uses some smart techniques to detect depth in the scene, particularly because the maze consists of several low texture white walls.



The robot is used to participate in the Firefighter contest, at IPG, so the candidate could be part of one such team, if she wants. The navigation will be done by adapting some already existing code in ROS [3] to our particular context.

The project can take advantage of visual odometry [1], a monocular SLAM approach [2] and navigation.

2 Work plan

The project has the following tasks:

T1 Introduction to robotic navigation and ROS (3 weeks).

T2 Study the requirements for the application and integrate already existing code (4 weeks).

T3 Implement new code to solve some of the remaining necessary requirements and integrate everything in the prototype (6 weeks).

T4 Write the project's report (2 weeks).

3 Technical and Academic Requirements

Be able to program using Python on Linux, use a source code repository and produce documentation (using doxygen, sphinx or other similar tool).

It is desirable that the student has grades above 13 on the following courses: Estruturas de Dados, Probabilidades e Estatística, Inteligência Artificial.

4 Expected Results

- A method that can make the robot navigate a maze using a single camera
- Source code and documentation of all code developed
- Project report

5 References

[1] Henning Lategahn, Andreas Geiger, Bernd Kitt, and Christoph Stiller. Motion-without-structure: Real-time multipose optimization for accurate visual odometry. In *Intelligent Vehicles Symposium (IV)*, 2012.

[2] C. Pereira, G. Falcao, and L.A. Alexandre. Pragma-oriented parallelization of the direct sparse odometry SLAM algorithm. In *27th Euromicro International Conference on Parallel, Distributed and Network-Based Processing*, Pavia, Italy, February 2019.

[3] Morgan Quigley, Ken Conley, Brian Gerkey, Josh Faust, Tully B. Foote, Jeremy Leibs, Rob Wheeler, and Andrew Y. Ng. ROS: an open-source robot operating system. In *ICRA Workshop on Open Source Software*, 2009.