Study of feasibility of image-based localization

Subject: Robotic
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Robotic in common words is the use of complicated mechanical instruments. Robots need to be controlled and programmed in order to work correctly. Alstom Innovation Robotic has developed the «Wall Crawler Robot» which is able to climb an oil cistern on over 10 meters. Today the robot uses an external laser system which has to be replaced by an internal system. This work is a step forward into the direction of an autonomous «Wall Crawler Robot».

Introduction

This bachelor thesis handles visual odometry. It is a concept coming from wheeled odometry but with a camera. The goal is to determine the robot's motion in 2 dimensions with a camera. The «Wall Crawler» is a robot developed by Alstom Innovation Robotics. It can climb a cistern vertically using magnetic wheels.

Initial situation

The «Wall Crawler Robot» can be controlled with a joystick and sensors such as laser system, an inclination sensor and wheel encoders data. With more or less accuracy each possibility is usable. In regards to the autonomous issue the laser system gives a precise result but the system is limited, it is therefore not an autonomous issue. The inclination sensor gives an approximate result but the robot oscillates around a vertical axis. The data coming from the wheel encoders also give approximate results which correspond to the laser recorded track. Those three solutions are not suitable for a full autonomous robot. That is why visual odometry is seen as a possible way to control the robot.

Goals

A goal of the thesis is the implementation and evaluation of one or more localization algorithms. Some visual odometry algorithm has to be tested on a video camera view which has been taken during tests on a cistern. This video is the only one support needed for an implementation of visual odometry.

Steps

Before correction of the distortion and the perspective, a detection of characteristic regions and points on each frame is done. The Lucas-Kanade algorithm is able to find corresponding points in the next frame. Unfortunately there are outliers which have to be rejected. Then the motion is extracted from the difference in coordinates.

Result and conclusion

During the creation of the visual odometry system, some difficulties appeared such as writing in a standard format of C++ code. The filter works fine and can be customized. Better initial calibration may further reduce the position uncertainty of the visual odometry and yield better localization results.

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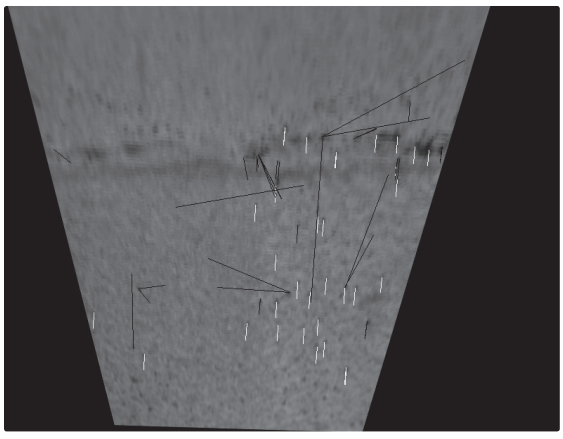
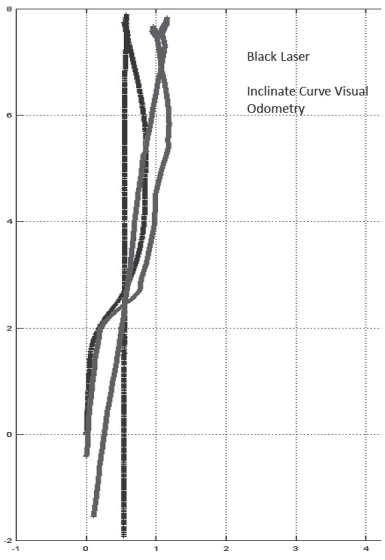


Filter of inliers (white) and outliers (black) of extracted points



Laser track compared to the developed visual odometry software