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AUTONOMOUS ROBOT NAVIGATION IN PUBLIC NATURE PARK

Extended abstract

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Abstract: This extended abstract describes a project to make a robot travel autonomously across a public nature park. The challenge is to detect and follow the right path across junctions and open squares avoiding people and obstacles. The robot is equipped with a laser scanner, a (low accuracy) GPS, wheel odometry and a rate gyro. The initial results shows that this configuration is (almost) sufficient to traverse the park, when following simple preplanned guidelines. This paper describes the decisions and solutions, results so far, and expected further development.

1. INTRODUCTION

This project is intended to produce a stable platform, that, with time, can be expanded from following a predetermined route, to be able to explore alternative routes, and draw a consistent map of the area. This is all part of an attempt to find a combination of tools and methods that will allow robots to cope autonomously in a real environments.

The environment for the project is selected to be a near by nature park (the Eremitagen near Copenhagen), where a high number of suitable paths, junctions and surface types are available, and not much traffic other than pedestrians, horses and bicycles.

The work is inspired by (Chris Urmson, 2004), (P. L. Klöör, 1993) among others, and builds on results from (Morten Rufus Blas, 2005) and (Nils A. Andersen, 2004)

Fig. 1. The robot and some kids in the park last winter.

2. OBJECTIVES AND OVERVIEW

The objectives, so far, is to select, develop and implement the solutions, that is needed to make

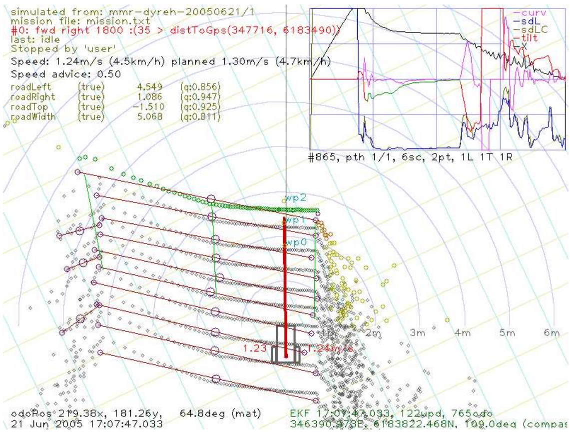

Fig. 2. Road detection on the asphalt road. 10 scans are shown, overlaid with detected passable interval lines, with circles at ends and at the top of detected road profile. The image is from the robot monitoring application, and shows other support information.

a robot autonomously follow a safe route to a destination, with as little preplanned guidance as possible. A route of about 4 km—across the park—is set as the initial navigation challenge.

The robot used—see figure 1—has two driving rear wheels and a caster front wheel. Each of the rear wheels are mounted with encoders for the odometry. A rate gyro is used to assist in determining the robot heading. The robot has a GPS receiver with an accuracy of about 5 meter (in open areas). The main sensor for detection of the environment is a laser scanner.

The selected solution has no map of the area, but is guided by a script, that in a few lines describe the route to follow.

The surface of the traversable tracks and open areas is either asphalt or gravel, the gravel parts may be corrupted by horse tracks and to some extend eroded by rainfall. Some of the paths has a profile with a high center and slopes down either side to shallow ditches. In other areas the path is rather flat and is edged by flat areas with cut grass or rough vegetation.

The selected guidance of the robot is comparable to the guidance you would give to a person, that is: Follow this road about for about 2 km, and then, at the castle, turn left to the narrow road downhill (second left), follow that road, ignoring all side roads and junctions, until you reach the red gate destination point. The semantics should be the same, but in a syntax that matches the robot sensor capabilities.

3. RESULTS

Driving along the asphalt road the first about 1.8 km is just about perfect. Figure 2 a bit of the data from this road. The only observations are a few unprovoked obstacle avoidance manoeuvres, an analysis shows, that a single measurement at close distance in one scan sparks the manoeuvre. This is most likely a detection of an flying insect. This could have been avoided by checking for consistency in neighboring scans.

The manoeuvres across the gravel area, in front of the castle, turned out to be a bit problematic, as the odometry errors gave an uncertainty of about the same order as the width of the exit road, especially if the robot had to avoid park visitors. Furthermore the edges of the exit road were difficult to detect, as they were warn down by the public. The robot has not yet been able to cross this area consistently.

The narrow gravel road with irregular edges behind the castle was traversed successfully, by following the top of the road profile. At times the robot gets tilted on the uneven surface, but manages to keep track of the road profile, and avoids the rough edges.

When crossing a wider road (again with a highly curved profile) the ability to plan a waypoint based on the last 20-30 meters of position history were very usefull, as the actual heading, when detecting the crossing road, were not consistent. The road on the other side were detected from the top of road detection quality, but again, as for the square in front of the castle, driving in curved terrain on odometry, with no sensor reference to follow, is difficult, and the ability to catch the road on the other side is not consistent.

The laser sensor do not like snow, as this gives random detections at shorter distances, but also rain is a challenge. Rain makes the roads wet, and this tends to reflect the laser beam (especially water filled pits and wet asphalt), resulting in a maximum range measurement, i.e. for the laser scanner it seems like the road is interrupted by deep holes. To compensate for this, all calculations ignore maximum range measurements.

4. CONCLUSION

The algorithms are tested on the route, and has shown, that a simple task of following simple directions to get to the other side of a park, is far from easy to implement on a robot.

The ability to detect different types of road types, has successfully enabled the capability to follow different road types. The ability to drive in open areas lack accuracy, and this is especially problematic if there is no distinct reference points, when leaving the open area.

The planned goal of being able to drive across the park autonomously is almost fulfilled, and it is expected that the robot will be able to complete the task consistently, when a few of the planned improvements are incorporated later this year.

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