System Description

Indoor mapping with autonomous vehicle

Version 1.0

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Status

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Document History

Version	Date	Changes made	Sign	Reviewer
0.1	2012-09-14	First draft.	All	All
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0.3	2012-09-21	Third draft.	All	All
0.4	2012-09-26	Fourth draft.	All	All
1.0	2012-09-26	First Version.	All	ET

Contents

1 Introduction

This document gives an overview of how the autonomous mapping robot is going to be designed. It specifies what hardware is used and the basic structure of the software.

2 System overview

The robot platform will be from Segway. Information of the environment around the robot will be gathered with the aid of a SICK laser range sensor and a stereo camera mounted on the robot. Additional information about the movement will be provided from an IMU-device. The on-board mounted computer will calculate a trajectory based on the information and guide the robot through the environment to collect the necessary data to produce a map of the area.

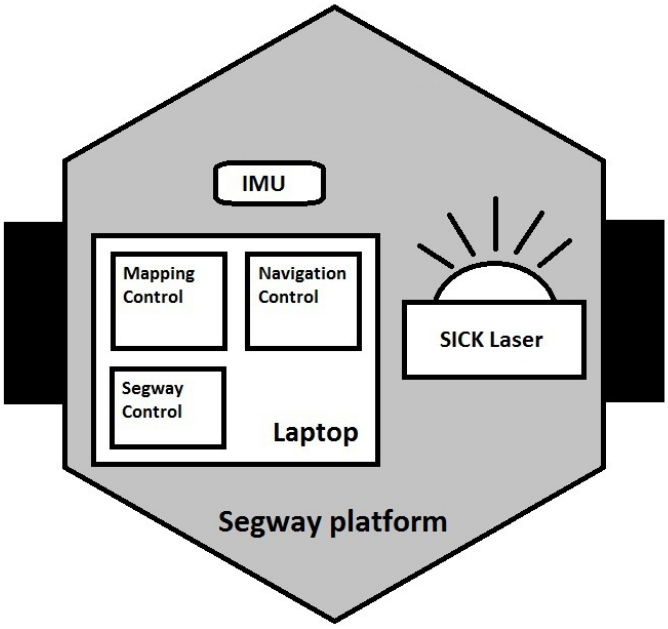

Figure 1: Sketch of the system.

2.1 Location

The system is going to be able to locate itself relative the environment given any starting point in an enclosed, flat, well lit and indoors area.

2.2 Mapping

The system is going to be able to generate a 2D map over the explored area, given the area is enclosed, flat, well lit and indoors.

2.3 Trajectory planning

The system is going to be able to calculate a trajectory that ensures that the entire area is explored, given the area is enclosed, flat, well lit and indoors.

2.4 Path following

The system is going to be able to follow a path according to the trajectory.

2.5 User interface

The system is going to be able to receive instructions from the user and also display desired information, for instance position, map of the environment etc.

3 Hardware

In this section all components and their functionalities are described.

3.1 Segway RMP50

The Segway RMP50 is a robot platform from Segway with two additional support wheels for stability and safety reasons. The segway's electric motors are controlled through a Matlab interface with commands to set the individual wheel speeds.

3.2 XSens MTi-G IMU

An inertial measurement unit mounted on the robot provides information of velocity, orientation and gravitational forces. Relevant specifications about the XSens MTi-G IMU that will be used:

- static accuracy $< 1°$
- dynamic accuracy $1°$ RMS
- angular resolution $< 0.05°$

3.3 Stereo camera

The stereo camera is a camera with two lenses, this allows the camera to collect images with a depth sense.

3.4 Laptop

The on-board mounted laptop will handle all the calculation and control of the other units. Communication between the diffrent components will also be handled by the laptop, obtained through USB and Ethernet.

3.5 SICK laser range sensor

A SICK LMS-511 laser range sensor will be used to scan the environment horizontally. Here are some relevant specifications regarding the sensor:

- field of view 190°
- resolution of the angular step width: 0.167/0.25/0.33/0.5/0.66/1°
- rotation frequency 25/35/50/75/100 Hz
- scanning range up to 65 m with 100% object remission (26/40 m with 10% object remission), 50 m according to tests performed by FOI

The range sensor will provide a view of the surroundings in front of the robot with measurement of distance and angle to detectable objects.

4 Software

This section contains a overview of the software. Most software is developed in Matlab.

4.1 SLAM

Simultaneous localization and mapping (SLAM) provides a localization system and generates a map. To achieve this two different methods will be evaluated.

4.1.1 IMU and SICK

This method will use the IMU and the SICK laser range sensor to estimate the position and orientation. The system will collect information of the environment via the SICK laser range sensor and processed to create a 2D map of the environment. The map will be updated when the robot moves and more information is gathered. This map will then be used by other subsystems both for planning the trajectory and to avoid collisions. The map will be built using occupancy grid to declare different areas in the environment as occupied or not.

4.1.2 CHAMELEON and SICK

The Chameleon system is an stereo camera- and IMU-based SLAM system, built and developed at FOI. Cahmeleon generates a 3D map represented as a point cloud and the location is given in six degrees of freedom. This software is provided as a resource and with some modifications it will work as a part of the SLAM system on the product.

This method will use the CHAMELEON system and the SICK laser range sensor. The system will collect information of the environment via the SICK laser range sensor and processed together with the information from the IMU about the movement of the robot to create a map of the environment in 2D. It will also estimate a location relative to the environment. The map will be updated when the robot moves and more information is gathered. This map will then be used by other subsystems both for planning the trajectory and to avoid collisions. The map will be built using occupancy grid to declare different areas in the environment as occupied or not.

4.2 Trajectory planning

Using the 2D map of the environment from the SLAM-system a trajectory will be created which will be recalculated along the way when the map is updated. The trajectory should evolve such as the whole area will be mapped after completion of the trajectory. Different algorithms will be tested for planing the trajectory the goal is to find an algorithm that make sure that the whole area is mapped and that enough information has been gathered to produce a closed map.

4.3 Path following

The path following system should be able to follow a planed trajectory. This will be done using the position from the localization system and an automatic controller.

4.4 User Interface

An interface for setup and control of the robot both for running in fully autonomous mode and in semi-autonomous mode for testing, will exist on the on-board laptop. Visualization of the generated map and other collected data will be available after the mapping is finished.