TTK4550

Mobile Autonomous Robot

An Interesting Topic About Mobile Autonomous Robots

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November 3, 2015

Abstract

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Oppgavebeskrivelse

Introduksjon

Denne oppgaven er en fortsettelse av tidligere prosjekter med utvikling av et konsept for robotisert vedlikehold utført av en mobil autonom robot. I løpet av tidligere prosjekter er en robotarm, flere sensorer, en trådløs ruter, innebygget batteridrevet strømforsyning og en sentral PC blitt festet til en vogn av aluminium. Vognen står på fire omnihjul med hver sin elektriske motordriver.

Målsetninger for prosjektet

For å øke robotens grad av autonomi er det ønskelig å utforske mulighetene for pålitelig og trygg forflytning av roboten uten menneskelig påvirkning. Hensikten med en slik forflytning kan være å nå frem til en ladestasjon eller et punkt der en spesiell vedlikeholdsoppgave eller inspeksjon skal utføres, samtidig som hindringer og farlige situasjoner unngås. Som et ledd i å oppfylle disse målsetningene, skal følgende punkter utføres:

1. Utforsk mulige metoder for autonom navigasjon som kan oppfylle målsetningen over, der datasyn er det primære navigasjonshjelpemiddelet.
2. Implementer en, flere eller en kombinasjon av metodene som ble funnet i punkt én. Dette inkluderer installasjon av nytt utstyr som f.eks. nye kameraer om det er nødvendig.
3. Gjør en vurdering av implementasjonens egnethet for autonom navigasjon i testmiljøet (Kontoromgivelser).
4. Vurder hvor godt systemet håndterer feil og potensielt farlige tilstander og situasjoner.
5. Foreslå endringer og forslag til videre arbeid for å forbedre sikkerheten, påliteligheten og egnethet for autonom navigasjon.

Problem Description

Introduction

This project is a continuation of previous projects in developing a concept for robotic maintenance performed by a mobile autonomous robot. Over the course of previous projects, the system has been equipped with a robot manipulator arm, several sensors, a wireless router, on-board power supply based on batteries and a central PC. This equipment is mounted on an aluminum wagon. The wagon stands on four omni-wheels, each with their own electric motor drivers.

Project Goals

To increase the robot‘s degree of autonomy, it is desired to explore possibilities for reliable and safe movement of the robot without involving a person. The purpose of such a movement may be to reach a docking station or a location where a maintenance or an inspection task will be performed while avoiding obstructions and hazardous situations. As a step towards achieving these goals, the following points shall be carried out:

1. Explore potential methods for autonomous navigation that may fulfill the goals above, where computer vision is the primary navigational aid.
2. Implement one, several or a combination of the methods found in point one. This includes selection and installation of new equipment, e.g. cameras, if necessary.
3. Performance and suitability assessment of the selected implementation with respect to autonomous navigation.
4. Assess how well the system handles errors and potentially hazardous states and situations.
5. Propose changes to the implementation and suggest further work in order to improve the safety and reliability of the system and its ability to navigate autonomously.

Table of Contents

1 Introduction

This section is intended to provide an overview of the contents and context of this report. The first part of this section gives a brief introduction to the field of mobile autonomous robotics and computer vision, as well as the benifits and potential applications for this technology. The robot system and tools used in the project is presented in subsection **??**. Lastly, each of the following sections will given short introductions.

1.1 Mobile Autonomous Robotics and Computer Vision

Put the task into a larger context. Bring in some points on the societal impact of autonomous robotics and the increased potential of mobile robotics.

1.2 System Overview

Brief description of the system.

1.3 Report Structure

How the report is structured, and a very brief description of the contents in each section.

2 Background Theory

The theory that is necessary to understand how the problem was solved.
This section presents the theory that is necessary to understand the implementation presented in section **??**.

2.1 GPU-Accelerated OpenCV

2.1.1 Introduction to Computer Vision and OpenCV

OpenCV started... 1999 Intel. Today, it is a fully open source library with a vast number of advanced computer vision algorithms. The pre-build library can quickly be plugged into an IDE such as Qt Creator or Visual Studio 2013 (not tested for compatibility with Visual Studio 2015 at the time of writing), thus giving the programmer access to all basic OpenCV features. A steb-by-step guide for using both the pre-built and a custom-built library can be found in Appendix **??**.

3 Stereo Vision and Depth Perception

3.1 Introduction

Stereo vision and depth perception is one of the core topics within this report. Here, the theory behind a method using two cameras is presented, while some additional methods are mentioned to provide context.

Methods for computer vision can be separated into two main categories, i.e. active and passive. Active sensors will usually project a light pattern onto the scene to be perceived, before sensing how this pattern is displaced by the topology of the scene. The Kinect sensor and 3d-scanners using laser light are typical examples of active sensors. Passive depth perception makes use of many of the same cues we use to perceive depth. The most common passive sensors extract the depth information by observing observing a scene from at least two different positions.

Optical flow is another important method for depth perception. Optical flow may be either active or passive. The passive variant requires only one camera, but depends on motion and a stream of images to extract depth information. Observing how much some chosen features in a scene has moved in the image frame at $t = 1$ compared to the frame at $t = 0$ is the basis of depth sensing from optical flow. In a static scene, objects that are far away will naturally have an optical flow field with a smaller magnitude than objects that are close.

In this project, passive stereoscopic vision is achieved by using two identical (in theory) cameras placed on the same plane. The second camera is displaced by a few centimetres from the first camera. The gist of this method is based on the fact that objects close to the cameras will have a large displacement from the left to the right camera compared to objects that are further away.

5 Implementation

Everything worked excacly as described in the theory section.

6 Testing and Assessment of Performance

6.1 Navigation

6.2 Real-Time Demands

7 Conclusion

It is a robot.

8 Further Work

8.1 Cooperation With Ole Magnus

Appendices

A Acronyms

blablabla

B Code Listings

```
printf("Hello world!")
```

C Bibliography