



AALBORG UNIVERSITY  
STUDENT REPORT

# P5 Project Report - Autumn 2015

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Group ??<sup>2</sup>

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<sup>1</sup>FiXme Note: Input project title

<sup>2</sup>FiXme Note: Input group number



Title:

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Theme:

Digital and Analog Systems  
Interacting with the Surroundings

Project Period:

P5, Autumn 2015  
02/09/2015 - 17/12/2015

Project Group:

??<sup>4</sup>

Synopsis

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Prints: ??<sup>6</sup>

Pages: ??<sup>7</sup>

Appendices: ??<sup>8</sup>

Concluded 17/12/2015



# Preface

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<sup>10</sup>FiXme Note: Write preface



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# Part I

## Introduction

# Introduction 1

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## 1.1 The Games on Track (GoT) system

We were provided with the 'Games on Track GT-Position' system as a start to be able to figure out the lawn mower position in space.

It is composed of four different parts both hardware and software :

- The tracked module, which emits ultra-sound waves. It should be placed on our lawn mower itself, so that the emitting cell is not obstructed by anything.
- Some beacons or receivers, placed all around the place the lawn mower will move in. Depending on the terrain, we can use from 2 to more than 20 of these : the more we place, the more accuracy we can get to fight against any ambient noise.
- The central system which gathers information about the distance of the tracked module to each beacon and transmits it to the computer via USB in regular intervals.
- The GoT software aggregates the received positions throughout time and can be used to draw a map of the terrain (the lawn) and send every needed information to a third-party (our) piece of software.

GoT was firstly designed for train modeling but it is easily adaptable for any use of position tracking and seems a good choice, at first, for our autonomous lawn mower.

## 1.2 Why not satellite positioning system ?

The reasons why satellite positioning system won't be used in our project are mainly related to accuracy and energy consumption.

Indeed, these kinds of system like GPS or GLONASS would require a dedicated chip to put on the final system. The problem then would be the lack of precision under a few meters (around 2 or 3 meters in ideal situations for the best chips).

Moreover, this kind of system implies slow communications with different distant

satellites at the same time. Therefore, the energy consumption would quickly rise, thus reducing the lawn mower autonomy, which is not desirable.

## 1.3 Potential consumer expectations

The design of a product has no real value if no one is interested in using it. Thus, choices made during this project have to be made in accordance with the final user's expectations.

For instance, we need to keep in mind considerations regarding the autonomy of the vehicle (both in energy and for the navigation), but also towards the overall cost (*insert price approximation here*). Even though, the GoT system itself has a cost beyond anything a normal customer would pay for a lawn mower, it appears, at first, as a good solution for us in terms of accuracy and energy consumption compared to GPS-like systems which are also quite expensive (*insert price approximation here*).

For an improvement, we could consider replacing it with a similar solution as it is only a simple brick of the whole system. (*This sentence should be perhaps moved to a dedicated part of the report*)

These are the types of preliminary considerations that will influence our design process for an autonomous lawn mower.

## Part II

# Design & implementation

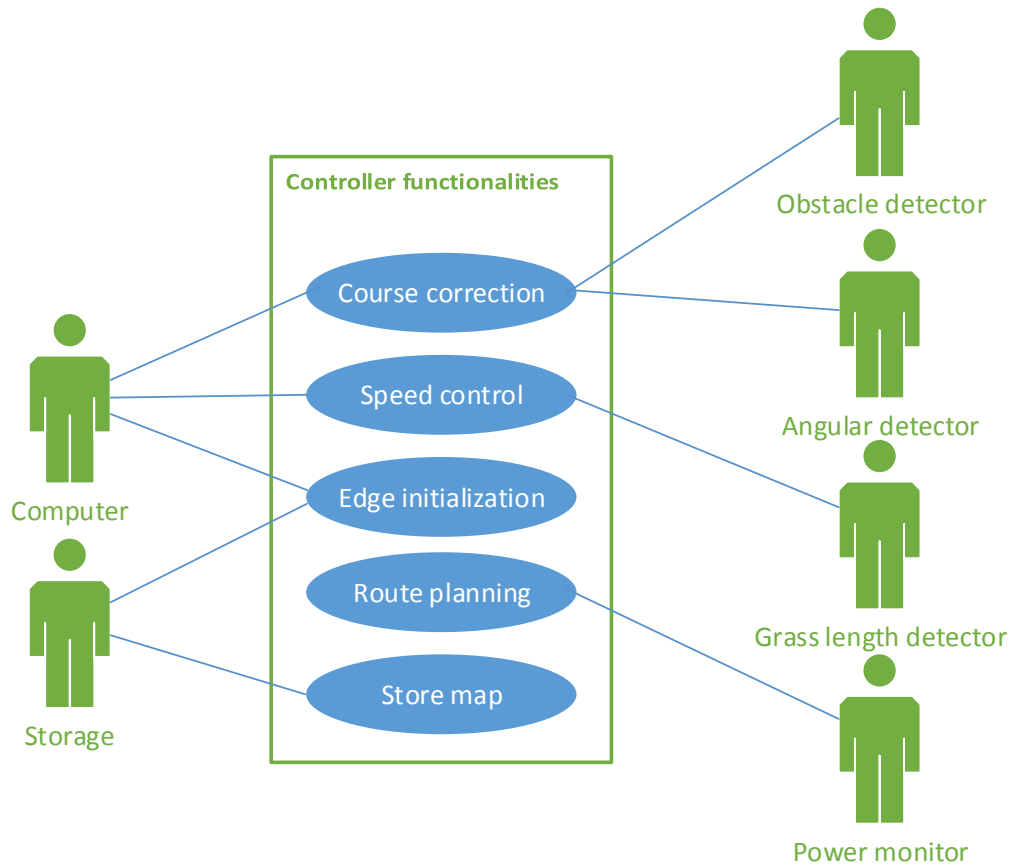
# Design Consideration 2

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In this chapter the system will be designed with a top-down approach. First a use-case of the overall functionalities in the system is described, in order to give an overall view of what the system must be able to do. Furthermore ..

## 2.1 Use case design

To give an overall view of what the system should be able to do, a UML use-case diagram is used to consider and describe the main functionalities and operators in the system, see **figure ??**.



**Figure 2.1:** Use-Case Diagram

The main purpose of the system is to automatically navigate in a specific area. In which area to navigate is decided by the *Edge initialization* functionality, which uses the *Store map* functionality to store the information in storage.

The route to navigate, in the specific area, is provided by the functionality *Route planning*. *Route planning* uses the information, about the specific area, provided by *Edge initialization* to plan the most optimal route in which to follow. Furthermore the *Route planning* needs information about the systems power level to insure the *Route planning* takes into consideration if the system needs charging.

To insure the system is moving with a constant speed or a speed which is fitted to the height of the grass, detected with the *Grass length detector*, a *Speed control* functionality is necessary in the system.

The last functionality, *Course correction*, include rain sensor the course correction is the brain speed control is the muscles.

## 2.2 Prototype Constraints

The aim of this project is to create a functional prototype of an automated lawn mower. To provide proof of concept not all the described functionalities are included. The following sections include a brief description of the technology base on which the prototype is constructed, along with argumentation for delimitation of functionalities.

### 2.2.1 Technology Base

The prototype base is a tracked vehicle as seen on **figure 1.1**, it comes with a brushed DC motor which provides drive power for the belts and a servo which breaks on each side to control the ratio of the differential steering. The tracked vehicle also includes two hall sensors, one by each belt, which keeps track of the speed by measuring pulses from magnets mounted on the front wheels.



**Figure 2.2:** Tracked vehicle with brushed DC motor and a servo<sup>1</sup>

### 2.2.2 Grass Length Detection

Detection of the grass length to control the speed of the lawn mower thus ensuring an evenly cut lawn is a submodule which can be added at any time. Since it is not fatal for a working system and might even be unnecessary depending on time between each mowing of the lawn, it is decided to exclude this functionality from the initial design.

### 2.2.3 Rain Sensor

As the lawn mower is supposed to work outside, it is important to consider that it may be raining, and that an electronic device can be affected by those environmental issues. Even if the electrical part is waterproofed, there is a mechanical threat, a rain sensor could be a security warning to order the vehicle to get back in time. It is possible to build the vehicle aware of those issues and add mechanical modules to secure it. However, the prototype will only be tested indoor, so this type of sensor will not be necessary.

### 2.2.4 Obstacle Avoidance

The lawn movers path might not always be clear, there could be some trees, garden tools, tables and chair, or even persons walking in it. The vehicle should be aware

of what is in front of it at any time, to correct its path and get around the obstacle. To avoid this the sensor could be a pushing button to detect a solid strong object, or an ultrasound detector if the object is breakable. As the aim of the project is to control the path of the vehicle by using angular positioning sensors, a proximity sensor will not be included. Statics objects could be registered on the map to avoid these cases.

### **2.2.5 Power Monitorng**

Power monitoring could be implemented by measuring the voltage across the batteries, to be sure that the lawn mower is not running out of power, and have enough to go back to the station. This will not concern this project because it will be used as an indoor prototype, and in worse case, the last position of the vehicle will be recorded. The user can then take it by hand and plug it into the station.



# Chapter 3

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# Chapter 4

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# Chapter 5

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# Chapter 6

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# Chapter 7

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# Chapter 8

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# Chapter 9

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# Appendix A

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# Appendix B

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# Appendix C

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# Appendix D

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# Appendix E

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# Appendix F

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# Appendix G

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# Appendix H

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# Glossary

## List of Corrections

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Note: Input number of appendices . . . . .	i
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