AALBORG UNIVERSITY
STUDENT REPORT

P5 Project Report - Autumn 2015

??[1]

Group ??[2]

---

[1] FiXme Note: Input project title
[2] FiXme Note: Input group number

AALBORG UNIVERSITY
STUDENT REPORT

5^{th} Semester
School of Information and Communication Technologies
Electronics and IT
Fredrik Bajers Vej 7B
9220 Aalborg
http://www.sict.aau.dk/electronics-and-it

Title:

??[3]

Theme:

Digital and Analog Systems
Interacting with the Surroundings

Project Period:
P5, Autumn 2015
02/09/2015 - 17/12/2015

Project Group:
??[4]

Participants:
Amalie V. Petersen
Julien Brehin
Mads Gotthardsen
Niels Skov Vestergaard
Romaric Destremau
Thomas Rasmussen

Supervisor:
??[5]

Prints: ??[6]

Pages: ??[7]

Appendices: ??[8]

Concluded 17/12/2015

Synopsis

??[9]

Preface

Preface Here[10]

Text by:

Amalie V. Petersen

Julien Brehin

Mads Gotthardsen

Niels Skov Vestergaard

Romaric Destremau

Thomas Rasmussen

[10] FiXme Note: Write preface

Contents

I Introduction 1

1 Introduction 2
- 1.1 The Games on Track (GoT) system . . . 2
- 1.2 Why not satellite positioning system ? . . . 2
- 1.3 Potential consumer expectations . . . 3

II Design & implementation 4

2 Design Consideration 5
- 2.1 Use-case design . . . 5
- 2.2 Prototype Constraints . . . 6

3 Chapter 9

4 Chapter 10

5 Chapter 11

6 Chapter 12

7 Chapter 13

8 Chapter 14

9 Chapter 15

A Appendix I

B Appendix II

C Appendix III

D Appendix IV

E Appendix V

F Appendix VI

G Appendix VII

H Appendix **VIII**

Part I

Introduction

Introduction 1

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 thoughout 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

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. Hereafter, constraints set by time limitations and a focus on the main scope of the project in regards to the proof of concept prototype, is considered. Based on the use-case description and the prototype constraints the requirements for the systems prototype are listed.

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** 2.1.

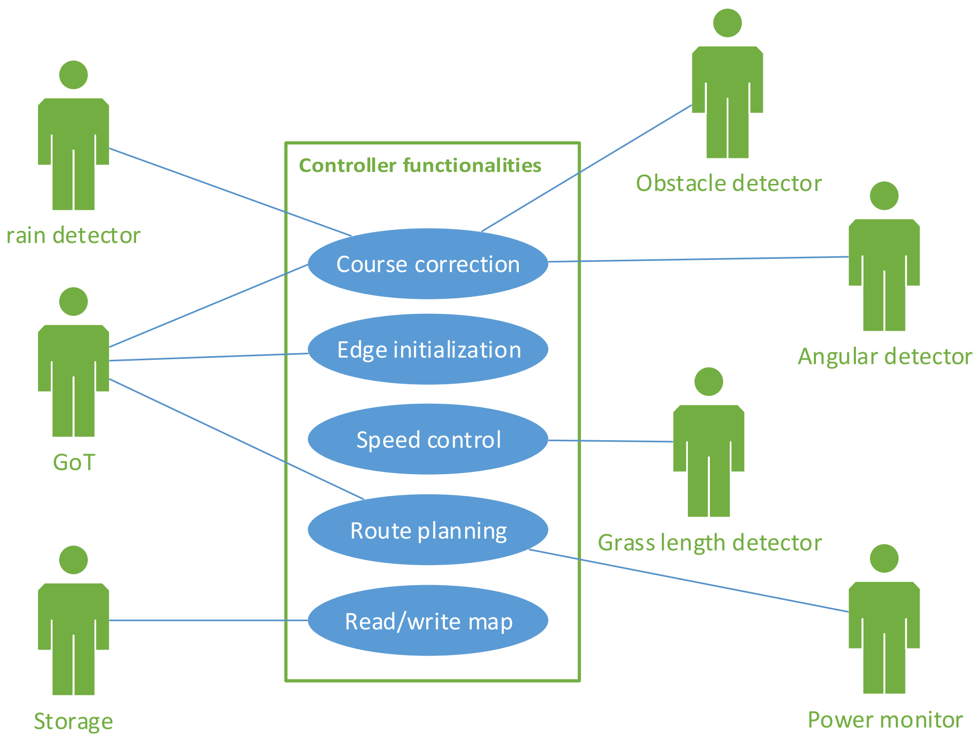

Figure 2.1: Use-Case Diagram

The main purpose of the system is to automatically navigate in a specific area. In which area to navigate is set up by the *edge initialization* functionality. This functionality handles the marking of the areas edges. This functionality only has to be used in the initialization process of the system. The concept is to only use the functionality after the GoT system has been positioned in the area. The consumer then takes the system around the edges of the area, while the GoT system tracks its positions. It is therefore only necessary to used this functionality, and for the consumer to walk with the system around the areas edges, if the GoT system has been moved. While the edge is being tracked, the *edge initialization* uses the *store map* functionality to store the information collected, in storage.

The route to navigate after, in the specific area, is provided by the functionality *route planning*. *Route planning* uses the information, about the specific area, which is collected from the storage, to plan the most optimal route in which to follow. Furthermore the *route planning* needs information about the systems power level to insure the functionality is considering if the system needs charging and therefore have to return to the charging station at some point on the route.

The *store map* functionality as described earlier, handles the communication with storage. Hence it stores information, received from the *edge initialization* and collects information from storage when the functionality *route planning* needs it.

To insure the system is moving with a desired speed (in a straight line and in a turn) 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. To insure the *speed control* can deliver the desired speed an *angular sensor* is utilized.

The last functionality, *course correction* is used when the system strays of the path calculated by *route planning* or if the path gets blocked. The obstacle which is blocking the route is detected by the sensor *obstacle detector*. Furthermore the GoT system and the *angular detector* will detect if the system is not on the desired path, or if the system starts to slip. Also, if it starts to rain, which is detected by the *rain detector*, the system has to return to the charging station. The *course correction* sends the calculated data to the functionality *speed control*. Hence the *course correction* is the brain and the *speed control* is the muscles.

2.2 Prototype Constraints

Before the prototype can be established, some considerations has to be made in respect to the time limitations and the main scope of this semester. The aim of this project is to create a functional proof of concept prototype of an automated lawn mower. The following section includes a brief description of the technology on which the prototype is constructed, along with argumentation for eliminate functionalities.

Technology Base

The technology which has been provided for the prototype is a tracked vehicle, seen on **figure 2.2**. The vehicle comes with a brushed DC motor which provides power for the rotating of the wheels, connected with the belts, and a servo motor which utilize breaks, connected the wheels, to control the ratio of the differential steering. Furthermore the tracked vehicle includes two hall sensors, one by each belt, which keeps track of the speed, of the belts, by measuring pulses from magnets mounted on the front wheels.

AALBORG UNIVERSITY
STUDENT REPORT

Figure 2.2: Tracked vehicle with a brushed DC - and servomotor[1]

2.2.1 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.

2.2.2 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.

2.2.3 Obstacle Avoidance

The lawn movers path might not always be clear, there could be some garden tools, tables or chairs, or people 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 if necessary. 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. Static objects could be registered on the map to avoid these issues.

2.2.4 Power Monitoring

Power monitoring could be implemented by measuring the voltage across the batteries, to ensure that the lawn mower is not running out of power, and to ensure the vehicles calculated route passes the charging station before the power runs to low. This will not be in the prototype, since it is beyond the scope of this project this semester.

Charging station and transmitter (Vicon Room(in technology base))? focus on a quadratic map.

2.2.5 Prototype

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

Chapter 9

Appendix A

Appendix B

Appendix C

Appendix D

Appendix E

Appendix F

Appendix G

Appendix H

Glossary

List of Corrections

Note: Input project title 1
Note: Input group number 1
Note: Input project title i
Note: Input group number i
Note: Input supervisor i
Note: Input number of prints i
Note: Input number of pages i
Note: Input number of appendices i
Note: Write synopsis i
Note: Write preface iii
Note: Insert picture of technology base 7