Degree Project in Computer Science

Second cycle, 30 credits

This is the title in the language of the thesis

A subtitle in the language of the thesis

LINUS WALLIN

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LINUS WALLIN

Master's Programme, Computer Science, 120 credits
Date: August 13, 2025

Supervisor: Christopher Peters
Examiner: Tino Weinkauf
School of Electrical Engineering and Computer Science
Swedish title: Detta är den svenska översättningen av titeln
Swedish subtitle: Detta är den svenska översättningen av undertiteln

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Abstract

Write an abstract that is about 250 and 350 words (1/2 A4-page) with the following components:

- What is the topic area? (optional) Introduces the subject area for the project.
- Short problem statement
- Why was this problem worth a Bachelor's/Master's thesis project? (*i.e.*, why is the problem both significant and of a suitable degree of difficulty for a Bachelor's/Master's thesis project? Why has no one else solved it yet?)
- How did you solve the problem? What was your method/insight?
- Results/Conclusions/Consequences/Impact: What are your key results/ conclusions? What will others do based on your results? What can be done now that you have finished - that could not be done before your thesis project was completed?

Keywords

Canvas Learning Management System, Docker containers, Performance tuning

Sammanfattning

Nyckelord

Canvas Lärplattform, Dockerbehållare, Prestandajustering

Acknowledgments

I would like to thank xxxx for having yyyy. Or in the case of two authors: We would like to thank xxxx for having yyyy.

Stockholm, August 2025
Linus Wallin

Contents

List of acronyms and abbreviations

This document is incomplete. The external file associated with the glossary 'acronym' (which should be called `main.acr`) hasn't been created.

Check the contents of the file `main.acn`. If it's empty, that means you haven't indexed any of your entries in this glossary (using commands like `\gls` or `\glsadd`) so this list can't be generated. If the file isn't empty, the document build process hasn't been completed.

Try one of the following:

- Add `automake` to your package option list when you load `glossaries-extra.sty`. For example:

  ```
  \usepackage[automake]{glossaries-extra}
  ```

- Run the external (Lua) application:

  ```
  makeglossaries-lite.lua "main"
  ```

- Run the external (Perl) application:

  ```
  makeglossaries "main"
  ```

Then rerun LaTeX on this document.
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Chapter 1

Introduction

1.1 Background

Search and rescue (SAR) can be aided by autonomous or teleoperated robots and multi-robot systems, which can help the SAR teams map the area, monitor, or search for victims. There are multiple SAR scenarios in which robots can aid the rescuers, where one such scenario category is urban SAR in which small robots can be used to find a way through collapsed buildings or other urban environments[1].

As earthquakes are very serious disasters which can be fatal due to buildings collapsing and trapping people, it is important that the victims can be found and get help fast. This is an area in which research has been done on multi-agent systems and how they can be used for collapsed building SAR scenarios.[2]

My project will build on the paper by Hengstebeck, et al.[3] which explores the usage of 2D boids in SAR scenarios. Their paper adds ghost boids to the boids algorithm in order to reduce collisions and direct the boids towards a target with a set strength. To reduce the amount of collisions further, Hengstebeck, et al.[3] implemented a control barrier function (CBF).

I will begin my project with implementing the proposed boids algorithm, but in 3D, and also adding the CBF to reduce collisions. The goal is then to expand on it by adding a high level planner (HLP)[4] in the form of an artificial potential field (APF)[5] and explore how it affects the 3D boids SAR algorithm.

The project is of interest to SAR organizations and the general public, as it could lead to advancements in SAR methods which help individuals in difficult scenarios. Collapsed building SAR scenarios are not that common in Sweden, as we do not have high magnitude earthquakes. Although I want to focus on these scenarios in this project, the results might be transferable to other areas that are more relevant in Sweden. Areas that this could be applicable in would be scenarios with fires in buildings or other urban SAR scenarios which might be more of interest to Swedish society.

The high level objective of the degree project is to contribute to the field of SAR by presenting an improvement of the methods that currently used find targets in collapsed building scenarios. The goal is to increase the efficiency of the rescuers by giving them the tools which would allow them to scout a larger area faster than they could without the tools.

1.2 Problem Description

1.3 Research Question

1.3.1 Research Methodology

1.3.2 Scientific and engineering issues

1.4 Purpose

1.5 Goals

1.6 Delimitations

1.7 Structure of the thesis

Chapter 2

Background

2.1 Summary

Chapter 3

Method or Methods

3.1 Research Process

3.2 Research Paradigm

3.3 Data Collection

3.3.1 Sampling

3.3.2 Sample Size

3.3.3 Target Population

3.4 Experimental design and Planned Measurements

3.4.1 Test environment/test bed/model

3.4.2 Hardware/Software to be used

3.5 Assessing reliability and validity of the data collected

3.5.1 Validity of method

3.5.2 Reliability of method

3.5.3 Data validity

3.5.4 Reliability of data

3.6 Planned Data Analysis

3.6.1 Data Analysis Technique

3.6.2 Software Tools

Chapter 4

What you did

4.1 Hardware/Software design . . . /Model/Simulation model & parameters/. . .

4.2 Implementation . . . /Modeling/Simulation/. . .

Chapter 5

Results and Analysis

5.1 Major results

5.2 Reliability Analysis

5.3 Validity Analysis

Chapter 6

Discussion

Chapter 7

Conclusions and Future work

7.1 Conclusions

7.2 Research Question

7.2.1 RQ1:

7.2.2 RQ2:

7.3 Limitations

7.4 Future work

7.4.1 What has been left undone?

7.4.1.1 Cost analysis

7.4.1.2 Security

7.4.2 Next obvious things to be done

7.5 Reflections

References

[1] J. P. Queralta *et al.*, "Collaborative multi-robot search and rescue: Planning, coordination, perception, and active vision," *IEEE Access*, vol. 8, pp. 191 617–191 643, 2020. doi: 10.1109/ACCESS.2020.3030190 [Page 1.]

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Appendix A

Supporting materials

Here is a place to add supporting material that can help others build upon your work. You can include files as attachments to the PDF file or indirectly via URLs. Alternatively, consider adding supporting material uploaded as separate files in DiVA.

The BibTeX references used in this thesis are attached. 

Some source code relevant to this project can be found at https://github.com/gqmaguirejr/E-learning and https://github.com/gqmaguirejr/Canvas-tools.

An argument for including supporting material in the PDF file is that it will be available to anyone who has a copy of the PDF file. As a result, they do not have to look elsewhere for this material. This comes at the cost of a larger PDF file. However, the embedded files are encoded into a compressed stream within the PDF file; thus, reducing the number of additional bytes. For example, the references.bib file that was used in this example is $10\,617\,\mathrm{B}$ in size but only occupies $4\,261\,\mathrm{B}$ in the PDF file.

DiVA is limited to $\approx 1\,\mathrm{GB}$ for each supporting file. If you have very large amounts of supporting material, you will probably want to use one of the data repositories. For additional help about this, contact KTH Library via researchdata@kth.se.
As of Spring 2024, there are plans to migrate this supporting data to

Figure A.1: Adobe Acrobat Reader using the paperclip icon for the attached references.bib file

Figure A.2: Adobe Acrobat Reader after right-clicking on the push-pin icon for the attached references.bib file

Appendix B

Something Extra

svensk: Extra Material som Bilaga

B.1 Just for testing KTH colors

You have selected to optimize for print output

- Primary color
  - kth-blue
  - kth-blue80
- Secondary colors
  - kth-lightblue
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  - kth-lightred80
  - kth-lightgreen
  - kth-coolgray
  - kth-coolgray80

black

Appendix C

Main equations

This appendix gives some examples of equations that are used throughout this thesis.

C.1 A simple example

The following example is adapted from Figure 1 of the documentation for the package nomencl (https://ctan.org/pkg/nomencl).

$$a = \frac{N}{A} \tag{C.1}$$

The equation $\sigma = ma$ follows easily from Equation (C.1).

C.2 An even simpler example

The formula for the diameter of a circle is shown in Equation (C.2) area of a circle in eq. (C.3).

$$D_{circle} = 2\pi r \tag{C.2}$$

$$A_{circle} = \pi r^2 \tag{C.3}$$

Some more text that refers to (C.3).

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"Keywords[swe]": €€€€

Canvas Lärplattform, Dockerbehållare, Prestandajustering €€€€,

}

acronyms.tex

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%%% Local Variables:
%%% mode: latex
%%% TeX-master: t
%%% End:
% The following command is used with glossaries-extra
\setabbreviationstyle[acronym]{long-short}
% The form of the entries in this file is \newacronym{label}{acronym}{phrase}
%                                      or \newacronym[options]{label}{acronym}{phrase}
% see "User Manual for glossaries.sty" for the  details about the options, one example is shown below
% note the specification of the long form plural in the line below
\newacronym[longplural={Debugging Information Entities}]{DIE}{DIE}{Debugging Information Entity}
%
% The following example also uses options
\newacronym[shortplural={OSes}, firstplural={operating systems (OSes)}]{OS}{OS}{operating system}

% note the use of a non-breaking dash in long text for the following acronym
\newacronym{IQL}{IQL}{Independent Q^^e2^^80^^91Learning}

\newacronym{KTH}{KTH}{KTH Royal Institute of Technology}

\newacronym{LAN}{LAN}{Local Area Network}
\newacronym{VM}{VM}{virtual machine}
% note the use of a non-breaking dash in the following acronym
\newacronym{WiFi}{Wi^^e2^^80^^91Fi}{Wireless Fidelity}

\newacronym{WLAN}{WLAN}{Wireless Local Area Network}
\newacronym{UN}{UN}{United Nations}
\newacronym{SDG}{SDG}{Sustainable Development Goal}
```