



Degree Project in Computer Science

Second cycle, 30 credits

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A subtitle in the language of the thesis

LINUS WALLIN

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A subtitle in the language of the thesis

LINUS WALLIN

Master's Programme, Computer Science, 120 credits

Date: August 25, 2025

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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

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?

Search and rescue (SAR) teams are a key part of finding missing people in the event of a natural catastrophe. Time is of the essence since the missing person might be in a critical health state.

To increase the likelihood of finding the missing people in SAR scenarios and reduce the time to do so, drones have become a key tool in aiding the SAR teams.

The issue with having a SAR team controlling the drones is that only one drone can be controlled by one person. By using swarm robotics it is possible for SAR teams to use a large amount of drones to cover larger areas and find the missing people faster.

There are different swarm robotics algorithms and it is of the public's interest to test them all on SAR scenarios, to see which is the best. One algorithm that could be used in these scenarios is the boids algorithm in combination with a control barrier function (CBF) that reduces collisions. This paper aims to explore the possible benefit of guiding the boids algorithm with an artificial potential field (APF).

The boids algorithm and potential field will be evaluated on X SAR scenarios that highlight aspects of real SAR operations.

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

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List of acronyms and abbreviations

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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 their 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

RQ1: How does target-seeking affect the 3D boids algorithm in terms of coverage, safety, and number of boids that are able to find the target location?[3]

RQ2: How does adding a high level planner in the form of a artificial potential field affect the 3D boids algorithm in terms of coverage, safety, and number of boids that are able to find the target.[3][5]

1.3.1 Research Methodology

The

1.4 Purpose

The purpose of the thesis is to provide insight into the potential of APF in combination with the *boids algorithm* to find missing people in SAR scenarios with collapsed buildings.

1.5 Delimitations

Although the goal is to provide valuable information about how well APF in combination with the boids algorithm could do in real collapsed building SAR scenarios, the focus of the project will not be to create realistic scenarios nor take into account for everything that could affect the agents in real life.

One of the delimitations for the project will be that it will not take into account how the drone would have to adjust in real life to achieve the movement in the simulation. This could lead to the agents movement not being completely realistic.

Another delimitation of the project will be that delays in signal processing will not be considered for both the communication between the different agents in the scene and the potential delays in the hardware of the real life drones. This should not make much of a difference, since the delays in todays drone hardware is quite low.

1.6 Structure of the thesis

Chapter 2

Background

2.1 Summary

Chapter 3

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

6.1 RQ1:

6.2 RQ2:

6.3 General Research Question

6.4 Limitations

6.5 Future work

Chapter 7

Conclusions and Future work

7.1 Conclusions

7.2 Reflections

References

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