

Autonomous Precision Drone Landing on Marked Landing Pads and Solidified Lava Flows

Joshua David Springer

5 February 2024

Dissertation submitted to the School of Computer Science at Reykjavík University in partial fulfillment of the requirements for the degree of **Doctor of Philosophy**

Supervisor:Marcel KyasReykjavík UniversityInternal Examiner:Joseph Timothy FoleyReykjavík UniversityInternal Examiner:Gylfi Þór GúðmundssonReykjavík UniversityExternal Examiner:Sebastian SchererCarnegie Mellon University

Pittsburgh, Pennsylvania

This manuscript has been read and accepted for the Graduate Faculty in Computer Science in satisfaction of the dissertation requirements for the degree of Doctor of Philosophy.

Signature	Date
Marcel Kyas Assistant Professor, Department of Computer Science Reykjavik, Iceland	
Joseph Timothy Foley Assistant Professor, Department of Engineering Reykjavik, Iceland	
Gylfi Þór Guðmundsson Adjunt Professor, Department of Computer Science Reykjavik, Iceland	
Sebastian Scherer, Carnegie Mellon University	

Contents

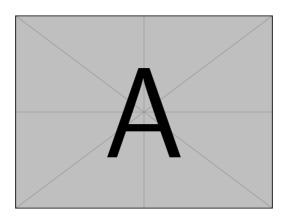
1	Intro	oduction
	1.1	Acknowledgements
	1.2	Abstract
	1.3	Abstrakt á Íslensku
	1.4	Overview
2		ctured Landing Sites with Fiducial Markers
		Overview
	2.2	First Autonomous Landing Attempt
	2.3	Fiducial System Tests and Modifications
	2.4	Second Autonomous Landing Setup
	2.5	Improved Autonomous Landing Setup
3	Viak	ole Landing Sites in Solidified Lava Flows
	3.1	Overview
	3.2	RAVEN Fieldwork, Summer 2022
		Bolluhraun Fieldwork
		Viable Landing Site Detection

iv *CONTENTS*

Chapter 1

Introduction

This is a LATEXtemplate document.[1]



1.1 Acknowledgements

Fusce mauris. Vestibulum luctus nibh at lectus. Sed bibendum, nulla a faucibus semper, leo velit ultricies tellus, ac venenatis arcu wisi vel nisl. Vestibulum diam. Aliquam pellentesque, augue quis sagittis posuere, turpis lacus congue quam, in hendrerit risus eros eget felis. Maecenas eget erat in sapien mattis porttitor. Vestibulum porttitor. Nulla facilisi. Sed a turpis eu lacus commodo facilisis. Morbi fringilla, wisi in dignissim interdum, justo lectus sagittis dui, et vehicula libero dui cursus dui. Mauris tempor ligula sed lacus. Duis cursus enim ut augue. Cras ac magna. Cras nulla. Nulla egestas. Curabitur a leo. Quisque egestas wisi eget nunc. Nam feugiat lacus vel est. Curabitur consectetuer.

Suspendisse vel felis. Ut lorem lorem, interdum eu, tincidunt sit amet, laoreet vitae, arcu. Aenean faucibus pede eu ante. Praesent enim elit, rutrum at, molestie non, nonummy vel, nisl. Ut lectus eros, malesuada sit amet, fermentum eu, sodales cursus, magna. Donec eu purus. Quisque vehicula, urna sed ultricies auctor, pede lorem egestas dui, et convallis elit erat sed nulla. Donec luctus. Curabitur et nunc. Aliquam dolor odio, commodo pretium, ultricies non, pharetra in, velit. Integer arcu est, nonummy in, fermentum faucibus, egestas vel, odio.

1.2. ABSTRACT 3

1.2 Abstract

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

1.3 Abstrakt á Íslensku

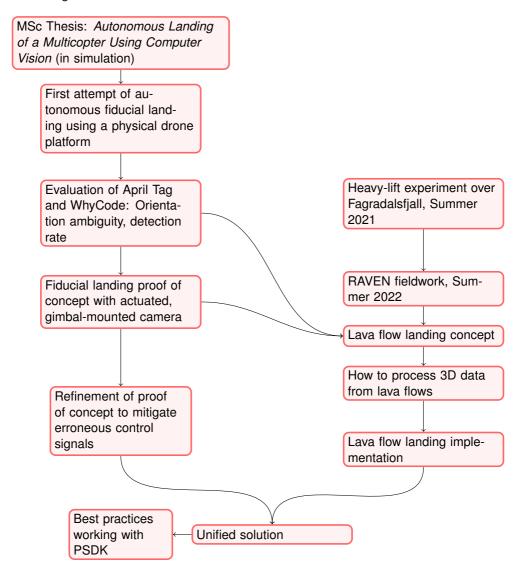
Fusce mauris. Vestibulum luctus nibh at lectus. Sed bibendum, nulla a faucibus semper, leo velit ultricies tellus, ac venenatis arcu wisi vel nisl. Vestibulum diam. Aliquam pellentesque, augue quis sagittis posuere, turpis lacus congue quam, in hendrerit risus eros eget felis. Maecenas eget erat in sapien mattis portitor. Vestibulum portitor. Nulla facilisi. Sed a turpis eu lacus commodo facilisis. Morbi fringilla, wisi in dignissim interdum, justo lectus sagittis dui, et vehicula libero dui cursus dui. Mauris tempor ligula sed lacus. Duis cursus enim ut augue. Cras ac magna. Cras nulla. Nulla egestas. Curabitur a leo. Quisque egestas wisi eget nunc. Nam feugiat lacus vel est. Curabitur consectetuer.

Suspendisse vel felis. Ut lorem lorem, interdum eu, tincidunt sit amet, laoreet vitae, arcu. Aenean faucibus pede eu ante. Praesent enim elit, rutrum at, molestie non, nonummy vel, nisl. Ut lectus eros, malesuada sit amet, fermentum eu, sodales cursus, magna. Donec eu purus. Quisque vehicula, urna sed ultricies auctor, pede lorem egestas dui, et convallis elit erat sed nulla. Donec luctus. Curabitur et nunc. Aliquam dolor odio, commodo pretium, ultricies non, pharetra in, velit. Integer arcu est, nonummy in, fermentum faucibus, egestas vel, odio.

1.4. OVERVIEW 5

1.4 Overview

This section outlines the overall story of the PhD, which originates with the author's master project. We discuss the motivations for each step of the research, and the conditions for transitioning between each.



Chapter 2

Structured Landing Sites with Fiducial Markers

- 2.1 Overview
- 2.2 First Autonomous Landing Attempt
- 2.3 Fiducial System Tests and Modifications
- 2.4 Second Autonomous Landing Setup
- 2.5 Improved Autonomous Landing Setup

Chapter 3

Viable Landing Sites in Solidified Lava Flows

- 3.1 Overview
- 3.2 RAVEN Fieldwork, Summer 2022
- 3.3 Bolluhraun Fieldwork
- 3.4 Viable Landing Site Detection

Bibliography

[1] I.P. Freely. A small paper. The journal of small papers, -1, 1997. to appear.