

CARNEGIE MELLON UNIVERSITY

ROBOTICS CAPSTONE PROJECT

Requirement Specifications and Analysis

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1 Executive Summary

This report provides a requirements specification for our robotics capstone project. Through this document we aim to sufficiently and succinctly outline our project.

1.1 Project Overview

The goal of this project is to build a multi-agent system that collaboratively and efficiently recreates inputted images at variable scale. This system can be used for either reproducing works of art on a larger scale for aesthetic purposes or for marking elements of infrastructure. By using a team of robots that work together, as opposed to a single robotic system, we hope to gain greater efficiency as well as explore various coordination schemes.

1.2 Document Outline

Following this executive summary, we begin by outline the purpose of our project, including its goals (Sec. 2.1) and motivation (Sec. 2.2). We detail both our intended scope in this project (Sec. 2.3) and assumptions we make about our environment and operation (Sec. 2.4).

Next we review the requirements of our system (Sec. 3). We begin by identifying our functional requirements (Sec. 3.1), which define the functionality of our system. Next we detail our non-functional requirements (Sec. 3.2), which provide us with testable performance benchmarks.

We then identify scenarios where our system could be deployed (Sec. 4). This various scenarios informed our requirements. **RH: Change order to put requirements last?** Finally, we describe the various use cases of our system (Sec. 5).

2 Project Description

2.1 Product Goal

items work together - break up a large into small independent pieces that can go on at the same time

will have test plan

2.2 Motivation

automate a dull task. Really dull. Could be dirty, in the sun.

It takes a lot of time, can do overnight for like airports so dont have to worry about paying people. This improves infrastructure quality

Also makes sports things easier to maintain.

Fun thing with children for chalk drawings. Toy. Get the robot to bring your picture to life.

2.3 Product Scope

We want to talk about whats in scope and what might be out of scope

its multi-agent. could have tons of robots. Right now we have 2 as a test bed.

while many use cases involve large scale applications like stadiums we are going to do smaller things like on a poster. Expanding to this would involve making same robots but more durable (ie function outside)

explore uses of different types of writing implements/surfaces: sharpies vs chalk vs spray paint vs markers. Wont explore all but explore some. Might use liquid chalk

out of scope: multiple colors, multiple sized writing tools that can be swapped out

2.4 Assumptions

Some introduction to this blah blah

- A1: Working on flat, homogenous surface (ie no muddy ground - thats out of scope - reference that section)
- A2: Manually loaded writing implement.
- A3: Using writing utensil that writes like a pencil, ie not spray something
- A4: Clear, perfect communication (no noise). Robots can communicate quickly and fairly perfectly in a timely manner

3 Requirements

Some details **MAKE THESE MEASURABLE, especially nonfunctional ones Priority order: 7 Likert Scale - include picture**

3.1 Functional Requirements

FR1: Move in 4 Directions Priority 1

- Fill in more details

FR2: Autonomous Priority 1

- Fill in more details

FR3: Robots Localize Globally and Locally Priority 1

- Fill in more details

FR4: Safe Priority 1

- Doesnt run into things. No dangerous external parts

FR5: Within Bounds	Priority 1
· Stay within bounds of drawing	
FR6: Change Tools	Priority 1
· Easy to swap out tools	
FR7: Drive Control System	Priority 1
· Details	
FR8: Turn on or off writing tool	Priority 1
· So lift pencil up and down while moving. That way doesn't have to be continuous lines	
FR9: Input drawing Plan	Priority 1
· how well can you give it commands	
FR10: Robots Know Progress	Priority 1
· Keep track of how much you have drawn	
FR11: Kill Switch	Priority 1
· immediately powers off robots for safety	
FR12: User Interface to robot	Priority 1
· how it gets controlled	
FR13: Be In Budget	Priority 1
· how it gets controlled	
FR14: Documentation	Priority 1
· Keep code and design documentation	

3.2 Non-Functional Requirements

NFR1: Portable	Priority 1
· Small, can be carried, easy to move around. Weight less than 50 pounds. Size: bigger than 2 foot cube	
NFR2: Completes Task in Timely manner	Priority 1
· Details	
NFR3: Quality	Priority 1
· Matches input well.	
NFR4: Mobile App	Priority 1

- Neil go nuts on your bullshit

NFR5: Reliability

Priority 1

- Percent up time

NFR6: Battery Life

Priority 1

- Needs to last

NFR7: Fault Tolerance

Priority 1

- Needs to last

NFR8: Coordination

Priority 1

- dont duplicate work or overlap

NFR9: Efficiency

Priority 1

- split up work evenly

4 Scenarios

Include pictures in this section

4.1 Chalk Drawing

Drawing large scale items on blacktop/asphalt. People draw for message around campus, proposal, community announcements

4.2 Parking Lot Lines

Redraw parking lot lines. Can be expanded for highway drawing or street markings. Add pavement lines specifications and details

also lines at airports for runways (get specs)

4.3 Sport Lines

Draw lines for football, american football, etc goal lines and posts.

5 Use Cases

5.1 Reload writing implement

Summary: Actors: writing tool Precondition: no writing tool in the system, or one that no longer works Postcondition: system has working writing tool Alternative: - improper loading results in robot alerting user. Other systems - other robot agents know broken robot cannot draw and replan accordingly Description:

5.2 Process input image

Summary: Actors: image, human Precondition: no existing image being drawn Postcondition: image processed and ready for work distribution between agents Alternative: report error on image processing failure. Description:

5.3 Localization

5.4 Scheduling and Robot Planning/Coordination

SHOULD THESE BE SEPARATE

5.5 Move robot

5.6 Deposit ink/marker/writing stuff

5.7 Return Home