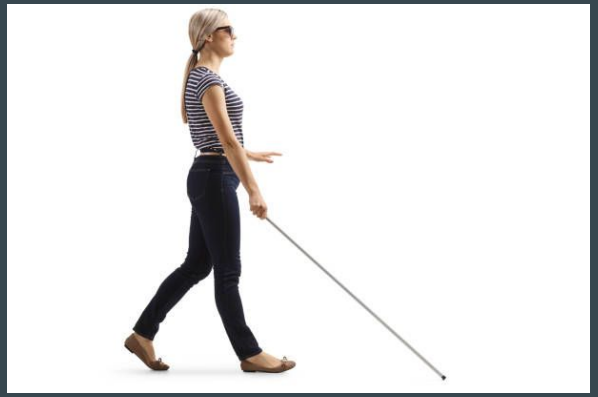
Project NavCampus

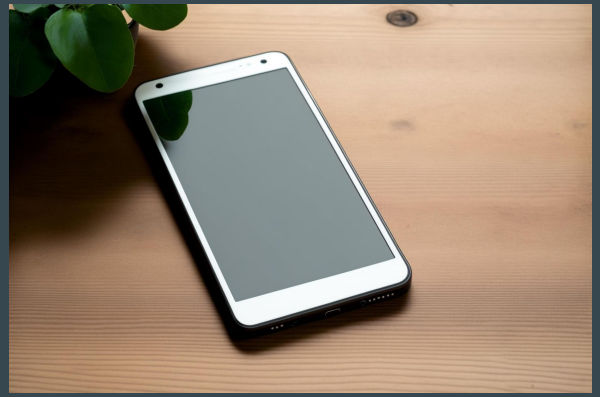
Navigation made simple.



AS-IS

The current state of things

- Alice is a visually impaired student at Cal Poly Humboldt.
- She relies on her cane and auditory cues from people around her to find the correct building and room.
- She cannot use indoor maps. Furniture placement can change without her knowledge.
- Alice must memorize the layout of each building and remember the locations of her classrooms.



TO-BE

How can we do better?

- Alice uses the NavCampus app on her mobile device.
- She uses the audio input feature to specify her desired location, like a building and room number.
- The app's detection system alerts her to any obstacles in her path, and suggests an alternative route.
- The app provides clear audio directions, such as the nearest entrance/route to a desired location.
- In case of an unexpected fall, the app's detection system starts a cancelable countdown. In the worst case, the app alerts the uni police dept. to her location.

Questionnaire Overview / Multiple-Choice Questions

- **How are you navigating on-campus?**
  - Mostly between different buildings
  - Mostly within one building, on different floors
  - Mostly within one building, on the same floor

- **What kind of mobile device do you use?**
  - Smartphone
  - Smartwatch
  - Tablet

- **What senses do you use to operate your preferred mobile device?**
  - Hearing
  - Touch
  - Sight

- **How do you interact with your preferred mobile device?**
  - Braille Keyboard
  - Voice controls
  - Touch feedback/controls

- **What do you value *most* in an interface?**
  - High-contrast
  - No reliance on colors
  - Customization options

- **What platform do you use?**
  - iOS
  - Android

Changes in the WRS

Clarified our definition of a “safe route”:

- **Added functional requirements –>**
  - RC8: Hallways that are hard to traverse shall be marked on the internal map.
  - RC9: Hard to traverse shall be avoided if possible.
- **Added non-functional requirements –>**
  - NR5.4 The safest route is determined by avoiding hard to traverse routes and stairs.
  - NR5.5. "Hard to traverse” is defined as environments posing significant obstacles, impeding smooth navigation.

Changes in other documents

- There were no changes in the Management plan
- There were no changes in the preliminary definition

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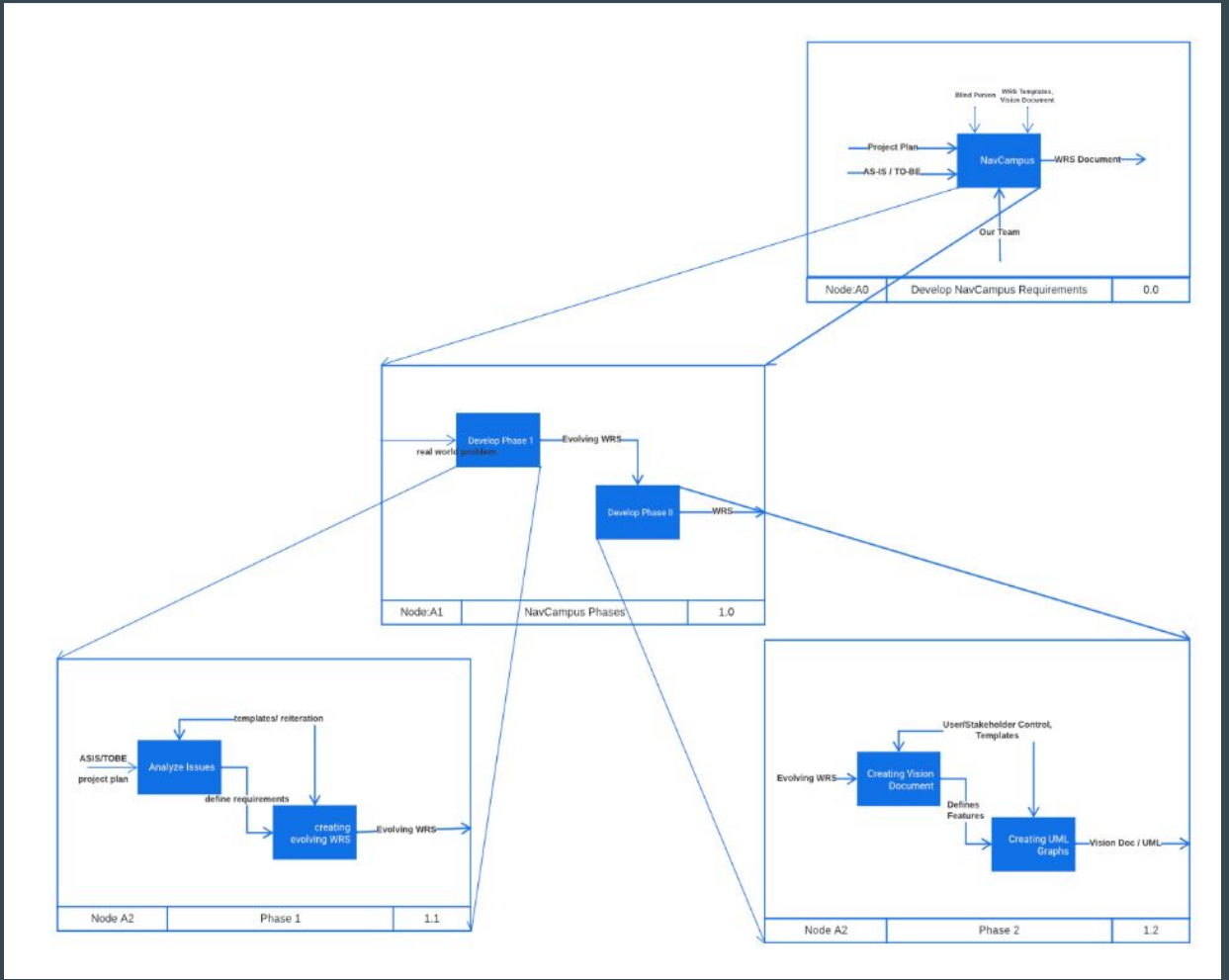
Our Development Process



Phase I - Problem analysis

- Goal –>
  - An analysis of the real life problem
  - Describe the necessary steps to solve this problem
  - Build requirements
- Result –>
  - Evolving WRS document

Phase II - Business Opportunity

- Goal –>
  - Propose a solution to the problem
  - Describe the system using UML
  - Describe the features in a vision document
  - Build a prototype
  - Finish WRS
- Result –>
  - Finished WRS
  - Finished Vision document
  - Functional Prototype
  - UML Graphs

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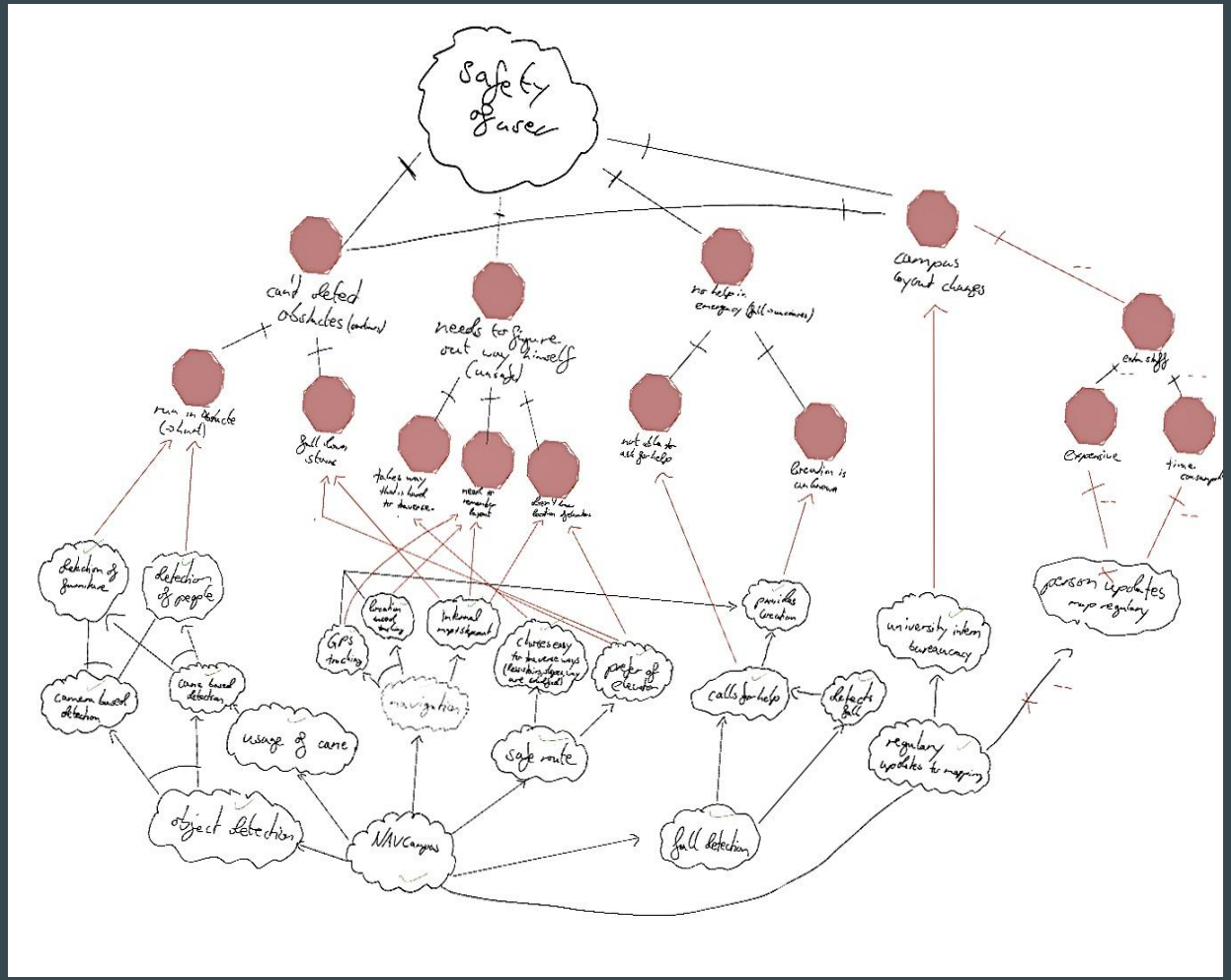
Problem Interdependency Graph



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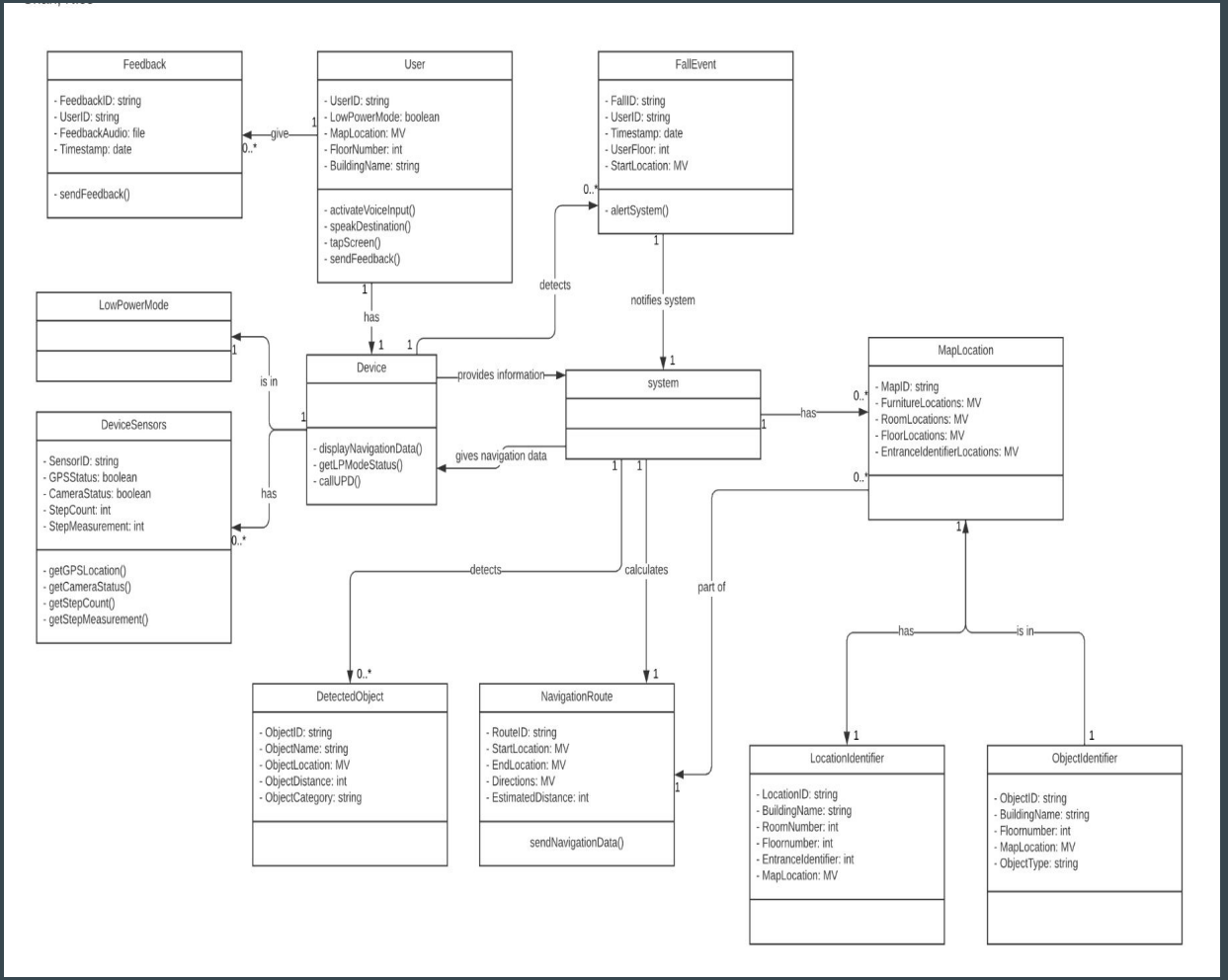
UML Class Diagram



Vision Problem Statement

The problem of	- Not being able to navigate on campus independently
affects	- Visually impaired students and staff members
the impact of which is	- The impacted could get lost on campus or be late to their classes or could decide to choose a different university
a successful solution would be	- a cheap and easy to distribute system that provides navigation as well as an object identifier to prevent collisions and accidents

Vision - Product Statement

For	- Visually impaired students
Who	- Making the university more attractive for those students and giving them the same opportunity's
The NavCampus App	- is a mobile application
That	- Offers navigation fall detection and object detection
Unlike	- The nonexistent system on the Cal Poly Campus
Our product	- Will be usable by all students but will be catered towards the blind ones

Vision - Stakeholders

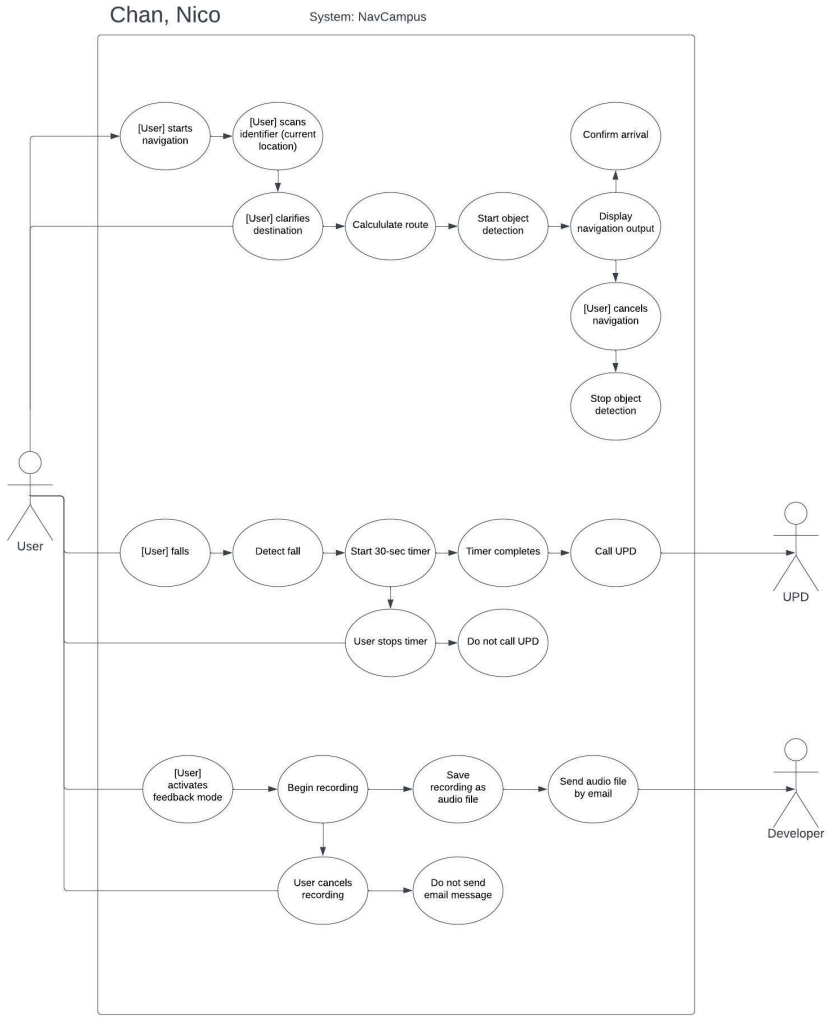
Name	Description	Responsibilities
- Cal Poly Humboldt University	- The main customer and cooperator of the project	- ensures that the system will be maintainable - promotes the project after publication - monitors the project's progress - approves funding - helps monitoring objects on campus - supports the project with the necessary hardware - gets the approval of being filmed from staff and students
- Team NavCampus	- The developers and designers of the system	- produces the product - monitors the project - overviews the project - ensures that the system will be maintainable - Making sure the system is safe

Name	Description	Responsibilities	Stakeholder
- Visually impaired student and staff	- Target audience	- In final testing phases giving feedback - Using the app according to manual	- advocates of blind students, help workers
- Students and staff members	- Secondary audience	- Using the app according to manual - Do not demand changes for seeing students with the feedback function	- Because they are not the primary audience they will not be taken into account

NavCampus Vision

Feature	Functioning
Finding the location	An internal map has identifiers on every room and entrance that can be scanned so the system knows the location
Object detection	The system can identify objects and the distance to them using the devices camera
Fall detection	The system uses the devices sensors to detect a fall and can call UPD if needed
Audio input and output	The system gives the navigation using audio files and can also understand the audio input of the user to find the destination
Safe route calculation	The system can find the safest route (less stairs) on campus between two identifiers and give the user the necessary instructions

Use Case


Chan, Nico
System: NavCampus
[User] starts navigation
[User] scans identifier (current location)
[User] clarifies destination
Calcululate route
Start object detection
Display navigation output
Confirm arrival
[User] cancels navigation
Stop object detection
User
[User] falls
Detect fall
Start 30-sec timer
Timer completes
Call UPD
UPD
User stops timer
Do not call UPD
[User] activates feedback mode
Begin recording
Save recording as audio file
Send audio file by email
Developer
User cancels recording
Do not send email message

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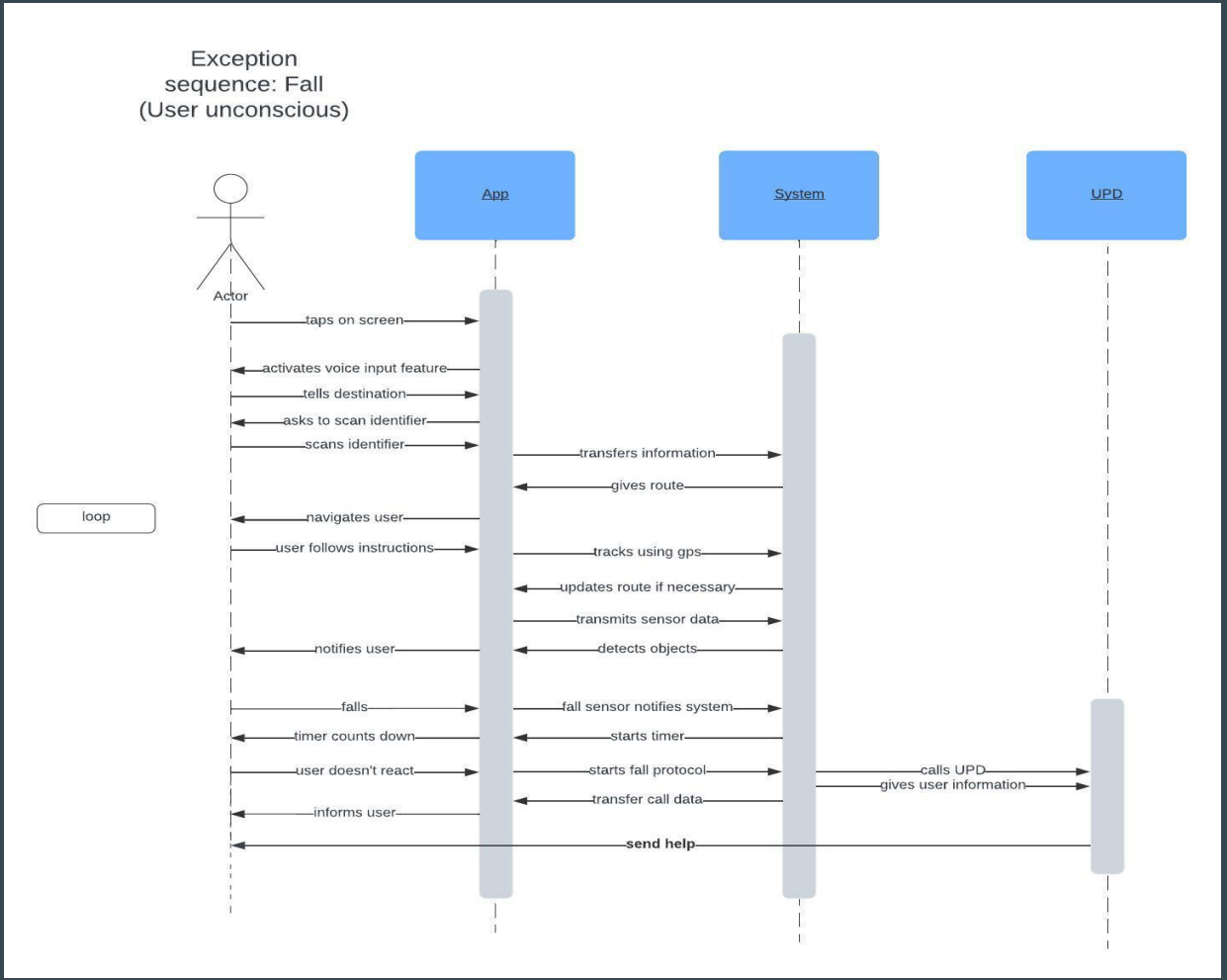
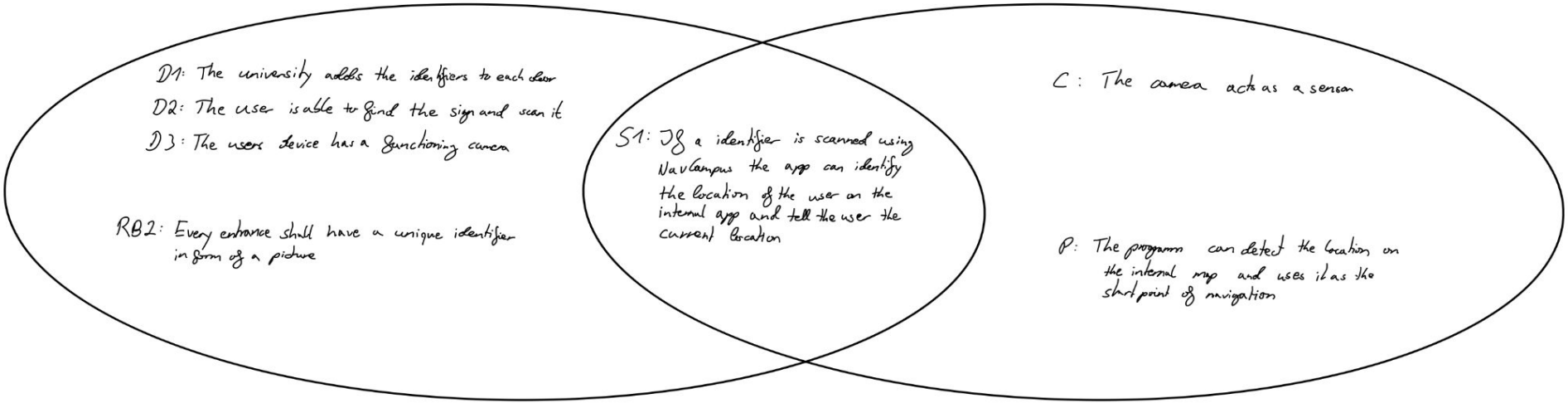
Functionality / Sequence Diagram

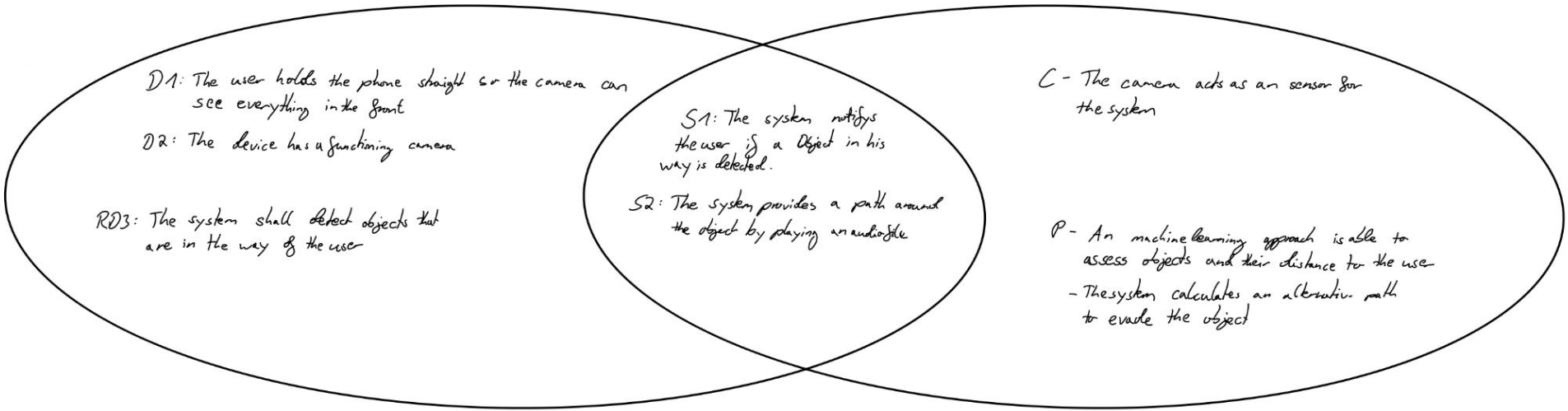


Reference Model



eh: All activities of the user as well as the general presence of a identifier
ev: When there is an identifier, the scanning of it as well as the users interactions with the device
SV: the algorithm to find the users location as well as well as the map itself
SH: the acoustic confirmation of the location

Reference Model



eh: The user uses the device correctly (straight), the user is able to hear the system
eV: Objects/Path in front of the camera
sV: Notification of detected object + instructions of the alternate path
Sh: the algorith that calculate the distance, the detection and the alternative path

WRS/Vision - Finding the Location

Vision:

5.1 Navigation

5.8 Map Identifiers

WRS:

RC 2 to 7

RC3: The system shall take the GPS to detect the direction the user is phasing and in which direction he/she/they are moving.

RB 1 to 2

RB2: Every location (entrances, rooms) shall have a unique identifier in the form of a picture.

WRS/Vision - Object Detection

Vision:

5.2 Object detection

5.10 Machine learning

WRS:

RD 1 to 3

RD3: The system shall detect objects that are in the way of the user, excluding the cane.

RD 4

RD4: The system shall have a machine learning algorithm to learn to detect objects and the distance to the user, using the camera of the device.

WRS/Vision - Fall Detection

Vision:

5.3 Fall detection and emergency call

WRS:

RE 1 to 4

RE1: The fall sensor shall be activated throughout the use of the app.

RE3: In case that the countdown is not deactivated, the system shall call the university police department to get help.

WRS/Vision - Audio Input and Output

Vision:

5.4 Voice input and output

WRS:

RA1, RA3, RA4, RA8

RA1: The app shall have an voice input feature, to give it the desired location.

RA4: The app shall give the navigation data via audio.

WRS/Vision - Safe Route Calculation

Vision:

5.5 Route Calculation

WRS:

RC1 and RC2:

RC2: The app shall prioritize elevators over stairs during navigation.

RC8: Hallways that are hard to traverse shall be marked on the internal map.

NavCampus - User Manual Overview

- Introduction
  - Explain what this document is about.
- System Requirements
  - Make sure the user's device meets a set of requirements.
- Installation Instructions
  - Tell the user how to go about accessing/installing the app.
- User Interface Overview
  - A tour of the user interface.
- Using NavCampus
  - Navigation
  - Fall Detected
  - Submitting Feedback
- Frequently Asked Questions
  - Answers to some common questions and issues.
- Contacting Support
  - Tell users how to reach out to our support team.

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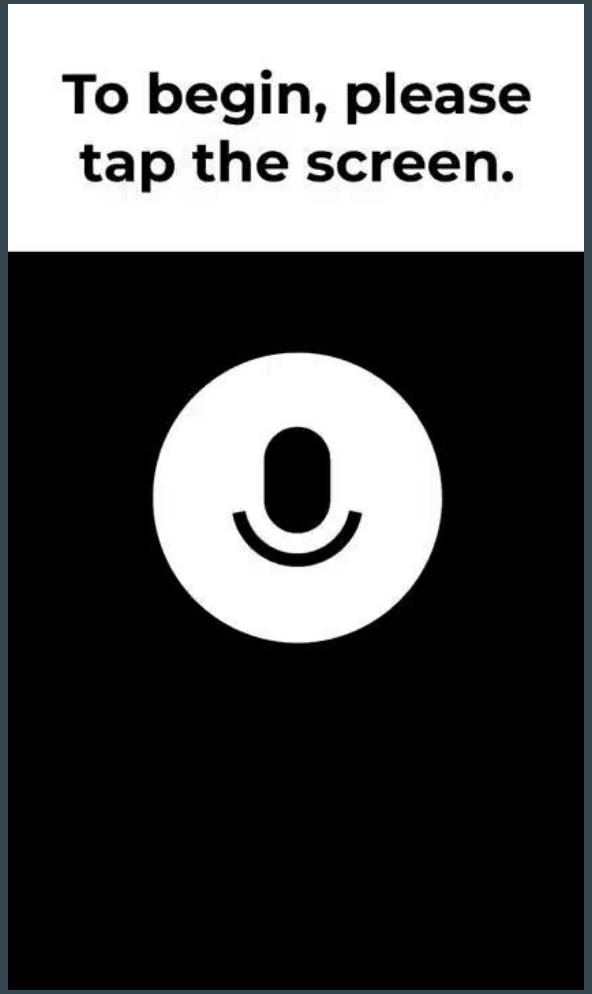
Fall Detection



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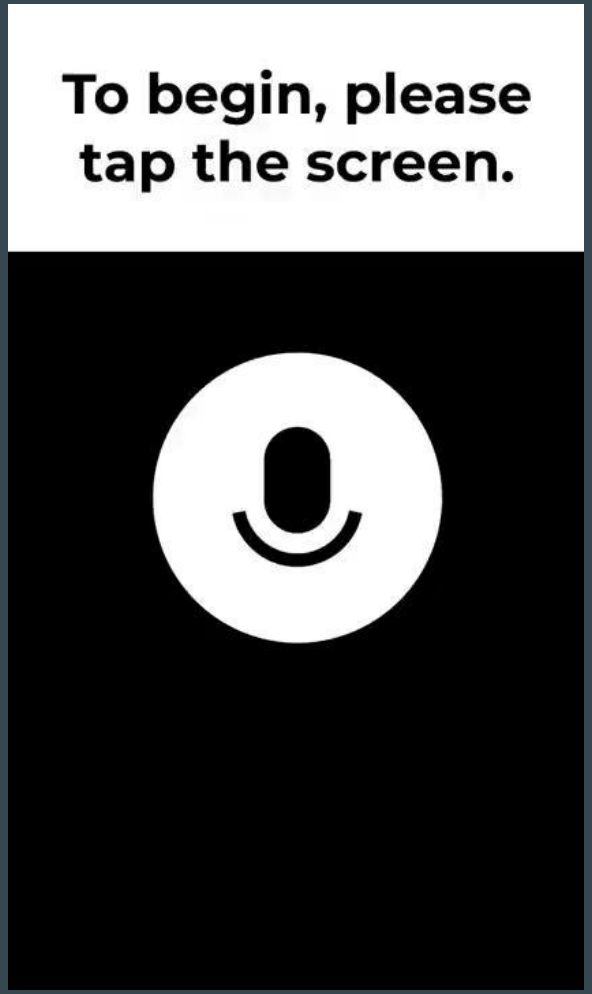
Navigation Demo



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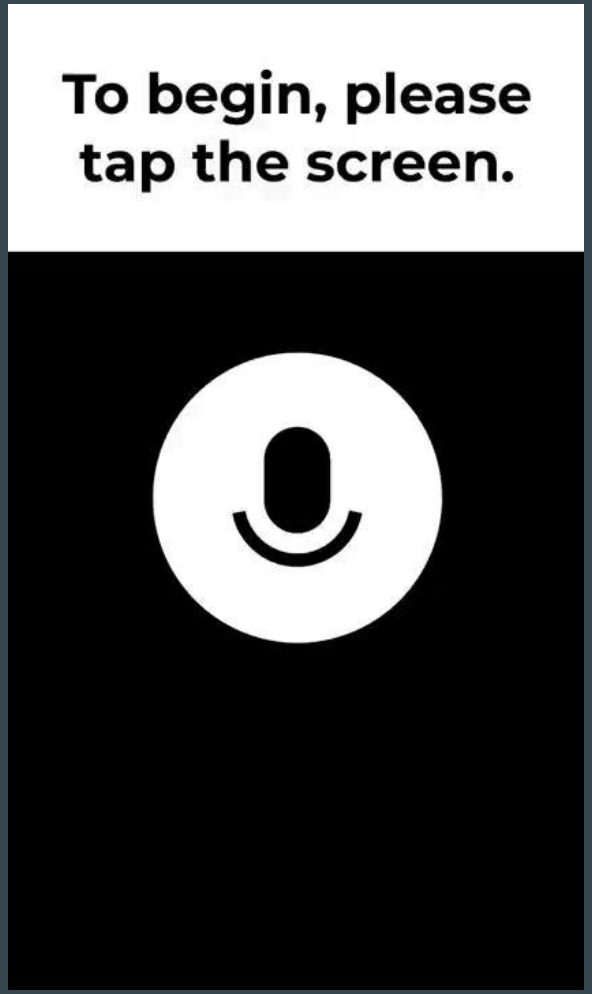
Object Detection Demo



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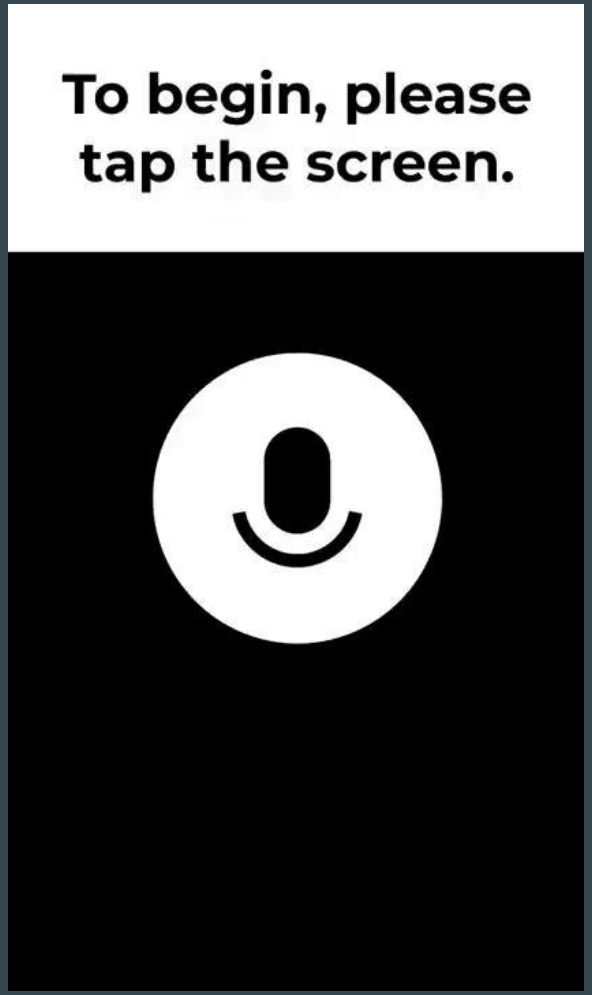
User Feedback Demo



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Creeping Rate: Estimation vs Reality

Why NavCampus?

- The user interface is simple: tap, speak, or both
- Power efficient, doesn't do anything it doesn't need to
- Anyone can use it, regardless of vision impairment level
- Focused on the lowest common denominator; makes use of features most mobile devices already have
- Doesn't need external hardware for navigation and is therefore cheap

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Q&A