Scotty Maps

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A system that aims to provide indoor navigation to help students find their next class

18500 Capstone / Team B7

Use Case

Problem

Students waste time find the rooms their classes are in, current navigational software utilizing GPS only works outdoors

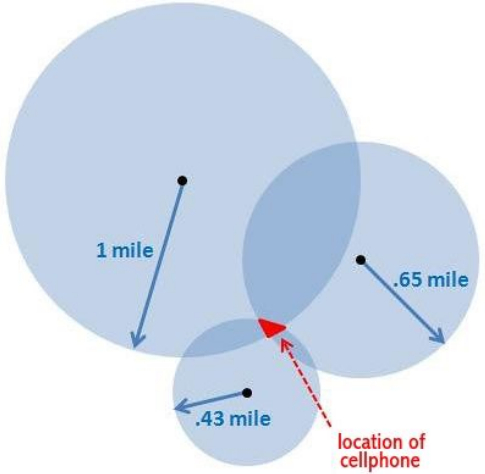
Solution

An indoor localization and navigation system that guides students to specific rooms in buildings

ECE Areas

- Software Systems
- Signals and Systems

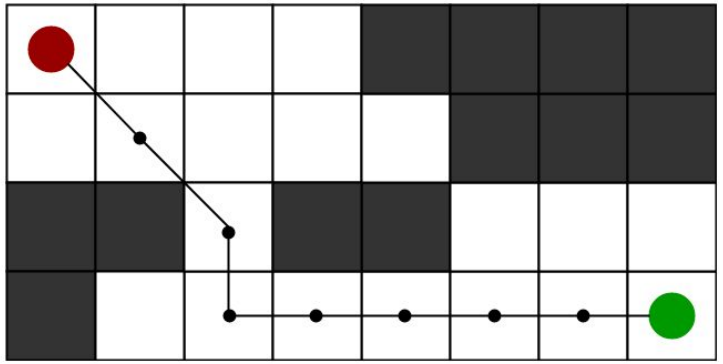
Use Case Requirements



Localization Accuracy

- Provide location of user to within 1 meter, as this about the width of a door and the tightest hallways, making it sufficient for modelling building features
- Determine orientation/heading of the student within 1 second of movement, as an average student walks at about 1 meter/second
- Should remain robust even if environmental factors change, such as obstructions and interference

Use Case Requirements



Responsive Directions

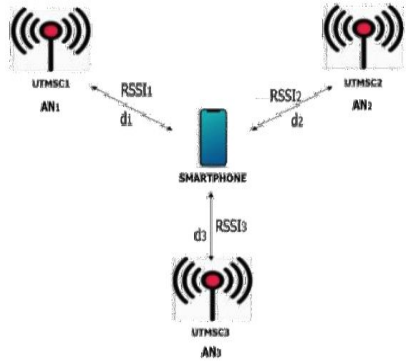
- Find the shortest route to the desired class, providing instructions to navigate around obstructions such as walls, corners, and other rooms
- Low latency (< 1 second) to update UI with directions and current position, to keep in line with our localization update time
- Environment is mapped manually beforehand, such that all relevant features are included

Use Case Requirements

Device Characteristics

- Size should be less than 0.3 cubic feet and weigh less than 3 pounds, similar to the size and weight of laptops
- Battery life should last at least 4 hours of use, as we estimate that this is the maximum amount of time that a student walks in a day, ensuring all-day use

Technical Challenges



Localizing the user

- Design an accurate method of localization robust to environmental interference (i.e. pre-existing Wi-Fi signals)
- Fusing data from multiple sensors to provide accurate localization

Responsiveness

- Implement efficient localization algorithm that runs quickly on embedded device
- Design webapp UI that quickly reflects changes in location

Technical Challenges

Map Directions

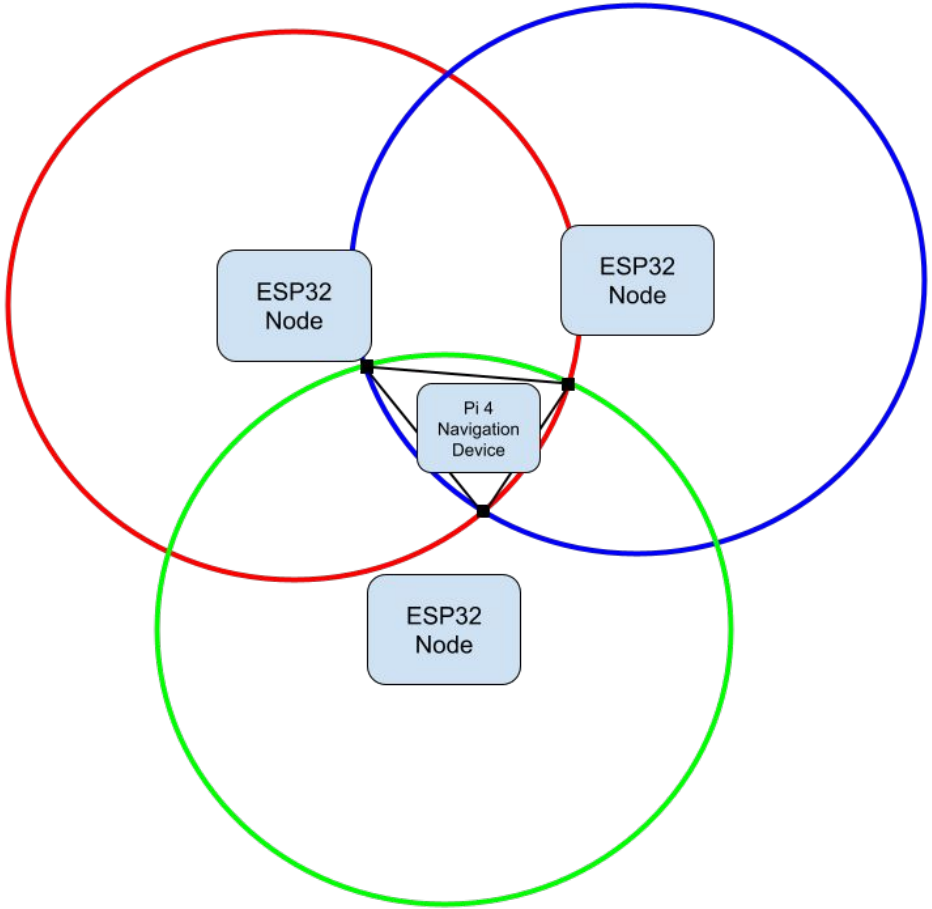
- Finding the shortest path within a building, even with walls and other obstacles present

Portability

- Device needs to run on low power to last long enough on a charge
- Power switch/sleep mode when the device is not used

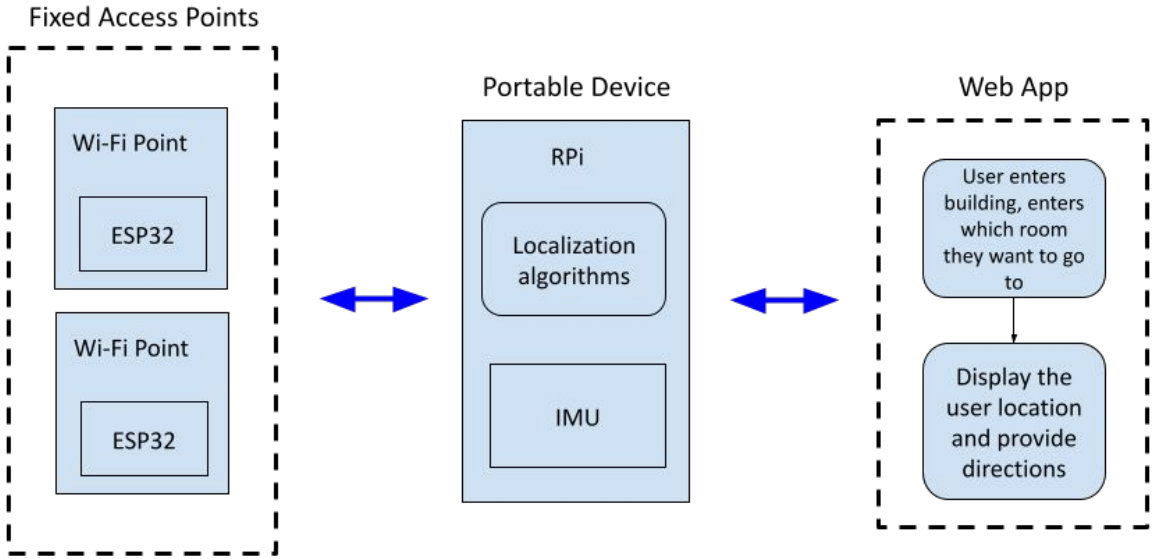
Solution Approach: Localization

- Esp32 as Wi-Fi access points
- Raspberry Pi as the Wi-Fi receiver
- Use received signal strength indicator (RSSI) to get distances from access points
- Use Triangulation and Trilateration for localization



Solution Approach: Block Diagram

- User interface with Django Webapp
- Display user location and directions on phone screen
- Use A* for navigation



Testing, Verification, Metrics

Wi-Fi Points

- Set up our nodes across a single floor of a building on campus
- Ensure the range of the nodes is **>25 meters**

Receiver

- Record predictions of locations and compare them with actual location and ensure the RMS error is **<1 meter**
- Ensure localization algorithm takes **<500 ms**
- Test power consumption so battery life is **>4 hours**

Web App

- Navigation should follow true shortest path directions through building
- Test usefulness of directions with clients, utilizing a survey to rate satisfaction out of five

Tasks and Division of Labor

Ifeanyi

- Wi-Fi access points

Weelie

- Design of receiver and localization algorithms

Jeff

- Web app, mapping features

Schedule

Scotty Maps

18500 Capstone / Team B7 / Development Schedule

Project start: Sun, 2/4/2024

Display week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Planning				
Ideation	All	100%	2/4/24	2/7/24
Proposal Slides	All	100%	2/11/24	2/14/24
System Design research	All		2/4/24	2/7/24
Acquire Components	All		2/8/24	2/11/24
Research design of receiver	Weelie, Jeff		2/9/24	2/14/24
Research design of nodes	Ifeanyi, Jeff		2/9/24	2/14/24
Development				
Set up Django App	Jeff		2/12/24	2/14/24
Frontend display building	Jeff		2/15/24	2/20/24
Create Graph of a Building	Jeff		2/21/24	2/26/24
Navigation Algorithm	Jeff		2/27/24	3/3/24
Set up Pipi, test RSSI	Weelie		2/19/24	2/22/24
Triangulation Algorithm	Weelie		2/23/24	2/28/24
Trilateration Algiorithm	Weelie		2/29/24	3/3/24
Position Estimation	Weelie		3/11/24	3/14/24
Communication with webapp	Jeff		3/15/24	3/21/24
Set up Esp32	Ifeanyi		2/19/24	2/22/24
Setup network w/ Pipi	Ifeanyi		2/23/24	2/28/24
RPi IMU	Ifeanyi		2/29/24	3/3/24
Wi-Fi Housing/Circuitry	Ifeanyi		3/11/24	3/15/24
Mapping location	Weelie, Ifeanyi		3/16/24	3/21/24
Refinement of Localization	All		4/1/24	4/8/24
Slack	All		4/15/24	4/22/24
Testing and Validation				
Test, troubleshoot localizatio	All		3/22/24	3/27/24
Test navigation	All		3/28/24	4/1/24
Full Scale Testing	All		4/9/24	4/14/24
Deliverables				
Design Presentation	All		2/13/24	2/18/24
Design Document	All		2/19/24	3/1/24
Interim Demo	All		3/2/24	4/1/24
Final Presentation	All		4/2/24	4/21/24
Final Documents			4/22/24	4/24/24