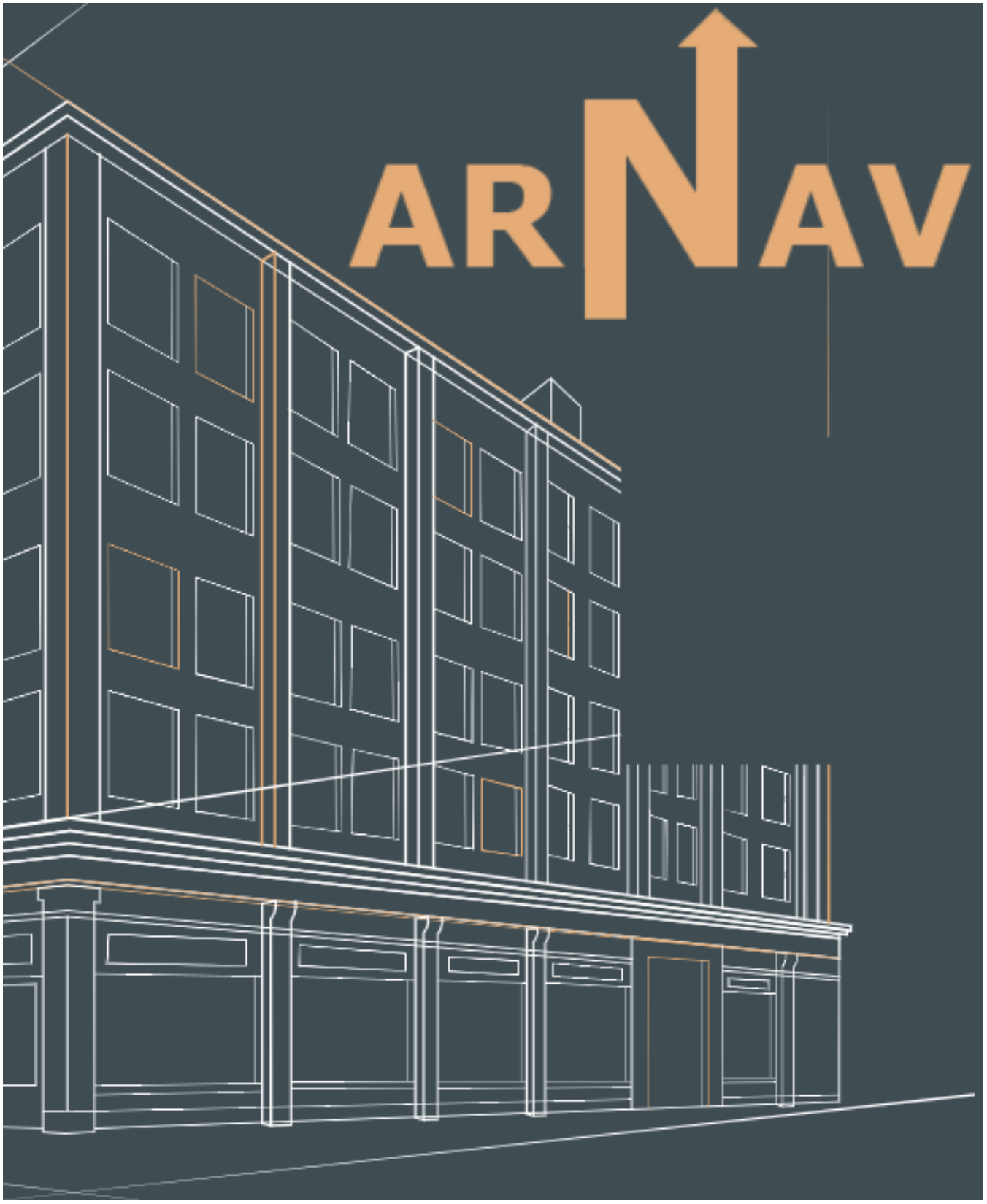

Honeywell Team 1

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- Honeywell
- Real Skills Education

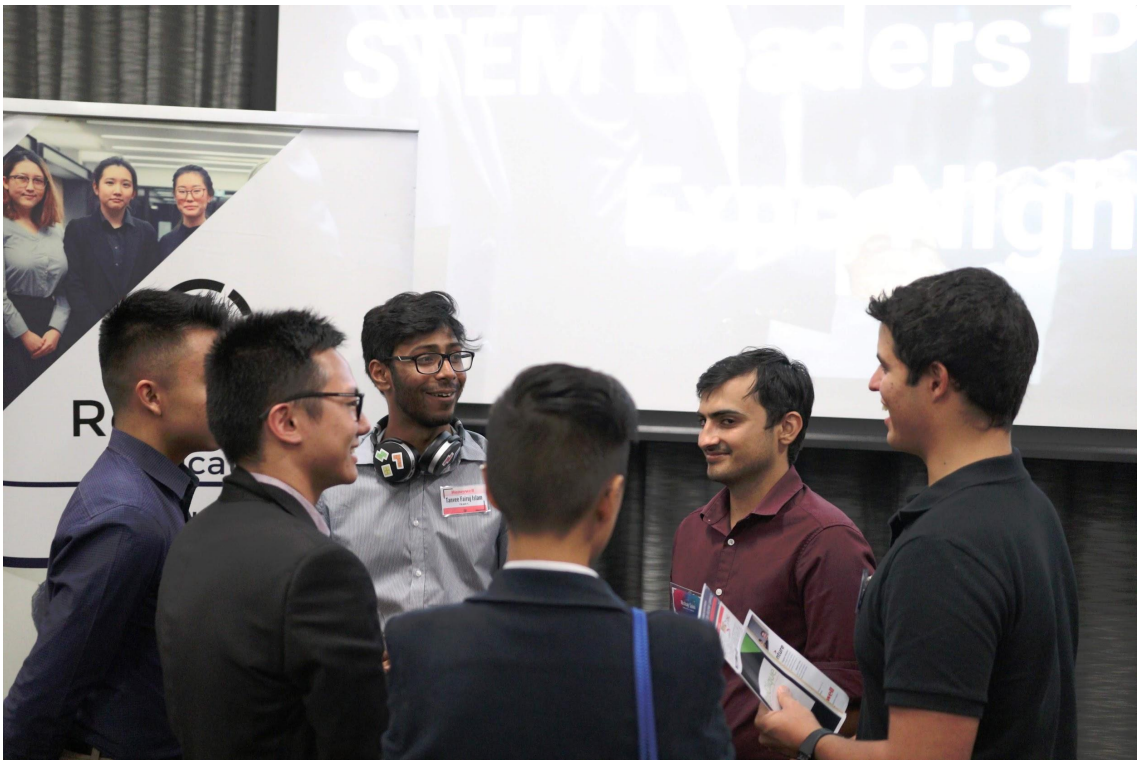


Table of Contents

Introduction

Project Background

This project revolves around the idea of navigating through an unfamiliar building, as many find themselves getting lost during moments after entry. Although visitors utilise the routes directed from kiosks, they tend to forget the visual information provided. Users also tend to misunderstand the maps and signs around them. When public users think of navigation, they would most likely think of existing map services such as Google maps and Apple maps which utilise GPS. Existing GPS technology is universally praised for its accuracy in outdoor locations but in large indoor locations, there are physical barriers and other interference sources which make tracking your exact location very difficult.

The scope of this project requires the design and creation of a solution which aids the visitor of the vicinity to navigate through the building to reach their destination. In this project, a single floor in a building was used as a simplified scale of the environment of which this project was based on.

Problem Statement

To design an application that allows visitors to navigate through an unfamiliar building to reach their destination without having the trouble to remember the route.

Design Concepts and Considerations

Design Concepts

Key Features	Description
Search Destination	The search destination feature involves the initial user input of which the ultimate destination is to be inputted by the user.
Navigation	The navigation feature involves a guidance interface which provides the literal direction or instruction as to which the user is to be navigated through.
Indication of Destination	The destination indication feature involves a visual representation of the location of the user’s intended destination.

Design Considerations

1. ***RSSI Wi-Fi Fingerprinting:*** Detects the user's location by determining the signal strengths of the Wi-Fi connection between the user’s device to the router located across the building.

Advantages	Disadvantages
- Cheap - Simple and fast implementation in pre-existing buildingsMost buildings have pre-existing Wi-Fi routers for users	- Very inaccurate - Available only on Android; limited audience

2. *RSSI Bluetooth Beacons:* Detects the user's location by determining the signal strengths of the Bluetooth connection between the user's device to the beacons located across the building.

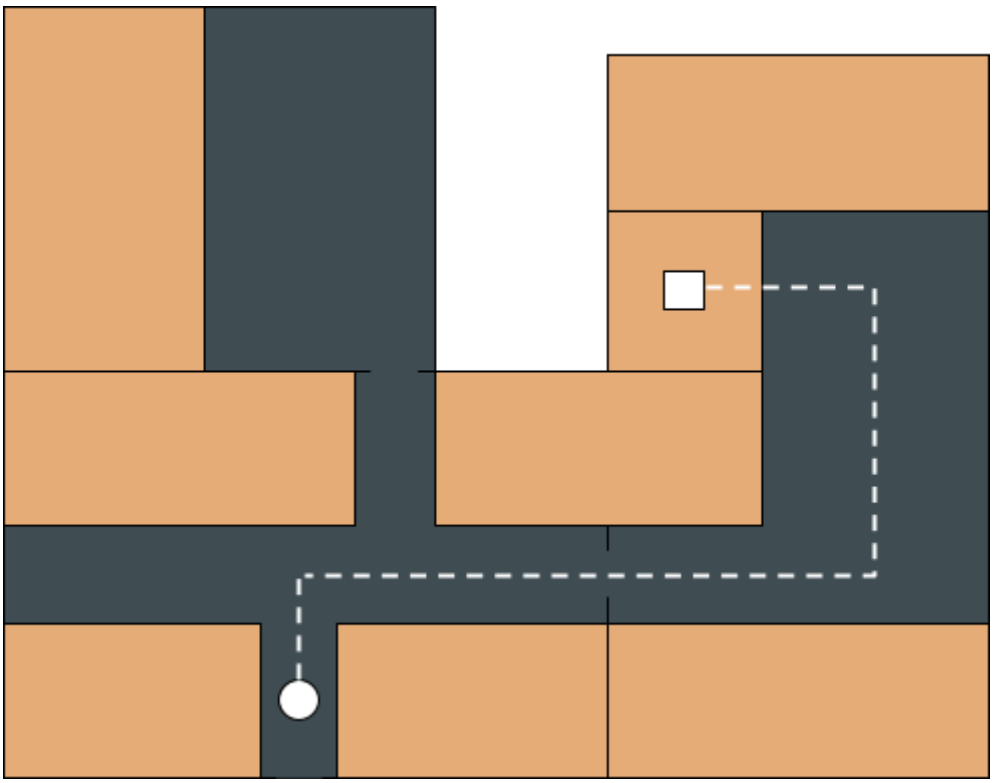
Advantages	Disadvantages
- Accurate	- Expensive; maintenance + initial installation - Can only connect in small ranges - many beacons have to be installed to cover the entire building. - Hard to install in pre-existing buildings

3. *Computer Vision using an open source SDK:* Detects the user's location by detecting computerised markers located across the building.

Advantages	Disadvantages
- Accurate outcome - Cheap	- Involves AI and machine learning - requires knowledge of it to use technology properly - Regular monitoring in case of system breakdown and glitches

Displaying the Map and Directions

2D Mapping



AR Technology

Design Evaluation

In culmination of all the initial concepts generated, the design involving the utilisation of AR technology was evaluated to be the most efficient and reliable solution both technologically and economically. This was due to the cheap expenses required for the design, and the ‘phone-window’ concept it establishes to provide the user with an easier and more efficient experience. Comparing this to a 2D map design, this design has already been widely used where the user would require constant action of looking down at their phone, therefore making user experience worse.

Design Process

Our design process was highly iterative and consisted of these main stages: brainstorming, research, design and evaluation. We considered utilising the agile software development process for the project but because many team members had many commitments throughout the first week, we could not strictly follow the key concept of regular online meetups or face to face communications everyday. Our team encountered many obstacles along the way and we had to respond to these changes rather than continuously follow a preset time management plan. Chief among these obstacles was deciding whether to make the prototype using an online AR.js library which had a very steep learning curve since no member had any experience with javascript. Our other option was using the Unity game engine and its many libraries such as Vuforia, ARCore and ARKit. Since there were far more tutorials on Unity and the fact Unity was easier to learn to use, we proceeded to design a prototype on Unity instead of our original preferred AR.js which we encountered during our research.

We put elements of the agile software development process into practice but ultimately we tried a user centred design process. During this process, we initially brainstormed features to include in a navigation application’s UI. By looking at existing Google Maps and Apple Maps UI, we decided to include a search bar with a dropdown option which showed destination/store names which match up to what the user inputted

in the search bar. To make it more user friendly, a small icon of the store name would also appear beside the text of the store name. E.g. Herschel logo icon appeared beside the store name Herschel. If the user misclicked a store name and wants to search a different store, a go back button was implemented to return to the previous page.

We then did some user testing by asking random passing people around the university and close friends on what to include and not include in our UI. From our small sample of users in the young adults demographic from 18-25 (five people), we found out that we could improve our existing UI by incorporating our store options which were originally just buttons into a dropdown list. This freed up space on the front page. Our users gave us feedback on the consistency of colours and textures in the UI on the different pages of the web app and also to keep the interface simple.

To build a working prototype, we utilised the incremental build model. The prototype was broken down into several components and each component was assigned to a different team. One group was given the responsibility of tackling the user interface (UI) and user experience (UX) while the other group handled the problem of developing the AR models and coding the navigation feature between the initial source marker and the destination.

The UI team ultimately decided on a simple UI design with consistent colours and font choices. We received great feedback from testers including the need for dropdown search lists and reminders of which store they selected as their destination. The backend developers of the project handled the challenge of hard coding a prototype instead of doing pathfinding algorithms such as the A* or Dijkstra pathfinding algorithms. Showing a 3D AR feature of the markers and the pathway users would take was a great challenge. We had a great time making unique markers that would be catchy and interesting to look at. We couldn't quite code in arrows showing the pathway for users to follow and instead it was a long 3D rectangular prism block which could be improved in future prototypes.

Performance

Final Outcome

As a result from the process, a UI demonstrating the usage of the webpage, along with a demo of how a 3D digital line created from AR to navigate was created.

Future Improvements

Since our product(ARNav) is at an early stage of development, there are many improvements needed in order to make our product a more viable solution to the broader users. Through the aim of giving the optimal navigating experience, we propose the following implementations that can possibly improve ARNav to suit the broader needs of the users:

- Navigating multiple floors - Building with multiple levels certainly adds to the difficulties of finding a specific location for the user, so we need to make ARNav to be able to direct users through different floors of the building.

- Navigating between buildings - An area with multiple buildings such as a university campus, users sometimes need to go from one building to another. In order to make ARNav a feasible solution to the University students, ARNav needs to have the ability to navigate between two different buildings
- Integration of a 2D map - For users that don't like the visual effect of augmented reality(AR) or they worry about the battery drainage of the AR technologies. We decided that we can integrate a 2D navigation map to the AR, so users can choose which mode of navigation they prefer to use.
- Automated Map Generation - If we can make ARNav to generate maps automatically, it can give the users a smoother and faster navigating experience.
- Voice Assistance - For users that don't want to look at their device constantly for navigation, users can choose to wear earphones/headphones to listen to the navigating instructions. Voice assistance can also be presented throughout the visual navigation to give the user an optimal navigating experience.
- Multilingual System - For users that don't understand English or they prefer to be navigated with another language, we can make ARNav into a multilingual technology to suit the broader needs of the users.
- Multiple Routes - We want to make ARNav to be capable of changing navigating routes if the user walks away from the original routes to visit another place or they want to go somewhere else first. ARNav would generate another route that is the closest to the destination from the user's current location if the user did not follow the original navigating instruction.
- Specific Routes for Special Needs - We also want people with disabilities to have the optimal navigating experience with ARNav. Users with disabilities or users that want to avoid stairs and escalators, they can choose the "Elevator Mode" where all the navigating routes generated will direct the user to use the elevator if needed.
- User Feedback - A "User Feedback" link will be available on our website as we want the user to give suggestions or report problems, so we can gather information needed for us to improve the navigating experience of ARNav.
- Potential business revenue from advertising sales/promotions available in a particular store when a user searches up that store. E.g. User searches Herschels and the page displays a 2D map preview and the sale currently at the store. Front page could also have a selection of the biggest sales available.

Conclusion

To conclude with, a fairly successful prototype was created for the model, with huge potential for future improvements and developments such as a multi-level navigation system and a user feedback interface.

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Program Evaluation

Outcome of STEM Leadership Program

During the duration of the STEM Leadership program, lessons both as individuals and as a whole team were learnt from throughout. As a team all of us gained a lot of important experience which will be used through the rest of our careers in the future. Despite the mass amount of mistakes done throughout, all of us individually thoroughly enjoyed the program. We had a great time putting ourselves out there and interacting with industry leaders. It was rewarding to present a pitch to a business audience and the resulting feedback will be a great boost for any future projects we do in the business world.