Deliverable C:

Conceptual Design

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Introduction

The purpose of this document is to organize the prototype's functionalities into three systems and the solutions generated by each team member. This has been completed by way of function decomposition with three main systems: The phone application (App), the specialized employee's application and the beacons which will be the physical product created to make the product functional. Following this, a decision matrix is used to organize and evaluate each concept according to the client needs, metrics and their corresponding importance. Then, an overall concept is finalized which explains how each concept will work together in order to enable the prototypes to satisfy the needs of the customer which are laid out in *Project Deliverable B: Product Benchmarking and Specifications.* Along with this written plan, visual plans have been sketched which explain how the product will look visually, and how it will perform its intended purpose. By creating and archiving this document, the team has a plan to follow in order to achieve the final prototype.

1. Functional Decomposition

To understand what is required to make a functional and useful final product, the team has organized functionalities into the central systems and subsystems.

- Client App
  - Home screen
  - Announcements
  - Destination Select
  - Navigation Screen
  - Help Screen
  - Settings Screen
  - Debug Screen
- Employee App
  - Mapping Tool
    - Walk around with the phone to build a map.
  - Announcement Creation Tool
- Beacons
  - Bluetooth-based
  - Self-powered or USB-powered

2. Individual Concepts:

Each team member has conceptualized several solutions for each of the subsystems, organized into one of two systems: app and beacon.

- Eric
  1. **App:** Creating an Android app from scratch
  2. **App:** Cross-platform app using prebuilt frameworks (React Native?)
  3. **Beacon:** Wi-Fi based beacons
  4. **Beacon:** Ultrasonic acoustic-based beacons
  5. **Beacon:** IR based beacons
- Adam
  6. **App:** App development using premade plugins in an app builder (MIT App Inventor)
  7. **Beacon:** Bluetooth beacon
  8. **App:** Auditory notifications for direction and distance
  9. **App:** Haptic notifications, for warning

- Steve
    10. **Beacon:** Can report the error
    11. **App:** Report a crash to the developer
    12. **App:** Employee can upload the new location of the beacon (in the map built by the app)
    13. **App**: Share user location in the library, help improve the Route planning
- Brendan
    14. **Beacon:** Create position vectors to determine the relative position to beacons
    15. **Beacon:** 3-D Printing the beacons using PLA to house electronic hardware
    16. **App:** Users can access a map of the floorplan
- Jarrett
    17. **App:** Saves previous notifications/announcements to be viewed at a later date
    18. **Beacon:** Sends notification via Bluetooth to the device where customers can interact with
    19. **App**: The client has an administrator account where each beacons announcement with ease
    20. **Beacons**: Are easily accessible and can be moved around by the client
    21. **App:** Some sort of audiobook functionality?

3. Screen Solutions:

During this portion of the design conceptualization, an analysis of each idea generated in the previous step has been completed by performing a decision matrix. The necessary information to understand the decision matrix is listed below.

Notes for the Decision Matrix:

- *M* represents the *Metric Number*, as seen in Deliverable B.
- *W* represents the *weight* (out of 100%) *given to that metric*.
    - The weight is how *importance* this metric is to achieving overall functionality
- The *top row contains the Concept Numbers* from Section 2 above.
- Scores are on a scale of 1-5, where *1 is poor performance, and 5 is a good performance*.

App						
M	**W**	**1**	**2**	**6**	**8**	**9**
1	27%	5	4	4	2	5
2	37%	5	4	4	5	3
5	10%	3	3	3	2	3
9	22%	4	3	4	5	3
10	4%	4	3	3	4	5
	Score	**4.54**	**3.64**	**3.86**	**3.85**	**3.62**

Beacons							
M	**W**	**3**	**4**	**5**	**7**	**14**	**15**
2	26%	2	1	2	4	5	5
3	16%	5	2	2	4	5	4
4	18%	1	4	4	4	3	3
5	3%	1	5	5	5	2	4
6	21%	2	4	5	3	3	4
7	8%	2	5	5	5	3	2
8	8%	2	5	5	5	3	3
	Score	**2.27**	**3.09**	**3.56**	**3.98**	**3.81**	**3.84**

4. Concept Selection

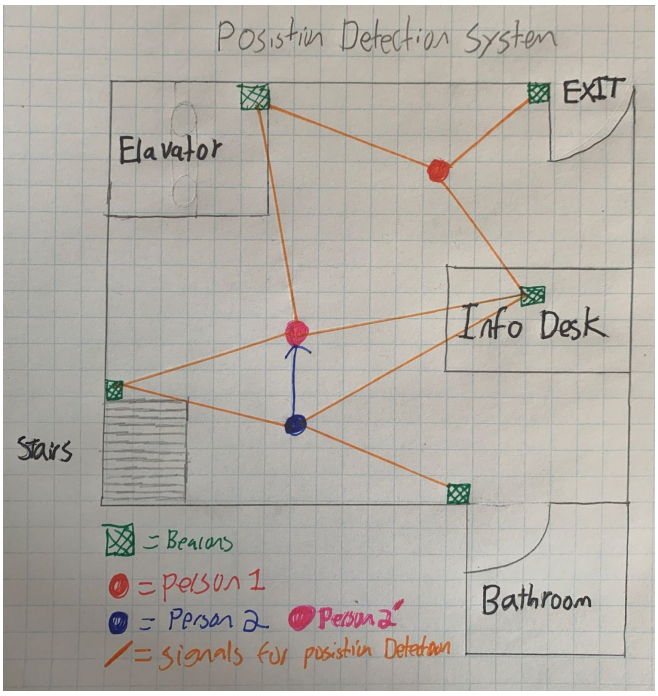
Below, the results from the decision matrix are listed. The scores from the matrix and the time required to implement each concept are taken into account for each decision. The concepts that have been selected are listed along with their corresponding concept number assigned during *Section 2: Individual Concepts*.

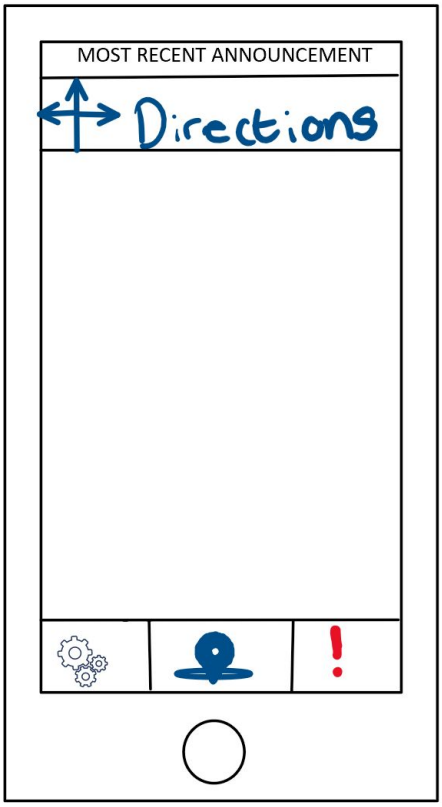
- Bluetooth Beacon (7)
- An android app built from scratch (1)
- Use of auditory notifications (8) or Use of haptics (9)
- Can report the error (10)
- Report a crash to the developer (11)
- An employee can upload the new location of the beacon (in the map built by the app) (12)
- Create position vectors to determine the relative position to beacons (14)
- 3D printed case (15)
- Are easily accessible and can be moved around by the client (20)

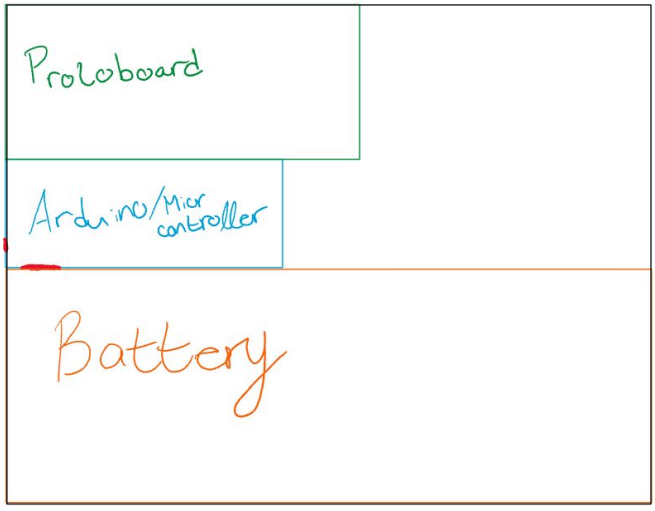
5. Finalizing Concept

The group has decided to design a Bluetooth beacon because of its significant advantages over the other types of beacons - the long battery life combined with the small weight and size allow the beacons to be repositioned easily with little maintenance. In contrast, Bluetooth technology allows the app to determine its position to an acceptable accuracy of three meters or less. The group has decided to use an Android app alongside these beacons to guide the user to their desired destination by using auditory and haptic notifications due to its fast running speed, simplicity, and flexibility compared to the other app formats. These notifications will give directions to key locations throughout the library, triangulating several beacons to find the user's location. Additionally, the system will be easily modifiable and repairable by using a direct relationship between developer and customer, with crash reports. Lastly, for structure, mounting, and aesthetics, the case will be 3D-printed and designed. The 3D-printed case will also ease the beacons' movability to new key locations within the library.

6. Represent Concept - Visual:







7. Represent Concept - Written

These chosen sets of concepts come with both advantages and disadvantages. Firstly, our decision to use Bluetooth will help us achieve our target specifications in cost, weight, size, and battery life. By using Bluetooth to allow the app to communicate, the beacon's range is less than what could have been achieved by using a Wi-Fi-based beacon. The usage of auditory and haptic notifications is beneficial in keeping the time to communicate with the user to a minimum, along with increasing the effectiveness of the notifications, especially for visually-impaired users. The Android app, along with the constant customer/developer feedback, will help increase customer satisfaction and minimize start-up time for the app. Lastly, the usage of a 3D case will enable the final prototype to meet the target specifications for customer satisfaction and the time required to reprogram beacon locations.

Conclusion

This document is an overview of the solutions which the team has ideated and considered in order to solve the problem stated at the beginning of this project. In the future, this document will act as an effective reference for each team member in order to understand the organization of the subsystems and to refer to any ideas that were once rejected. The team is excited to be able to continue working on this project in collaboration with the Morisset Library at the University of Ottawa to capture the full potential of this project.