# Project Title: Cart-E Prototype 2: Low-cost Indoor Localization

## (Team – 34)

Project Definition:

We propose to embark on the development of Prototype 2 of Cart-E, a cutting-edge localization system. Building upon the foundation of the previous prototype, we aim to overcome its limitations and create a more robust and versatile solution for room-level localization. Our goal is to extend the range, improve accuracy, and enhance battery life while introducing several key features such as improved power management, enhanced vibration sensing, Wi-Fi router triangulation, and the implementation of location signatures. Additionally, we plan to develop a semi-automated mapping system to accelerate the environmental mapping process.

Project Timeline (estimated)

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| --- | --- |
| Name | Due Date |
| Getting the Proposal Ready | 2023-09-30 |
| Understanding and validating the previous design | 2023-10-15 |
| Come up with a way to map more building | 2023-10-15 |
| Improve Battery Life (vibration switch) | 2023-11-30 |
| Map more buildings | 2023-11-30 |
| Move the server to local | 2023-11-15 |
| Working on studying the strength vs distance profile of Wi-Fi router we are using | 2023-11-15 |
| Algorithms to use the past positions to avoid position jumps | 2023-12-30 |
| Prototyping the new version using breadboard and testing | 2024-01-31 |
| Getting the PCB for the new version ready (attempt 1) | 2024-02-29 |
| Getting Multiple PCBs and make them work together | 2024-03-15 |
| Getting the user interaction portal ready | 2024-03-31 |
| Working on triangulation and accuracy improvement | 2024-05-15 |

Gantt chart: <https://drive.google.com/file/d/1APWzZJeDykUM0AtdNHeYAZXsLIDrN3V2/view?usp=drive_link>

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# Definition of initial (minimal) project for MEng completion:

The primary objective of this initial project is to enhance the existing Cart-E indoor asset tracking system. Key goals include extending battery life through the implementation of a vibration-based power switch and improving overall tracking accuracy within indoor environments to room level accuracy.

# Project Goals:

1. Evaluate Previous Versions: Analyse the strengths and weaknesses of previous iterations of the system to inform the design and development of the new asset tracking solution.
2. Semiautomated Mapping Method: Develop a method, potentially involving a combination of bots and April tags, to efficiently map the Wi-Fi signal environment. This method should accelerate mapping while extending the range of coverage.
3. Battery Longevity Improvement: Integrate a vibration switch with the required sensitivity to optimize battery life by utilizing the sleep mode of the ESP32 module.
4. Local Server Deployment: Transfer the server infrastructure from Amazon EC2 to a local server to reduce costs and enhance communication efficiency.
5. Signal Filtering and Modulation: Explore signal processing techniques, including continuous moving average, exponential moving average (EMA), and Kalman filtering, to identify and mitigate outlier router signals.
6. Prototype Development: Design and create a printed circuit board (PCB) for the first version of Prototype 2, incorporating the improvements and features outlined in the project.
7. Multiple Simultaneous Tracking: Scale the system by producing 10-20 tracking boards and integrating them into the portal. Ensure simultaneous tracking and data visualization for multiple assets.

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1. Router Signal Analysis: Investigate the distribution of Wi-Fi signals around routers and assess how non-static objects, such as humans or moving items, affect signal strength.
2. Triangulation for Improved Accuracy: Implement triangulation methods to enhance the system's accuracy, achieving room-level precision in asset tracking.
3. Enhanced Accuracy with Sensor Fusion: Extend the project scope to explore advanced sensor fusion methods, potentially involving additional sensors like IMUs, to achieve the highest possible tracking accuracy.

# Tests at each phase to ensure the working of each sub-system:

\*\* We plan to think of each of the phase wise tests and make the detailed plan of it with timeline once we are done with finalising the goals and order the above objectives in the most optimal manner.

However, if we talk in a broader sense, we plan to conduct tests at different level starting with the testing of each of the components and programs that goes into the system to crosscheck the claims made by the supplier and the output we can get from the components specially the power related components.

Once we are sure about the components, we start the testing of each subsystem against specially designed rigorous test to ensure optimal performance in worst possible scenarios ensuring robustness of each sub system before integrating all the subsystems to form a complete PCB and work in an integrated fashion.

Once we are done with the integration, we will divide our testing into 2 phases starting with a single PCB and ensuring its working and then bringing in multiple replicas of it and sync them to work simultaneously in the same environment without disturbing or hampering the performance of other.

Measurable results at all phases:

\*\* We will make sure to have the predefined standards/results for each designed unit tests that would indicate that we are good to go to the further steps which would give us clarity as well as help us to ensure the robustness and reliability of the system.