

Cart-E Prototype 2: Low-cost Indoor Localization

(Team – 34)

Proposal for a Design Project for the School of Electrical and
Computer Engineering

By

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Abstract:

Introducing Cart-E, an indoor tracking device revolutionizing location-based tracking through WIFI router addresses. Designed for efficiency, Cart-E is compact, cost-effective, and user-friendly. Easily attached beneath carts, it enables users to effortlessly locate and monitor movement history within Phillips and Upson (maybe more halls if after mapping) via a web interface. By utilizing open-source data and implementing deep sleep mode for energy efficiency, Cart-E ensures accurate tracking with minimal privacy concerns and operational costs. This innovative technology provides an affordable, low-maintenance solution for detailed 3D spatial information, streamlining object retrieval processes.

Introduction:

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)

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

The project timeline comprises two distinct phases. In the initial phase, emphasis is placed on devising efficient methods for data collection and rapid environmental mapping. Concurrently, efforts are directed towards the deployment of a local server and prototyping and testing power management-

related components. The subsequent phase focuses on leveraging the collected data to develop algorithms aimed at enhancing the precision of the initial Cart-E prototype. This phase also involves the finalization of the PCB design, ensuring seamless integration with the server, and concluding with the deployment of the fully functional Cart-E system. This systematic approach ensures a comprehensive development process, covering both data acquisition strategies and algorithmic advancements to deliver an optimized and precise localization solution.

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.

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

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.

Conclusion:

In conclusion, our project introduces Cart-E, an indoor tracking device leveraging WIFI router addresses. The Abstract outlines Cart-E's compact design, affordability, user-friendly interface, energy efficiency, and reliance on open-source information. Building on the success of Prototype 1, our proposed development of Prototype 2 aims to overcome limitations and enhance room-level localization.

Reference:

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[2] Campus Congestion & Guide project by Minjung Kwon and Esther In, Campus Congestion Project of ECE 5725 Spring 2022:

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