Milestone 2 Report - Minimap

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1   Progress

We have made significant progress. We now have two complete breadboard hardware prototypes for which we are writing software. The microcontrollers are now able to read GPS and IMU data, and communicate with each other through LoRa. Additionally, we are able to display fixed landmarks on the screen and their relative position to the device in a minimap fashion.

2   Resources

At the moment, we believe we have all the physical resources we need.

Hardware

Microcontroller: ESP-32, **Lora Module:** RFM9X Lora Module, **IMU:** MPU-9250 9-Axis IMU, **Batteries:** 500mAh 1s LiPo, **GPS:** Grove GPS module, **Screen:** Teyleten Display.

Software Libraries

Screen: esp_lcd_gc9a01, lvgl **Lora Module:** esp32-lora-library, **IMU:** esp-mpu9250, **GPS:** Espressif nmea0183 parser. **OS:** Espressif ESP-IDF.

Software & Design

We have implemented[1] a magnetometer-based heading calculation with the IMU and an API for displaying GPS data and headings on the screen. We have designed but not yet implemented a pairing protocol for two parties, and a transmission protocol for shared radio medium.

3   Modification to Scope and Major Risks

Given that we have limited time to finish the project, we have decided to set incremental goals (which we call Versions in this document) for the final deliverable. These Versions are ordered in terms of feasibility and importance. For instance, LoRa communication, a key component of our deliverable, is included in Version 0. On the other hand, power-saving optimizations, while useful for making our device more efficient, are not the most important part of our project and thus have been moved to a later Version.

The details of what is in and out of scope for the project are better outlined in our schedule of remaining time (below). Versions 0-2 are considered in scope and feasible for the final showcase. These comprise the core functionality that we want to include for the showcase. In contrast, Versions 3 and 4 include features that we do not consider necessary for a working demo and that might be too difficult to implement in the time we have left. We hope to implement them by the final showcase, but we have no guarantees at this point in time.

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[1]The Github repository can be found here.

4 Schedule of Remaining Time

Version 0 (MVP): 12/7

- Transmitting raw data from one device and receiving on the other
- Both running the same application
- Single party composed of two members
- Display relative position of other member of party
- Display GPS heading

Version 1 (Pairing): 12/10

- Rudimentary Host and Join modes with buttons (no interactive display).
- TDMA (Time Division Multiple Access) implementation to allow for LoRa communication between parties.
- PTP (Precision Time Protocol) implementation to synchronize the clocks of the two members of the party.

Version 2 (Robust Demo): 12/15 – Showcase Target

- Menu, Host and Join modes along with an interactive visual display.
- Encrypted communication between parties to ensure communications remain confidential[2].

Version 3 (Stretch Goal – Generalization): 12/15

- Support the same features as Version 2 for parties with an arbitrary number of members.

Version 4 (Stretch Goal - Wearable Prototype): 12/15

- Printed Circuit Board version of the prototype.
- 3D-printed band to wear the device.

Version 5 (Stretch Goal – Optimization): 12/15

- Continuous magnetometer calibration to ensure accuracy of heading readings over time.
- Party Persistence - ability to rejoin a party even if disconnected temporarily.
- Power Saving - turn off screen and radio when not in use.

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[2]We are not concerned with integrity for this project; we assume a passive attacker that can only listen to messages sent on the public LoRa channel, but is unable to inject or modify messages sent through said channel.