Indoor Navigation System Using Ultra-Wideband Localization

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Goals

- ❑ User can navigate via directions to predetermined points of interest
- ❑ Localization system with precise user location accuracy for indoor applications (<1m) and adequate range (50m+)
- ❑ Low cost compared to other existing navigation systems

Background

- ❑ Common ways of navigation utilizes GPS, but has low precision so cannot be for shorter distances
- ❑ UWB has low interference with other commonly found wireless signals

Research Challenges

- ❑ Difficulty in mapping buildings into a usable format for navigation
- ❑ Robustness of Ultra-Wideband in non-line of sight conditions
- ❑ Limited computation power of microcontroller unit
- ❑ Deviations from determined path due to fluctuations in measured user position
- ❑ Trilateration using a limited amount of Ultra-Wideband anchors

Acknowledgements

Design & Methodology

Constructing and testing UWB-based chips – ranging done via time-of-flight

Navigation system: shortest path found using Dijkstra's Algorithm

Android application development & integration with hardware Bluetooth module via Bluetooth sockets

Trilateration method done with non-linear damped least square fit
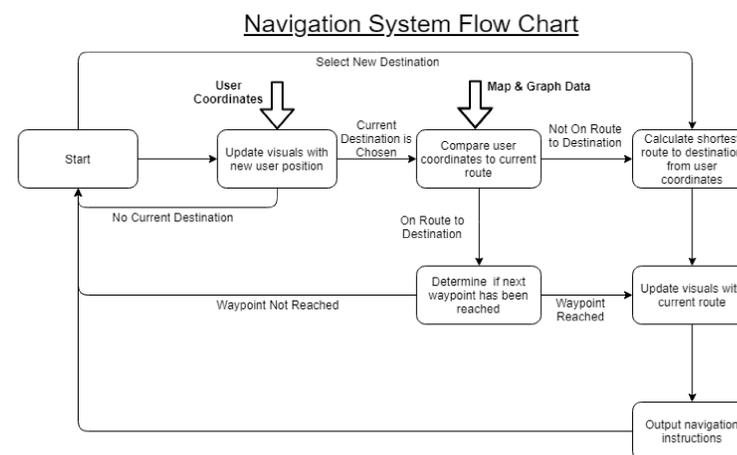
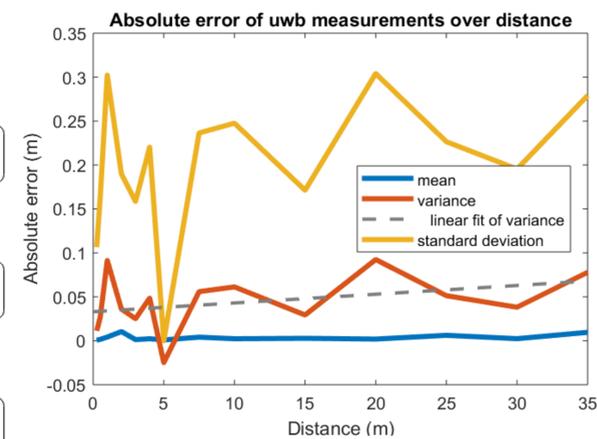Cost: $231.65 per unit / $182.37 for 25+ units

Figure 3. Hardware Implementation

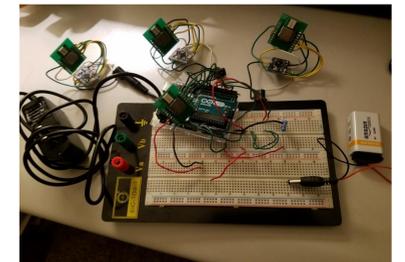Figure 1. Navigation System Program Logic
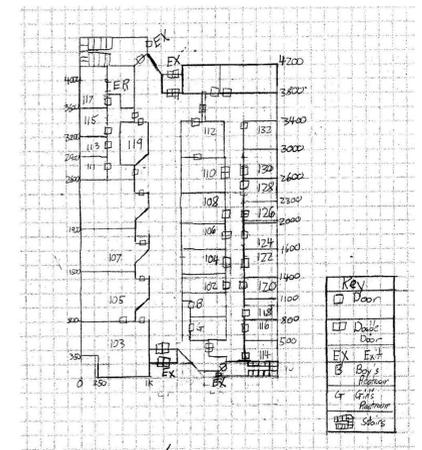

Figure 2. UWB Ranging over distance

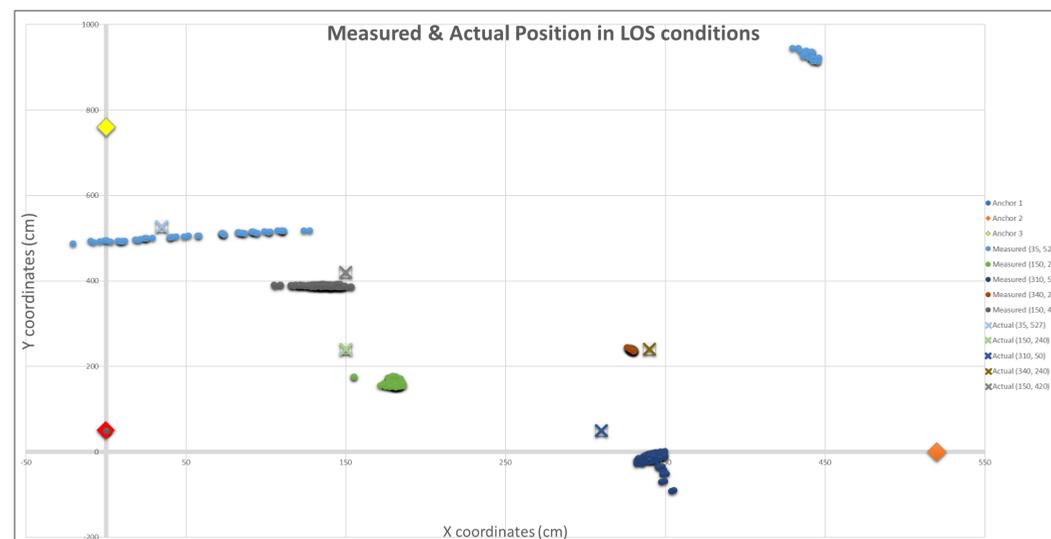Figure 4. Mapping of locations of interest

Results

Figure 5. Location Data collected via Trilateration

Discussion/Further Work

The non-linear fit to determine the user's positional data from the anchor positions and distance readings finds the local minimum, not the absolute minimum, for the least square error value. This approach does result in inaccurate results at some locations.

The system is functional in LOS conditions. However the connectivity is not robust in non-line of sight conditions, as the tag experienced frequent disconnections as well as infrequent communication with the anchors. With a stronger background in communications additional testing can be done to determine the usefulness of this chip in NLOS conditions.

References

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