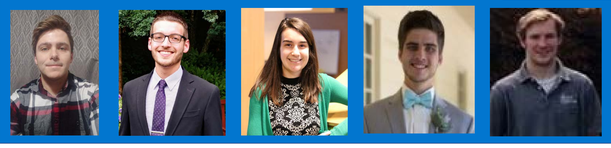
DornerWorks Asset Tracking Platform



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Sponsor: DornerWorks

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Abstract

DornerWorks has sponsored a senior design to create a functional prototype for asset tracking based on existing trilateration technology created by Decawave. There are two solutions considered in this senior design project. The first situation is called the proximity solution, which involves tracking assets with respect to a specified vicinity. The second situation is called the precision solution, which involves tracking the general location of assets within a building. Using Xamarin, a mobile application was developed for both solutions. Both solutions initialize through a blue-tooth setup process. The proximity solution was created through the Decawave module to utilize ultra-wide band communication between devices for detection of field unit devices within a radius of a single base unit device. This solution was tested to accept input of field units within 3 differing radius' of a base unit for proximity sensing. The precision solution uses ultra-wide band to track an asset within a room, but switches to Wi-Fi to communicate information over a server for tracking within a building on a single floor. The precision solution was tested to be accurate within 20 feet and a tolerance of 6 inches to actual location with a grid setup of anchors (or position sensors) in a single room.

Background

Proximity Solution

Base Unit: Central, fixed device used to locate distance to relative field units compared to base unit location.

Field Unit: Mobile device that can move relative to the base unit and triggers alerts on the base unit when a distance boundary condition is met.

Precision Solution

Tag: Mobile position device whose location will be repeatedly calculated at a specific rate.

Anchor: Fixed position device that is used in the computation of tag location.

Gateway: A Wi-Fi-connected device which aggregates tag locations and sends them to the server.

Server: Tables of information for tags, anchors and gateways that store important data and transfer that data over Wi-Fi.

Key Specifications

Test Type	Target/ Description	Units	Test Type
Decawave Trilateration Accuracy with Assigned Anchor Location	20 ft. +/- 6 in.	Inches	Unit
Proximity Range Test	Proximity boundary changes radius from specified location	N/A	Unit
Precision Disconnected Alert Test	Application alert when tag is not within range of a gateway (no data being received)	N/A	Unit
Low Battery Alert Test	Communication of low battery for devices	N/A	Unit
MQTT Receive Server Data	Receive data from MQTT	N/A	Integration
MQTT Send Server Data	Send data from MQTT	N/A	Integration

Proximity Solution Design

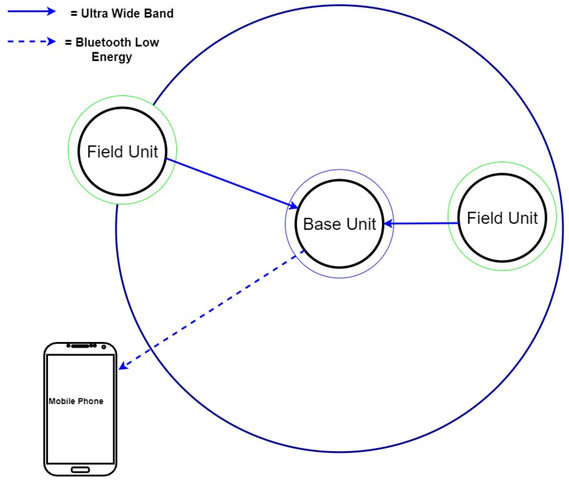

Figure 1: Proximity Solution Map

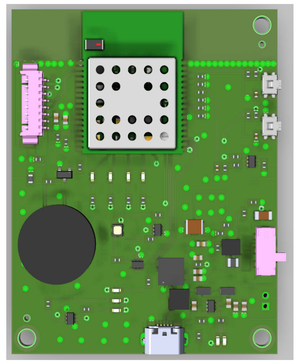

Figure 2: Field/Base Unit PCB Design

Field Unit devices are intended to be worn on people or objects that require monitoring of their general distance within a zone. Depending on the situation, alerts can be enabled for cases if the tracked unit is leaving the desired zone or if it nears an off-limits region. The base unit is to be worn by the person keeping track of the field units. Both devices can be incorporated in a single PCB design. A mobile application is accessible to holder of the base unit. In the mobile application, the field units' distance can be seen and there are features that are customizable. A few of these features include being able to rename the base unit, change if alerts should go off for when the field devices are leaving a zone or entering it, and modify the default distances that trigger a notification on the base unit. Those app-configured distances can be cycled through on the base unit from a button.

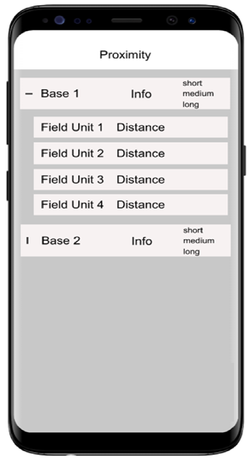

Figure 3: Proximity Mobile Application

Precision Solution Design

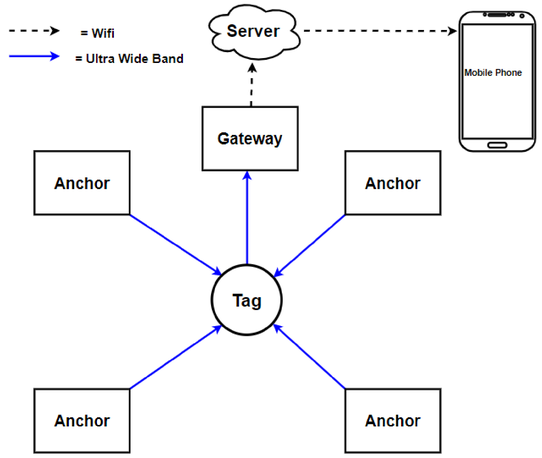

Figure 4: Precision Solution Map

This solution uses trilateration to determine tag location within a grid of anchors. The goal of this solution is to track a tag's location regardless of which floor it may be on within six inches of its exact location from twenty feet. The anchors are to be fixated onto walls throughout two floors of a building. The tags are attached to the objects being tracked. A server is designed and used to store system data, most notably tag locations and device configurations. The gateway device is to facilitate communication from the system to the server. Just as the previous solution, the phone app will allow a user to control many features of the system for this solution. This phone app will allow the user to upload a floor plan, change anchor location according to where they are placed in real-life, modify ping rate, view device locations, and add or remove devices.

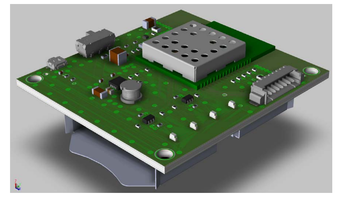

Figure 5: Tag PCB Design

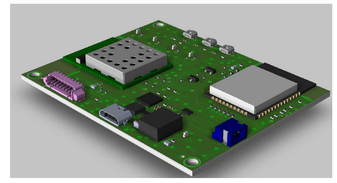

Figure 6: Anchor/Gateway PCB Design

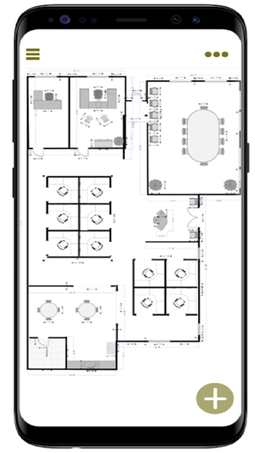

Figure 7: Precision Mobile Application

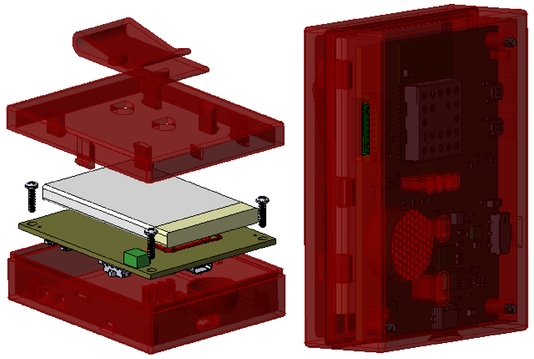

Figure 8: Field/Base Unit Enclosure

Example Enclosure: Field/Base Unit

- 3D printed ABS enclosure
- Cantilever beam locking design
- Locking ridgeline
- 2mm thick wall
- Belt clip fastener holes
- Speaker grille for buzzer
- Battery holder

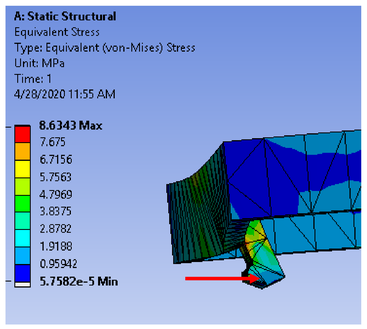

Figure 9: Field/Base Unit Enclosure

Cantilever beam FEA

- User push force = 11.2 lbs
- Mating force = 3.76 lbs
- Hand Calc FoS = 1.4
- ANSYS FoS = 6

Acknowledgements

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