An Infrastructure-Free Localization System for Firefighters

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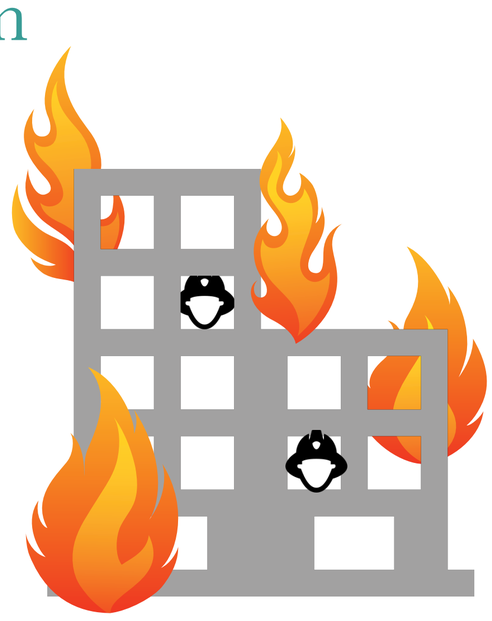
Problem



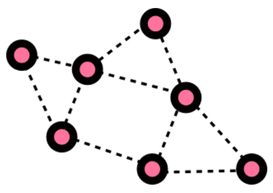
Where are the firefighters?

Localization Platform Goals

Hardware

No prior infrastructure

Ad-hoc wireless connectivity



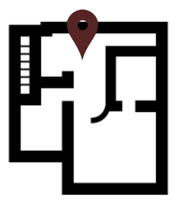
Deployment

Restricted perimeter

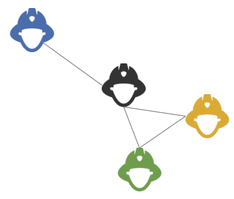
No user-effort

Location algorithm

Absolute location and orientation



Relative location



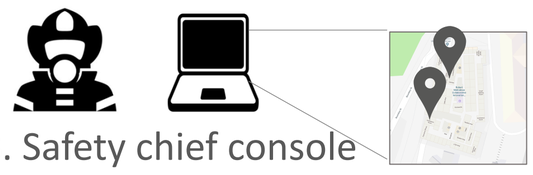
Our Approach

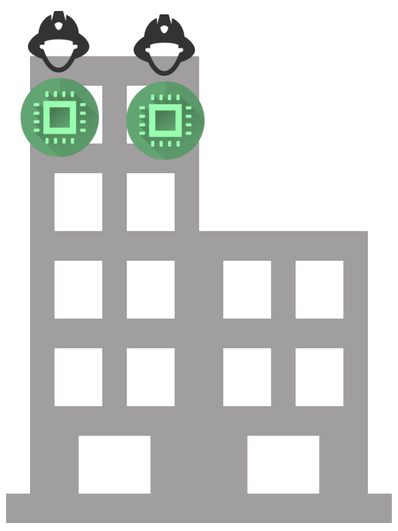
Pre-install

Beacons on vehicle

Tags on firefighters

On-site





Challenges

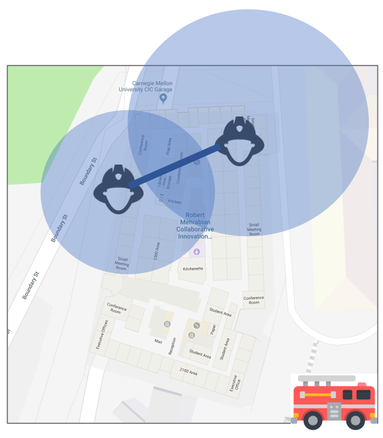
Challenge : In reality, IMUs drift over time and inter-device connectivity is sparse
Insight : Combine IMU data with inter-device ranging, leverage the buddy system, apply theory from SLAM, network localization to solve the framed mobile sensor network localization problem

Challenge : No infrastructure available; rapid deployment required
Insight : *Relative* location is often valuable even when absolute location is unavailable. Whenever possible, communicate all *relative* location information to operator.

Challenge : Firefighter motions make traditional dead reckoning techniques unreliable
Insight : Use high fidelity visual tracking as a baseline for training machine learning models. When visual sensors are impaired, fall back on IMU-only approach using learned models.

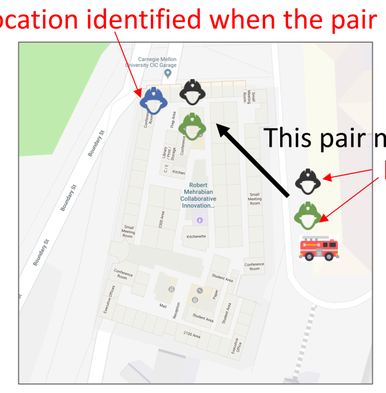
Location Application Scenarios

Absolute location of firefighters on map



- Uncertain absolute location
- Confident relative location

Location unknown.
Location identified when the pair is in proximity



A group of firefighters are able to localize a firefighter with unknown location

System Components

Location Solver

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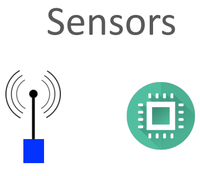
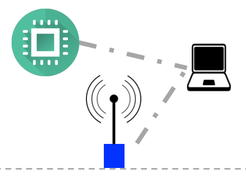
Sensors

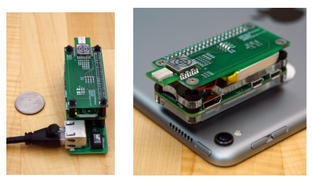


Communication

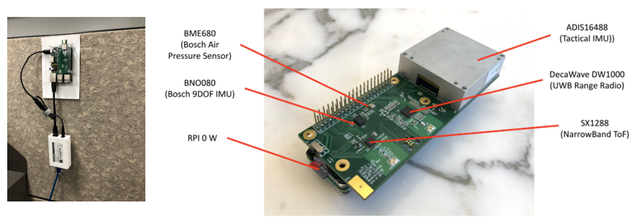


Hardware

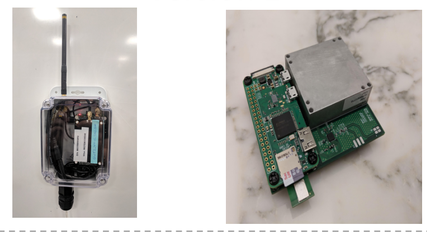
Prototype



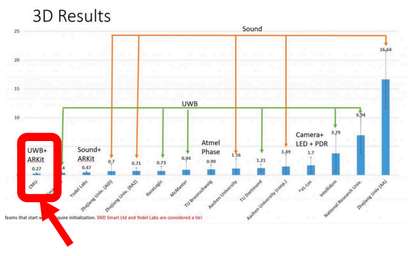
Version 1



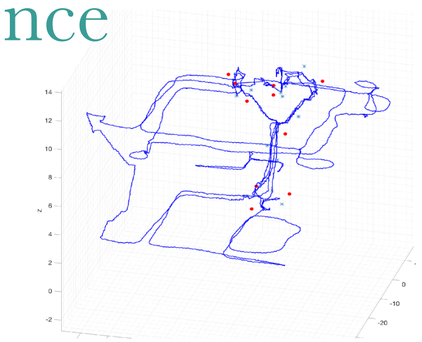
Version 2



Indoor Localization Experience



27 cm 3D accuracy!



3D tracking with sparse beacon placement

Demo

1. Three ingress beacons are fixed
2. Two volunteers with tags are mobile and walk around
3. Computer shows locations of the volunteers