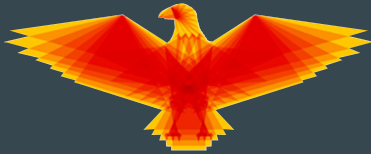


Eagleye: Personnel Tracking in an Augmented Reality Environment



Team: sdmay18-34

Client: Optical Operations LLC

Faculty Advisor: Dr. Daji Qiao

Team Members: Chandler Chockalingam, Victor Da Silva, Josua Gonzales-Neal, Logan Highland, Jason Ramirez, Christopher Stapler



Problem Statement

- Personnel and safety issues
- No way for construction General Contractors (GCs) to view workers in real time
- Lost time and money on megaprojects
 - 9 out of 10 go over budget by 50% (McKinsey & Co.)
 - \$3.3 million a day lost
- Current systems do not deliver quantity or quality of data needed for decision making
- Leading indicators of safety issues should be more clear to supervisors
 - Construction: 1 in 5 worker deaths in 2015



What is Eagleye?

- System to track personnel
- Viewable in real time from HoloLens
- Efficient project management tool
- Displays vital data for daily operations



Functional Requirements of System

- **Worker shall wear token on toolbelt**
- Admin website
- System uses site wifi
- Data storage for future playback
- Token uses signal strength (RSSI)



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Nonfunctional Requirements of System

- **Shall be accurate within 6 meters**
- Battery life = 1 work day (10 hours)
- Real-time, outdoor tracking
- Maintainability - Must be maintainable to allow for future development



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Deliverables

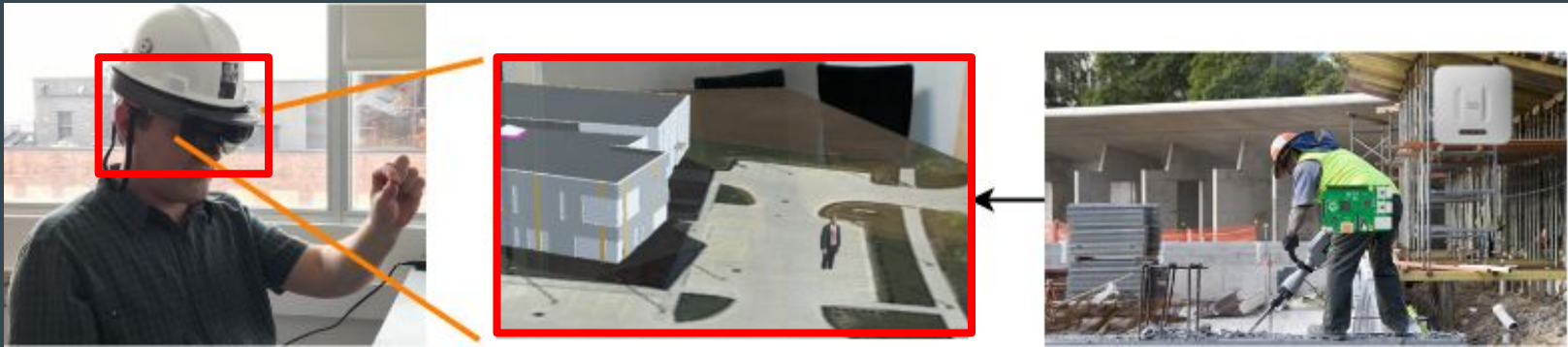
- A real-time tracking system capable of locating users
- HoloLens Application that retrieves information from our services and displays a 3D map with personnel tracking
- A modular solution that can be easily modified or upgraded
- Project demo ready for client to show investors



Deliverables



- A real-time tracking system capable of locating users
- **HoloLens Application that retrieves information from our services and displays a 3D map with personnel tracking**
- A modular solution that can be easily modified or upgraded
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Site Overview

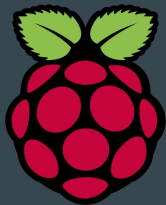
- ISU Startup Factory
- 5 Cisco Outdoor Wireless Access Points



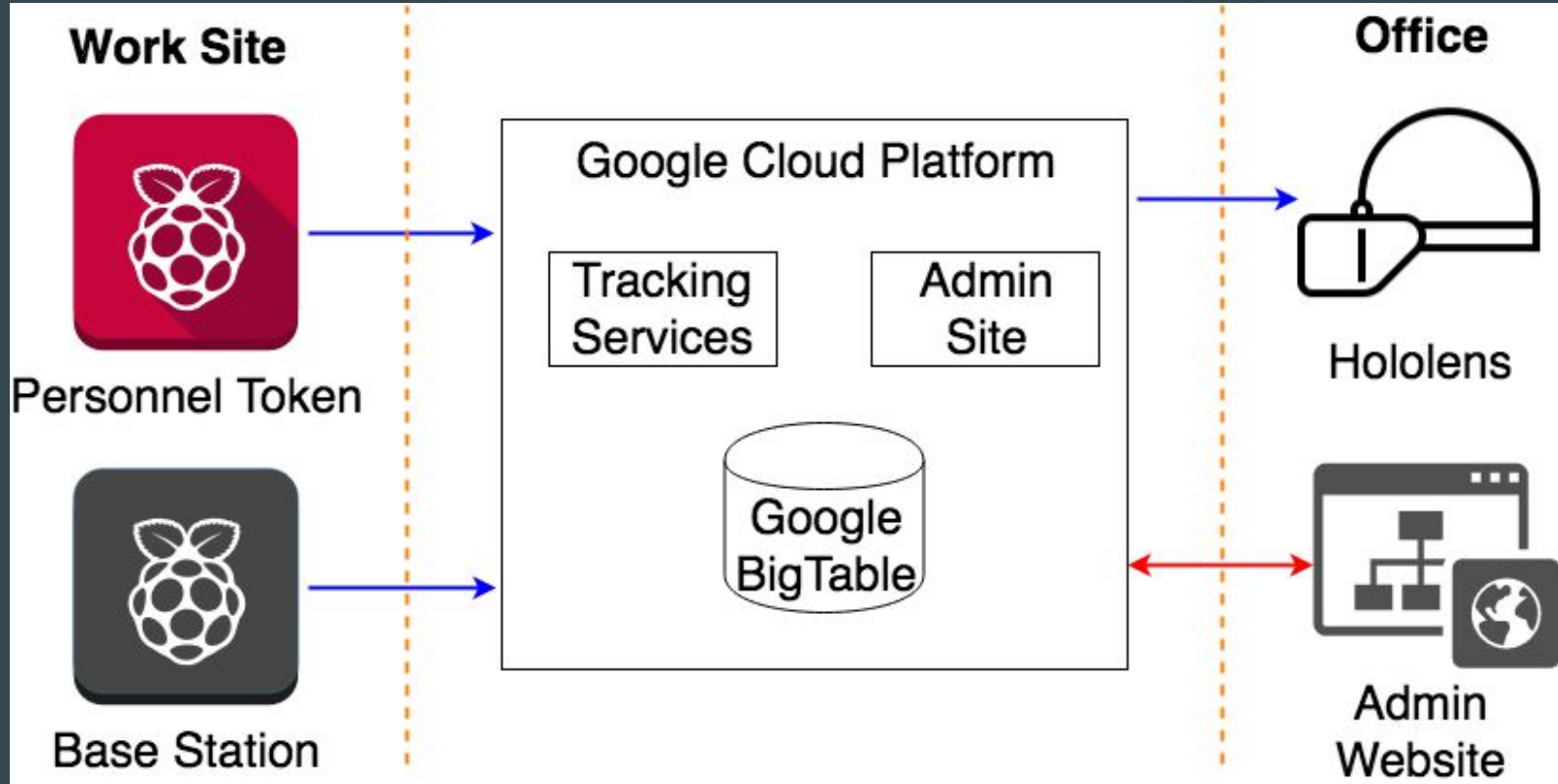
Demo Video

System Specifications and Resource Requirements

- User Interface Specification:
 - HoloLens application displays map with personnel in their respective locations
- Hardware Specification:
 - HoloLens, Raspberry Pi Zero, and Cisco wireless access points (APs)
- Software Specification:
 - Python for the Raspberry Pi and C# for the HoloLens
 - GCP, Kubernetes, Docker: managing tracking cluster micro-services

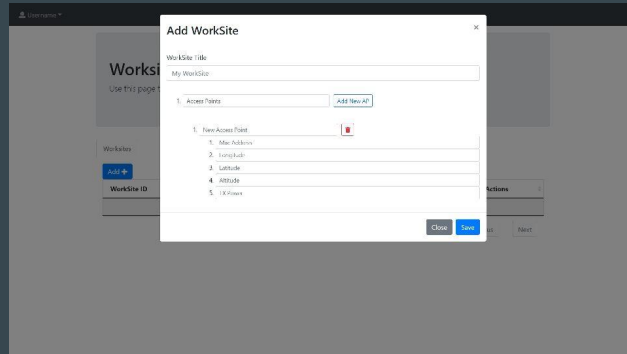
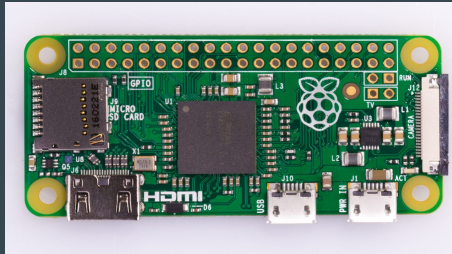


Concept Sketch of Solution



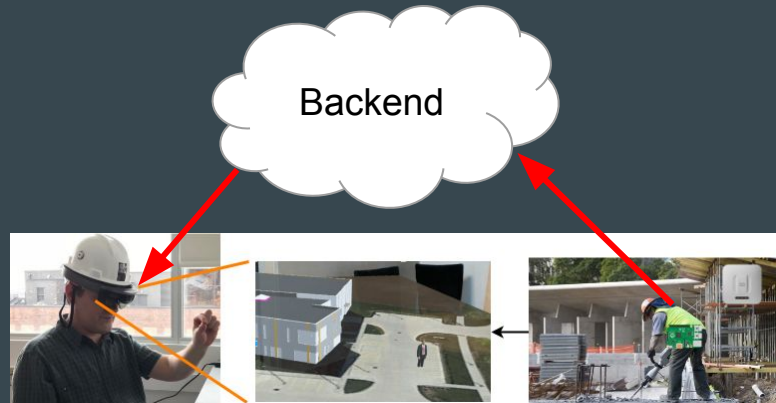
Description of System (Frontend)

- Work Site Setup Interface
 - Sets up a work site with users and AP settings
- Tracking Device
 - Obtains Wireless Tracking Data (WTD): [(Mac Address, RSSI Value)], Time, UserID, WorkSiteID
- HoloLens Application
 - Uses Augmented Reality to virtually place GC's teams in a virtual work site

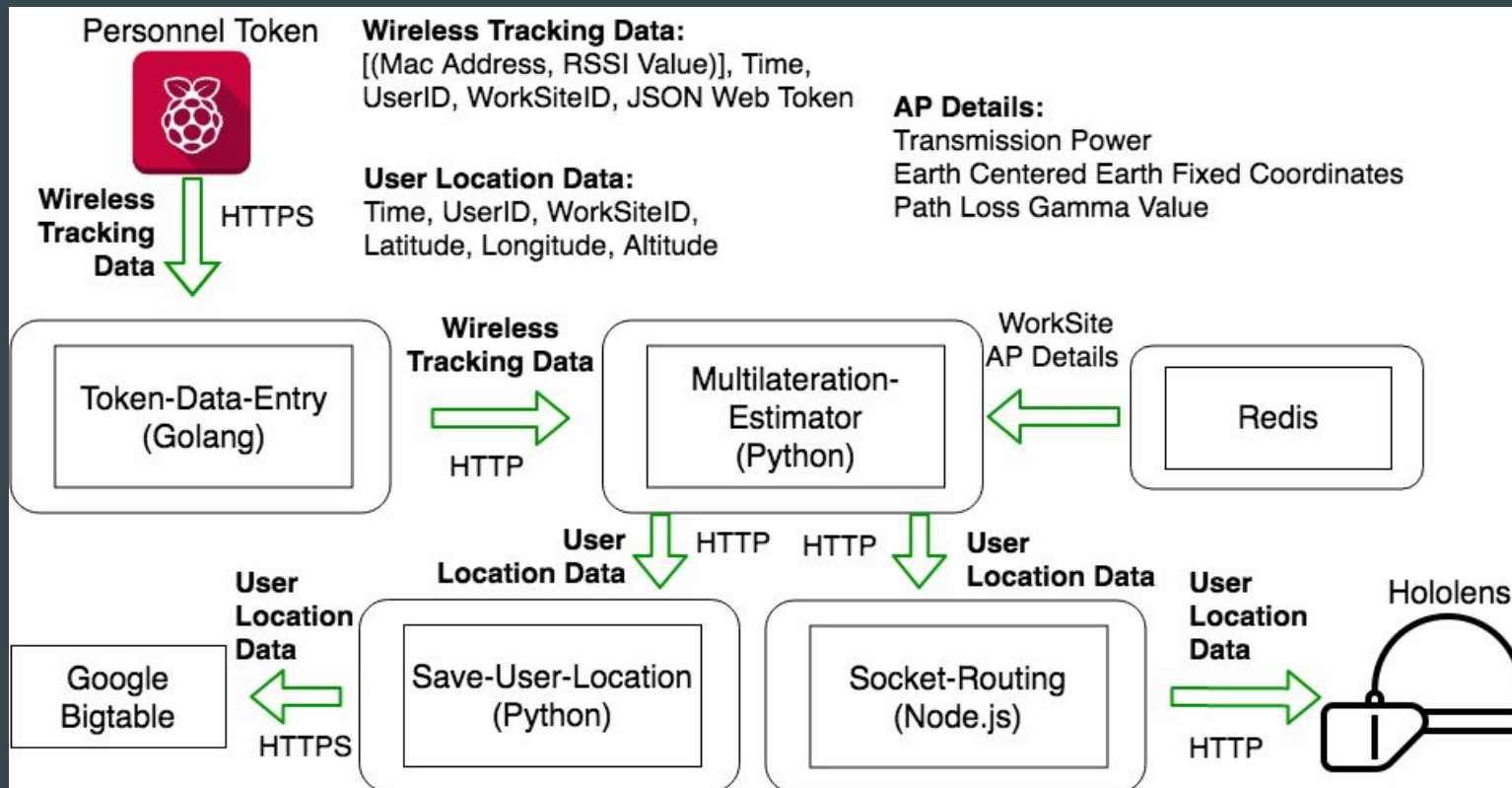


Description of System (Backend)

- Multilateration Service
 - Runs triangulation algorithm to create User Location Data (ULD) from WTD
 - ULD: Latitude, Longitude, Altitude, Time, UserID, WorkSiteID
- Socket Service
 - Sends ULD updates to the general contractor's view of the work site in real time
- Save User Location Data Service
 - Saves ULD in Databases / Google BigTable



Personnel Tracking Dataflow



Tracking

RSSI

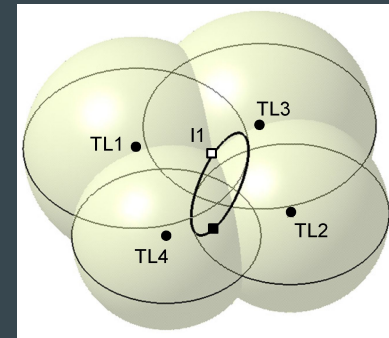
- Transform RSSI (Received Signal Strength Indicator) to Distance via path loss function
- d : distance
- n : gamma
- L : RSSI Value
- C : constant

$$L = 10 n \log_{10}(d) + C$$



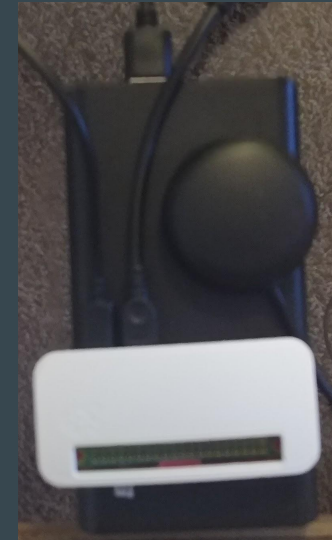
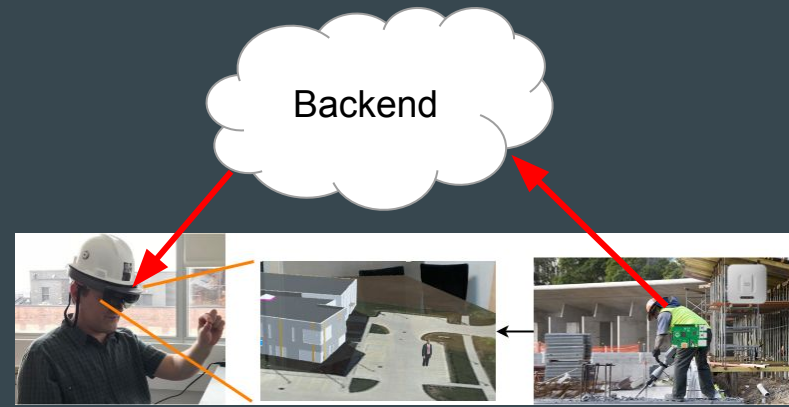
Multilateration

- Since we know where the access point is, and the distance away from each access point, we can run multilateration to get the position



Base Station

- Takes RSSI readings from multiple different locations
- Knows its location from GPS
- Combines Position and RSSI to get best Path Loss Values from Machine Learning
- Sends updates to Base-Correcting Service



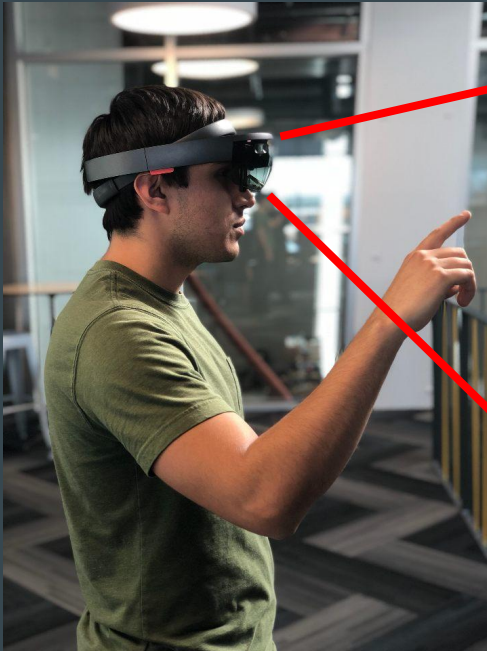
HoloLens Application Overview

- Login Screen
- Main Application
 - Dashboard Element
 - Filter
 - Dashboard
 - Live Cam Footage
 - Map Element
 - 3D model of ISU Startup Factory
 - 3D Model of a construction worker



User Interface

- A bird's eye view of the environment, with personnel moving within that environment

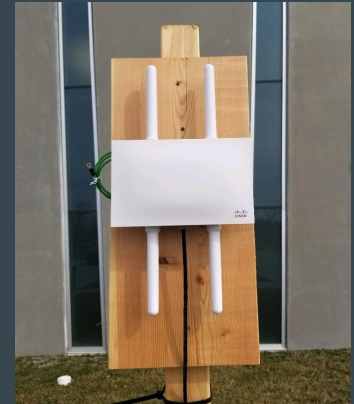
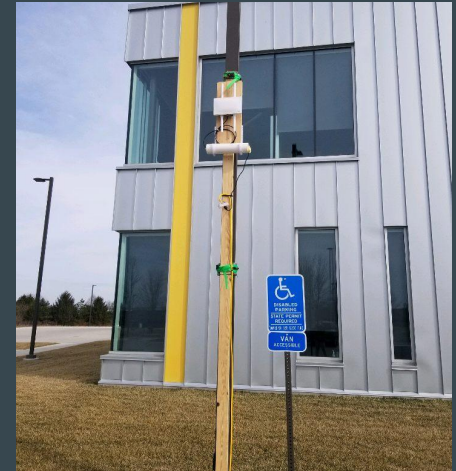


Similar Existing Product Comparison

- GAO RFID Personnel Tracking System
 - An enterprise solution for tracking using solely RFID.
- NAViSEER Precision Personnel Tracking System
 - This system uses GPS, but the precision goes down in GPS-denied areas.
- Buildertrend - The #1 Construction Management Software for home builders and remodelers
- Accuware - Indoor and GPS located tracking components
(<https://www.accuware.com>)

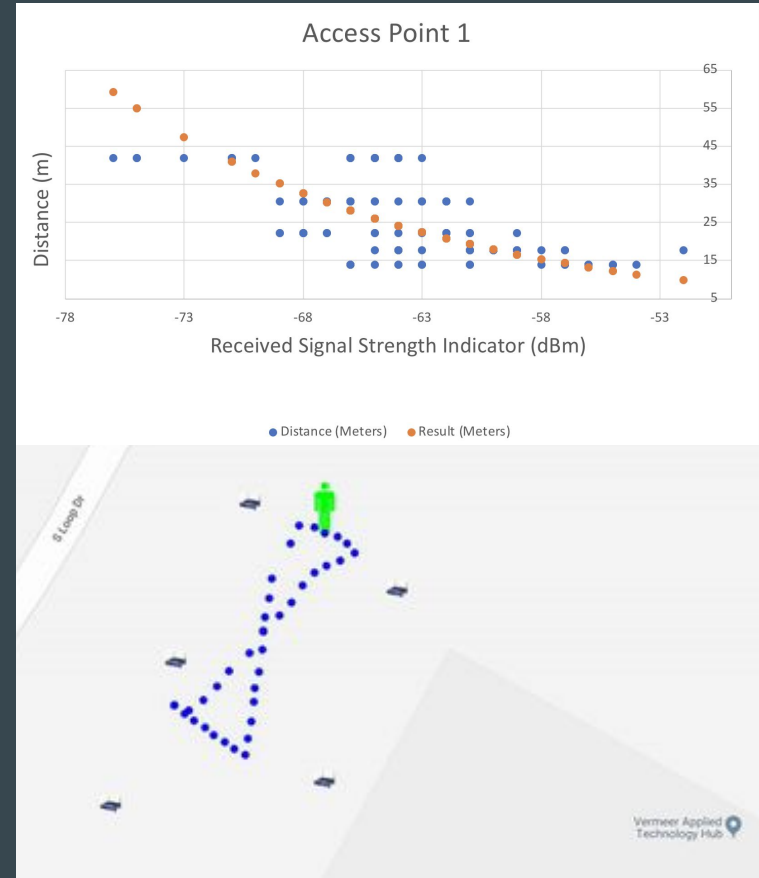
Testing and Evaluation

1. Software Testing
 - a. Unit Tests
 - b. Wrote software to simulate service usage
2. Hardware Testing
 - a. Connectivity testing between Pi, Services, and HoloLens
3. Final Evaluation
 - a. Full-system test with all components



Results of Experimentation and Implementation

- RSSI to Distance Tests:
 - Set AP Location, retrieve data
- Simulation Tests:
 - Simulate based on RSSI To Distance Tests
- Full System Test:
 - Setup:
 - 5 Access points
 - 6 Raspberry Pis, 3 each per person tracked
 - Accuracy within 6 - 7 meters



Known Risks Associated with Product

- Privacy concerns and backlash from workers
- HoloLens purchase is required to use system
- Competitors with cheaper versions (Smartphone, Cameras)
- Sunken cost on Tracking R&D
- Training managers on software



Lessons Learned

- Project timeline and scope can change drastically due to using new technologies (HoloLens)
- Communication is key to making sure client, advisor, and members are in unison
- Realizing sunk cost of time and resources and move forward



Conclusion

- System to track personnel
- Viewable in real time from HoloLens
- Major technologies
 - HoloLens, Raspberry Pi Zero, Cisco wireless access points (APs), GCP

