

Hyper-Reality Helmet with Multimodal Interfaces

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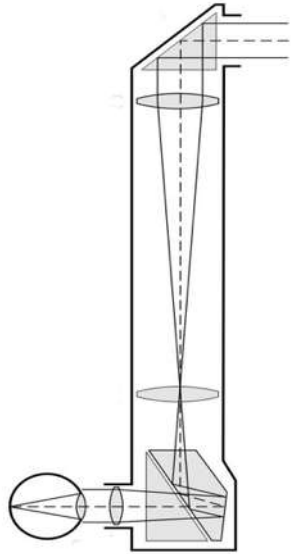
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Content

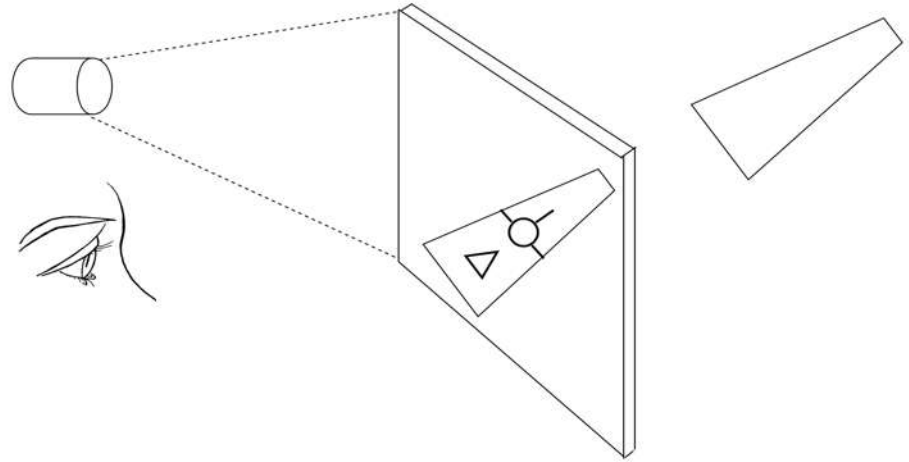
1. Hyper-Reality Helmet
2. The “Third Eye” Camera
3. Thermal Imaging
4. Stereo Display
5. Voice interface
6. LIDAR Imaging
7. Indoor Navigation
8. Sensory Fusion and Self-Calibration
9. Pre-Incident Mapping
10. Impacts of the Project

Many Devices Are Invented To Extend Human Vision

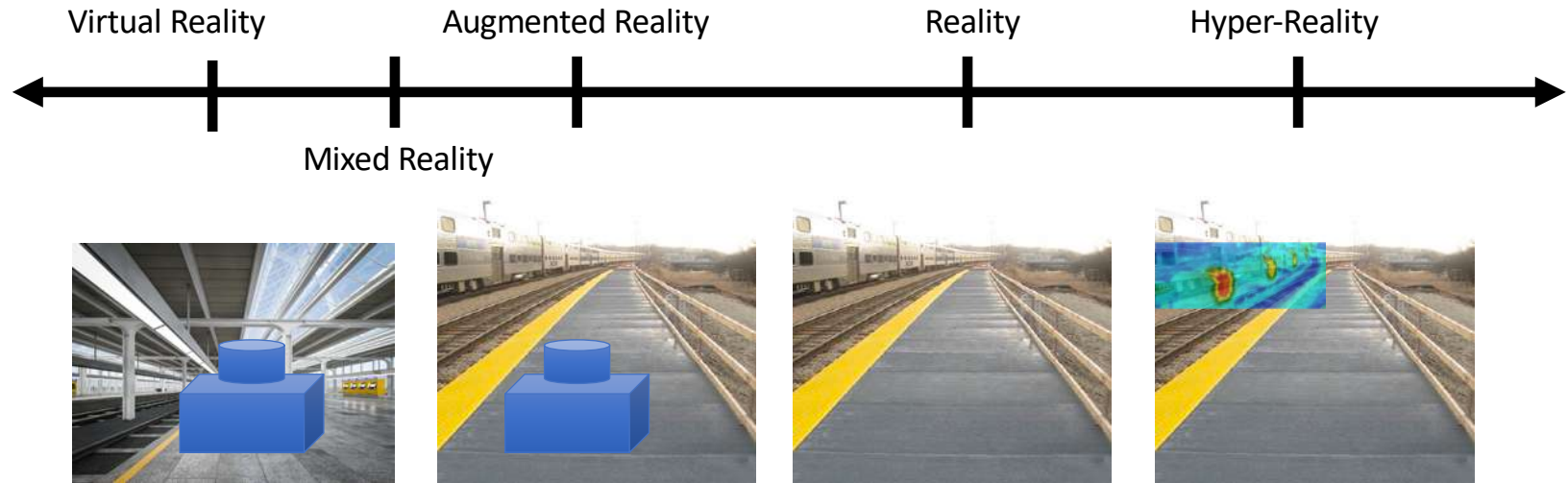
Periscope



HUD Overlay for Pilot



Hyper-Reality Is Real-Time Sensory Fusion

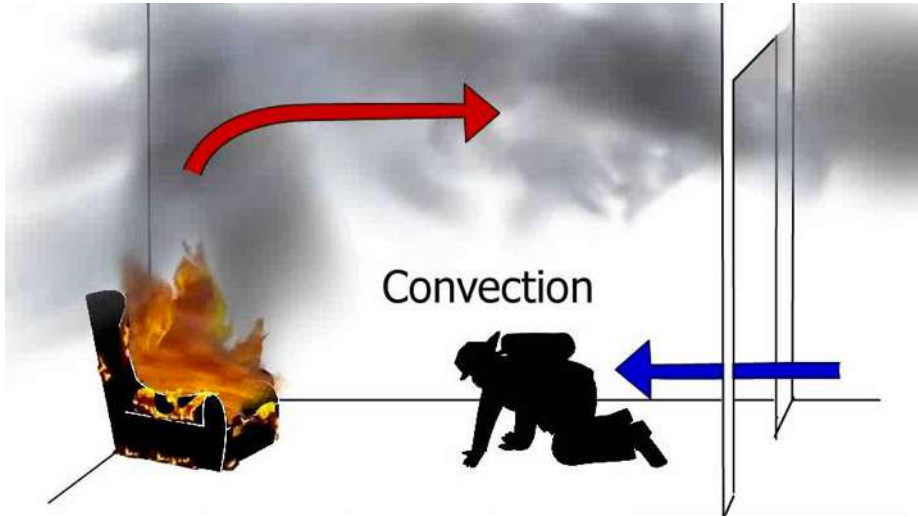


Hyper-Reality Helmet

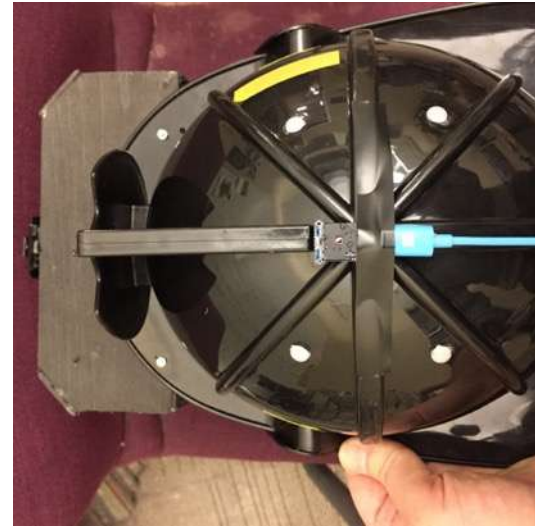
- 10 Sensors
- Processors
- Stereo HUD
- Bluetooth
- WiFi
- HDMI
- Libraries



The “Third Eye” Camera



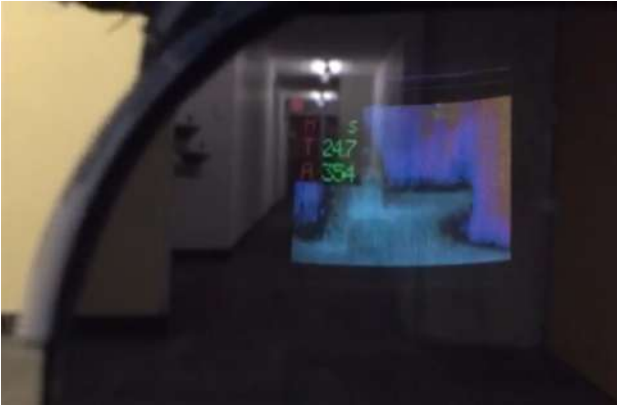
Fire fighters sometimes crawl on the floor



Camera on top of the helmet

Thermal Imaging

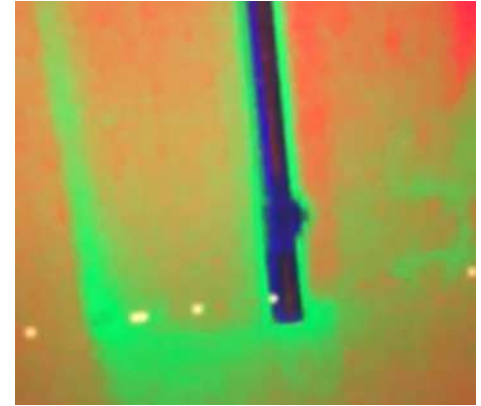
Heading, Temperature, and Altitude



Heads-Up-Display View of a Hallway



Thermal Image of a Human

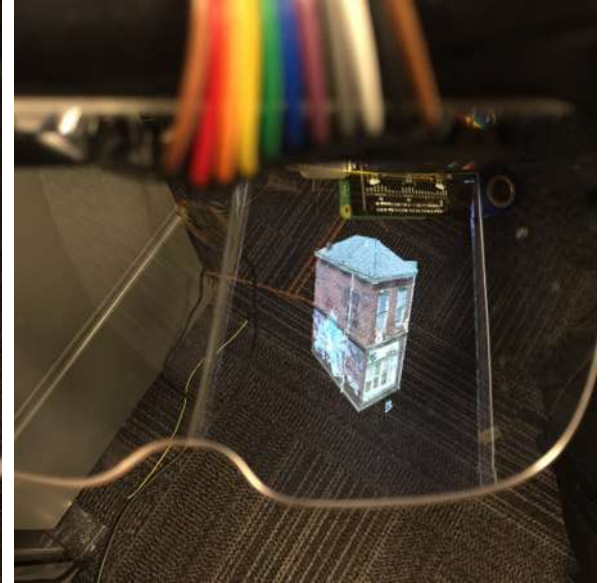
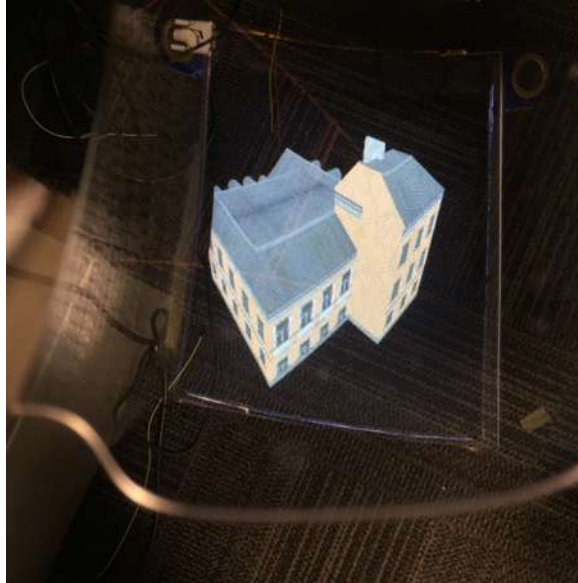


Water Pipe Line in the Wall

Thermal Imaging with Stereo Display



Stereo Display



Depth Information Is Helpful



Voice Interface

Microphone



Zoom-Out



Zoom-In

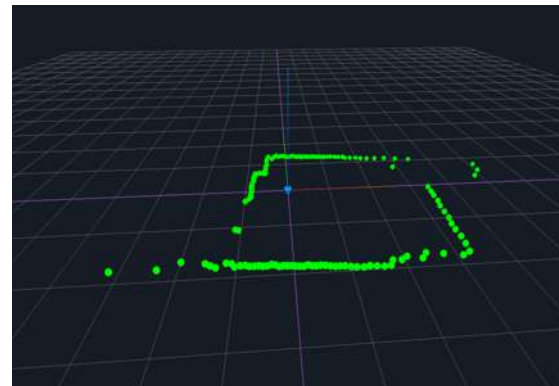
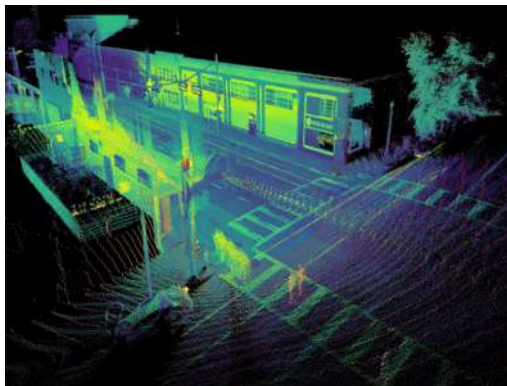


LIDAR – Light Detection and Ranging

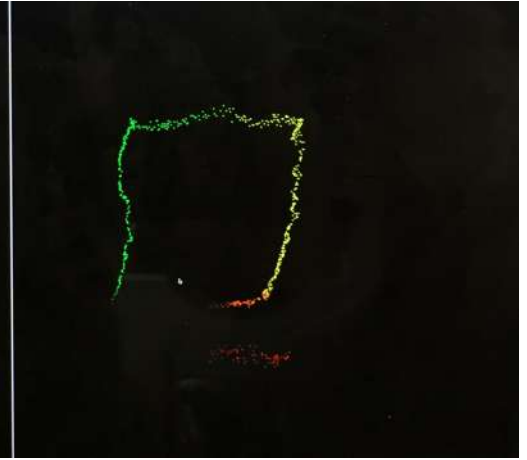
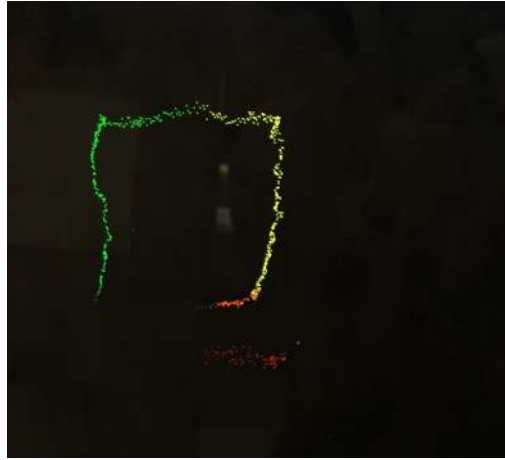
3-D LIDAR



2-D LIDAR

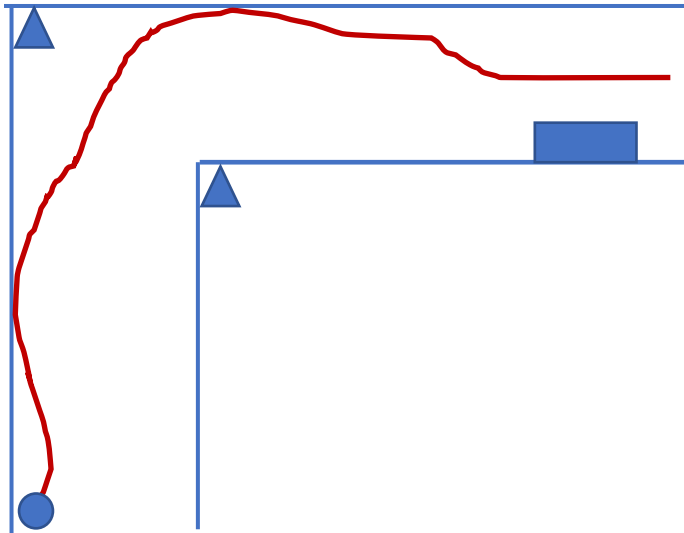


1-D LIDAR Sensor for Mapping



How to Walk in the Dark?

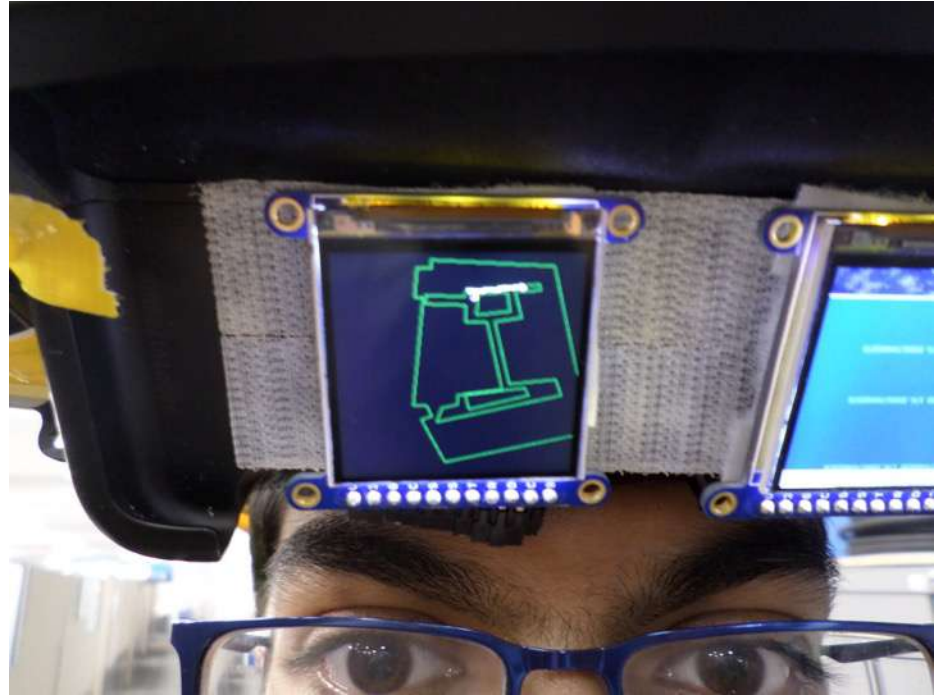
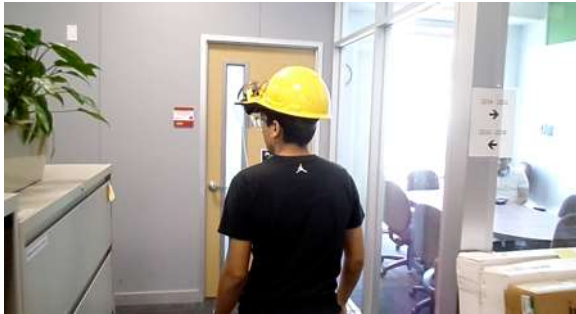
- Follow the wall
- Landmarks (corners, doors, elevators, stairs...)
- Interactions (cane, echoes, tactile sensing...)



Interactive Navigation

- Computing user position from steps and moving directions
- Checking labeled landmarks and pathways to improve accuracy
- Fuse multiple sensors to reduce drifting issues

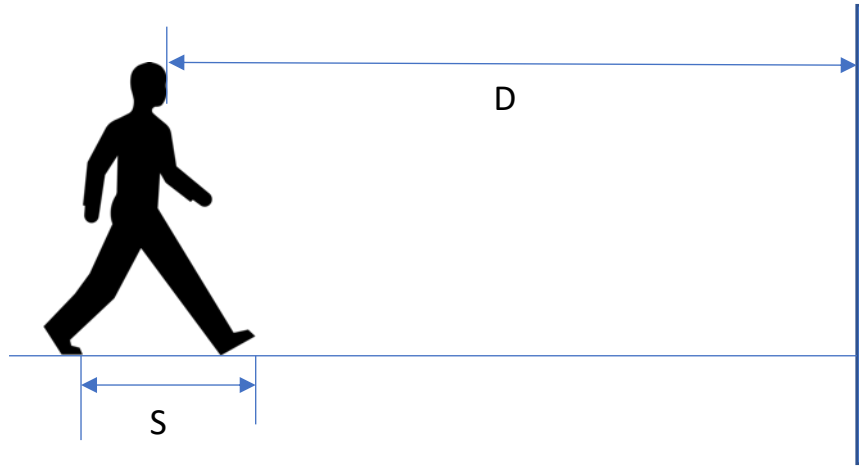
Indoor Navigation with Interactive Map



Sensory Fusion and Self-Calibration

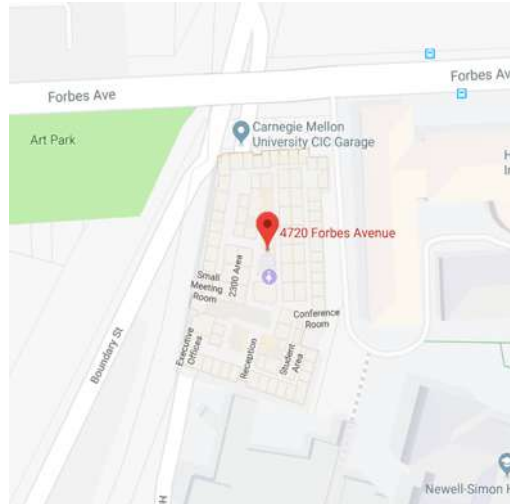
Accelerometer + Magnetic + Filters + LIDAR

Use 1D LIDAR to calibrate the pedometer's step distance.



How to Generate the Interactive Map?

1. Align the floor plan to Google Map for GPS coordinates (4 points)
2. Add landmarks and pathways with icons, labels, or shapes.



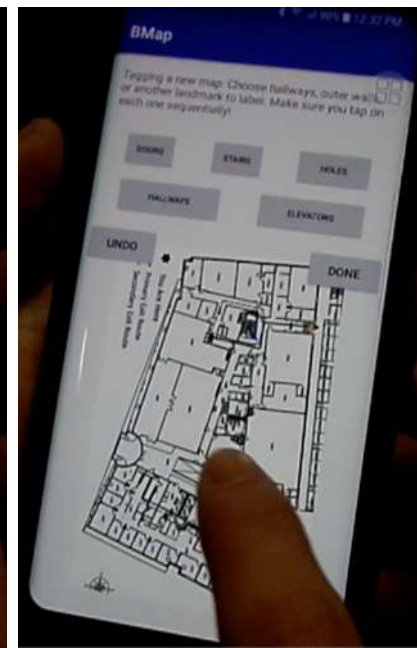
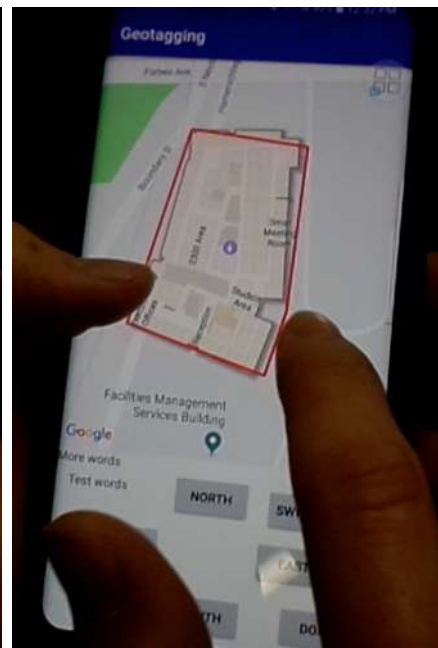
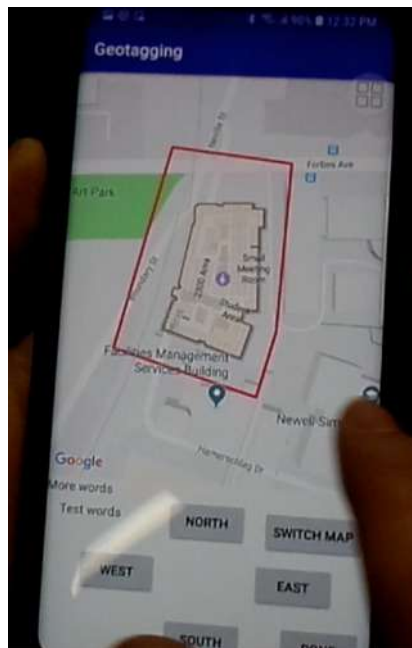
How to Generate the Interactive Map?

Mark 4 anchor points

Geo-tag to map

Alignment

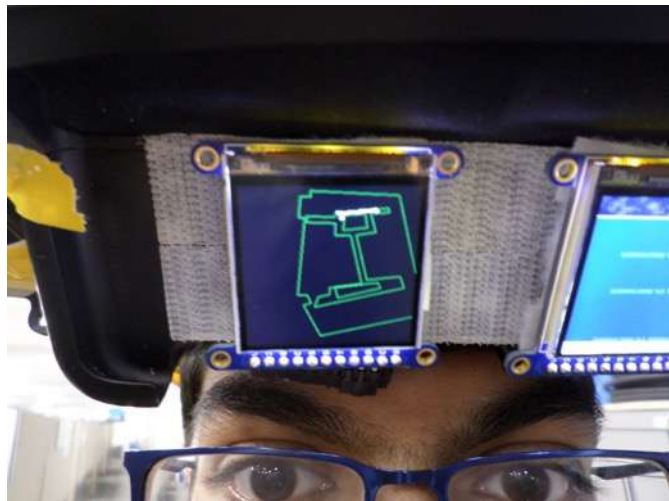
Enter landmarks and



Interactive Map for Indoor Navigation

Advantages

- Simple
- Affordable
- Works in the dark
- No beacons



Disadvantages

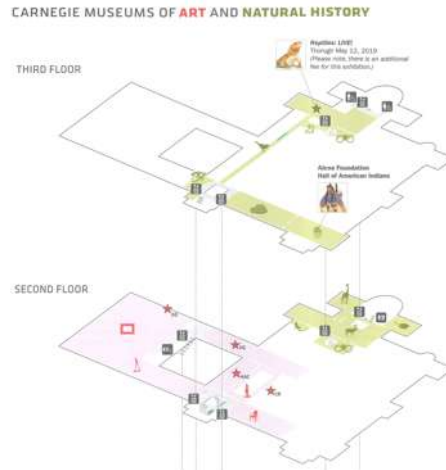
- Annotated map
- Vulnerable to changes
- Magnetic interference
- Not for long-distance

Map in Different Forms

2D



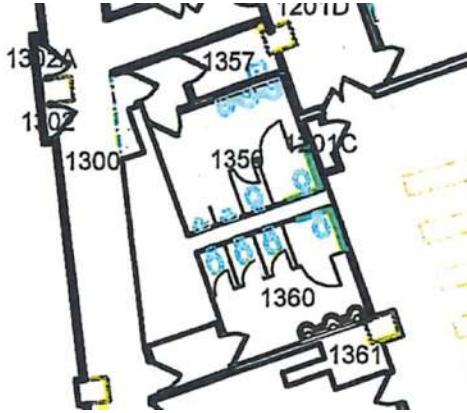
3D



3D Cutaway



Problems with Existing Maps



- Too much details (e.g. toilet)
- Too little utility data (e.g. AED)
- Incomplete data (e.g. multiple owners)
- Inaccurate data
- High-value asset data
- First response pathways

Give me six hours to chop down a tree and I will spend the first four sharpening the axe.

- Abraham Lincoln

Importance of Pre-Incident Planning

- Digital map for mobility
- Geo-tagged maps
- Navigation landmarks
- Navigation pathways
- High-value asset maps
- Update frequently
- Map “hidden” stuffs during construction

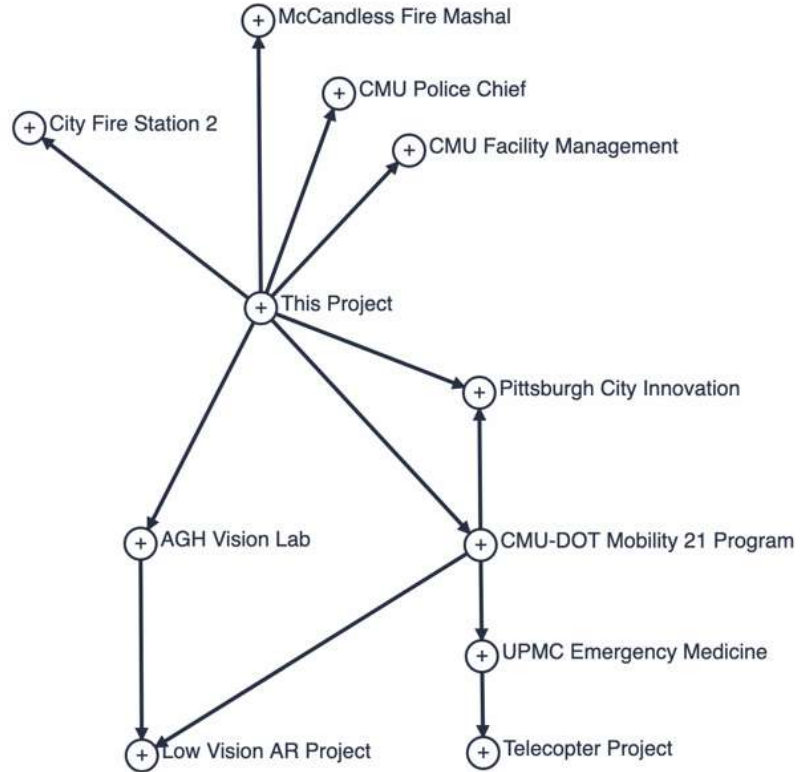
Mapping During Construction



Summary

1. We developed the helmet-based multimodal interfaces for imaging, mapping, and navigating.
2. Sensory fusion shows great potential to improve accuracy and reduce overall costs. However, multiple sensors also create challenges in calibrations.
3. Pre-Incident Planning is essential to our indoor navigation algorithms. It minimizes the risk. So we need to shift our attention from response to prevention and planning.

Broader Impacts



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Session**
3:15 PM