PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

MAKEABILITY LAB

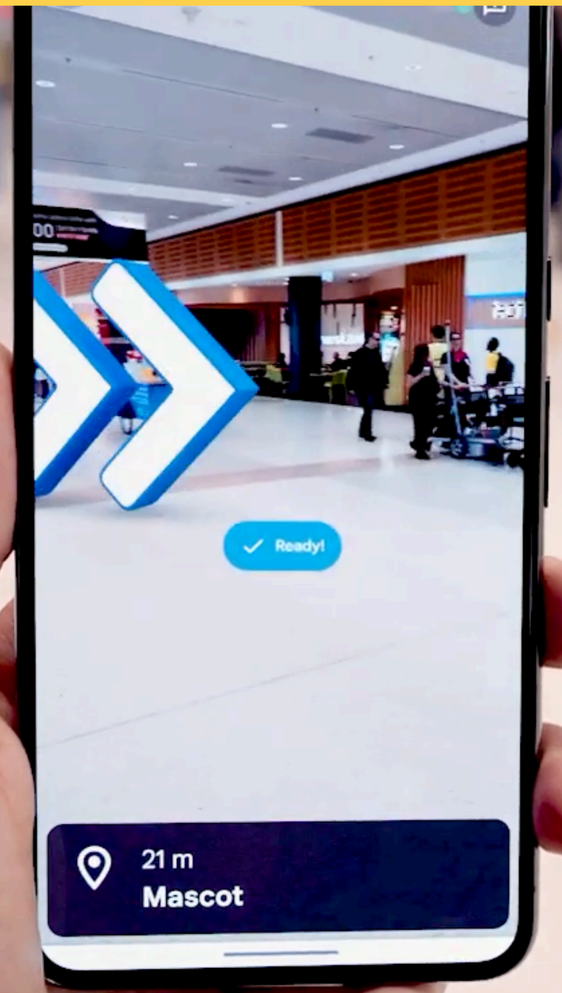
UIST 25
BUSAN, KOREA | SEP. 28TH – OCT. 1ST 2025

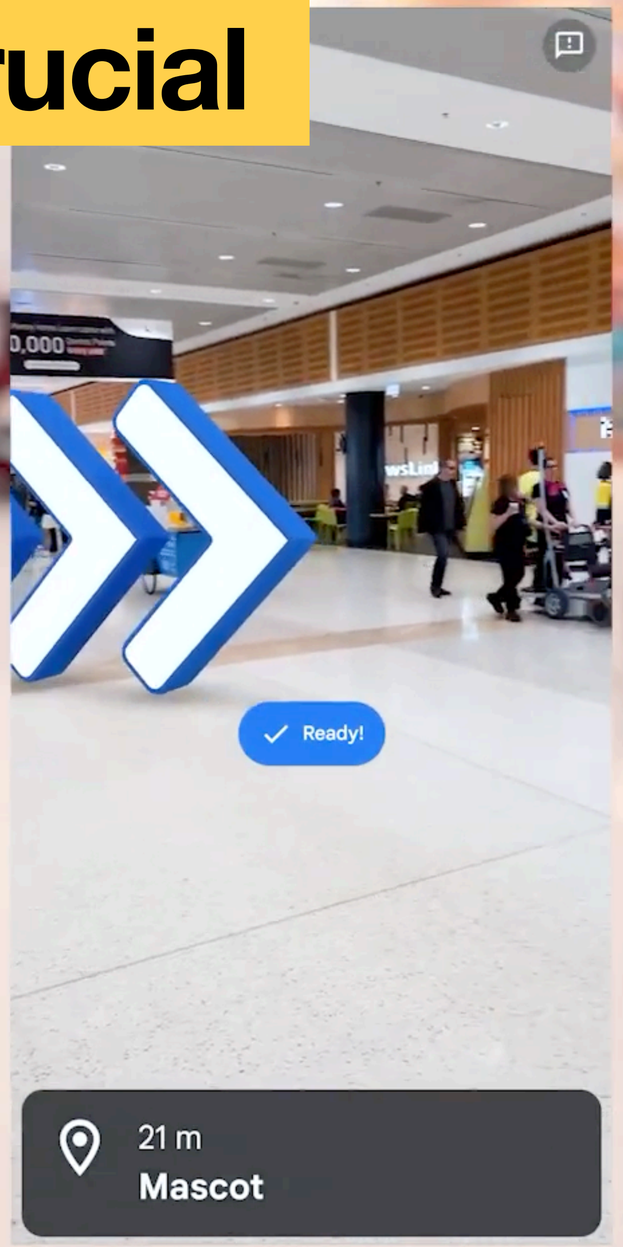
FlyMeThrough

Human-AI Collaborative 3D Indoor Mapping with Commodity Drones

Xia Su*, Ruiqi Chen*, Jingwei Ma, Chu Li, Jon E. Froehlich

Indoor mapping data is crucial





Indoor mapping data is crucial

However, collection is expensive and slow

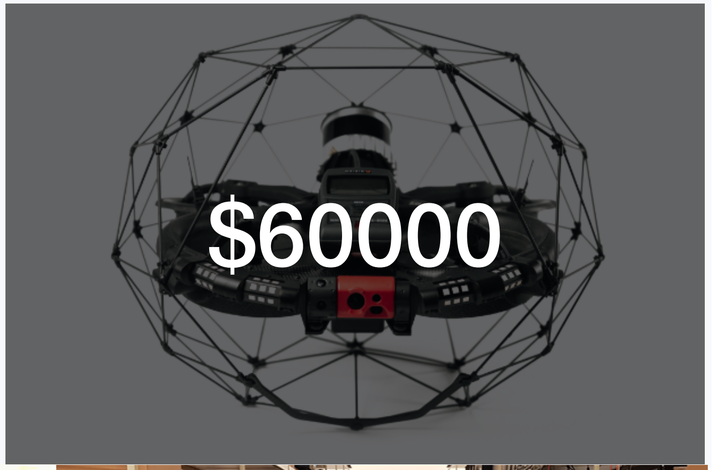
Drone as a special and efficient solution

Large Indoor Space

Efficiency

Availability

Related Works



Malhotra, A., & Söderström, U. (2022, December). Fixed camera drone based photogrammetry for indoor mapping. In *2022 IEEE 9th Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON)* (pp. 1-5). IEEE.

Safa, Ali & Verbelen, Tim & Catal, Ozan & Maele, Toon & Hartmann, Matthias & Dhoedt, Bart & Bourdoux, Andre. (2023). FMCW Radar Sensing for Indoor Drones Using Learned Representations. 10.48550/arXiv.2301.02451.

Research Goal: Lower the Bar

- 1. Explore a hardware-agnostic solution
- 2. Enable non-professionals to incorporate situated knowledge
- 3. Understand opportunities, application scenarios, risk, challenges.

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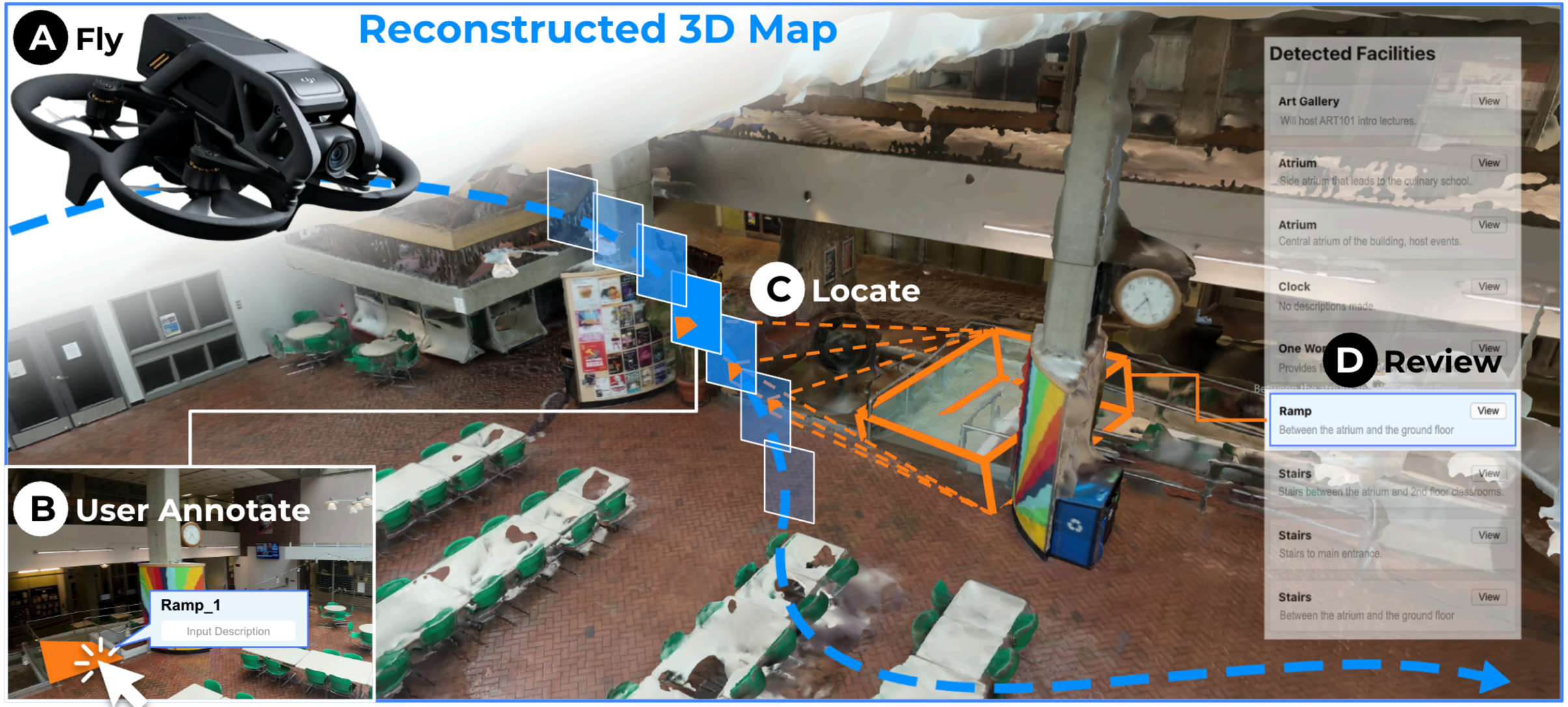
Human-AI Collaborative 3D Indoor Mapping with Commodity Drones



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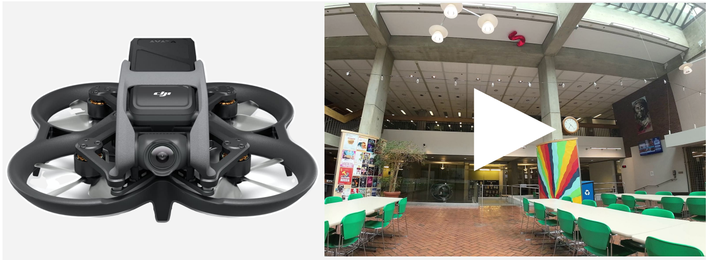
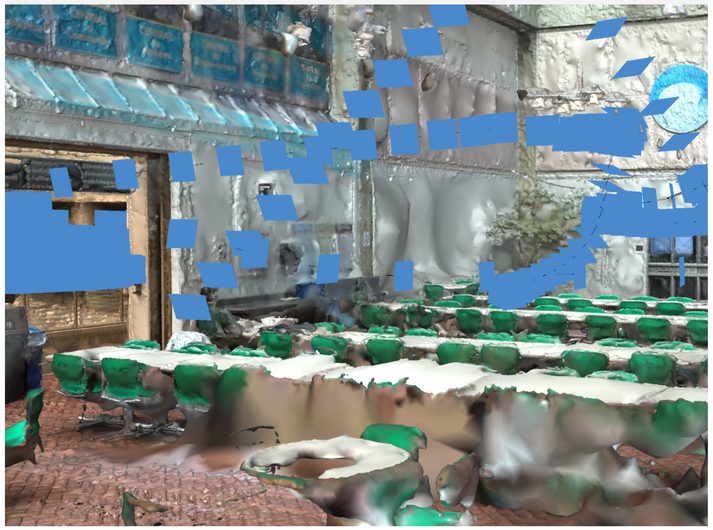
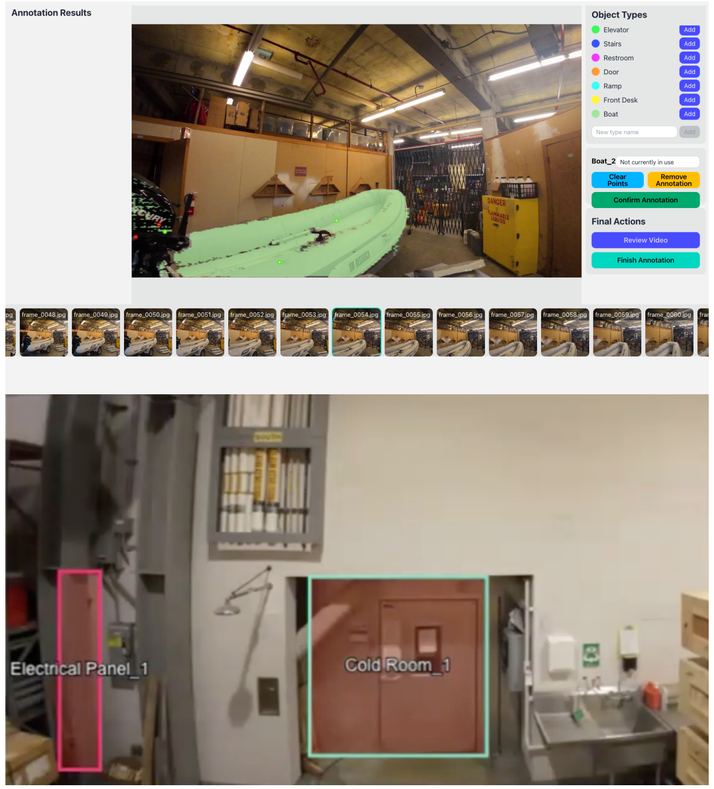
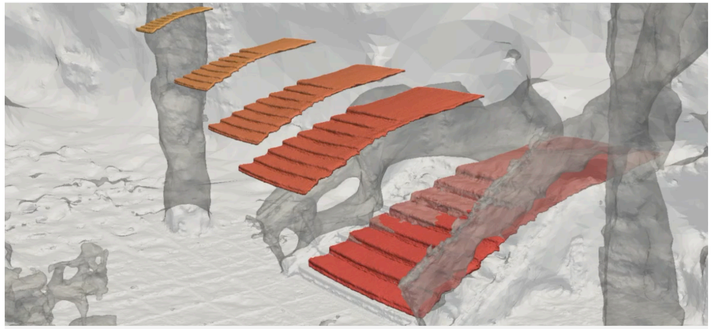


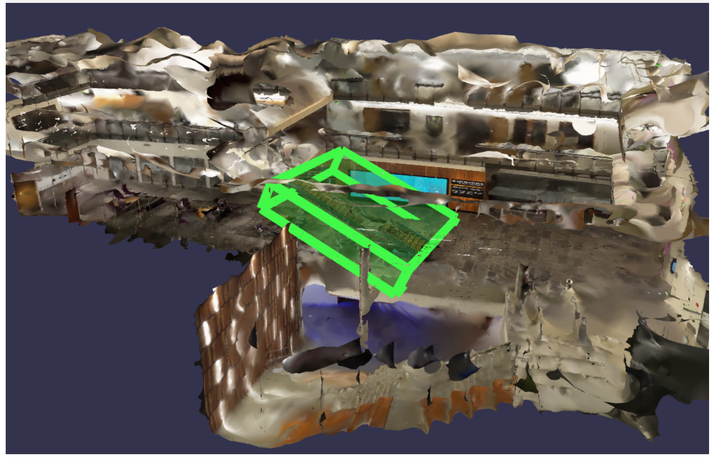


Structure from Motion
With Commodity Drone



Annotation
On Video Frames





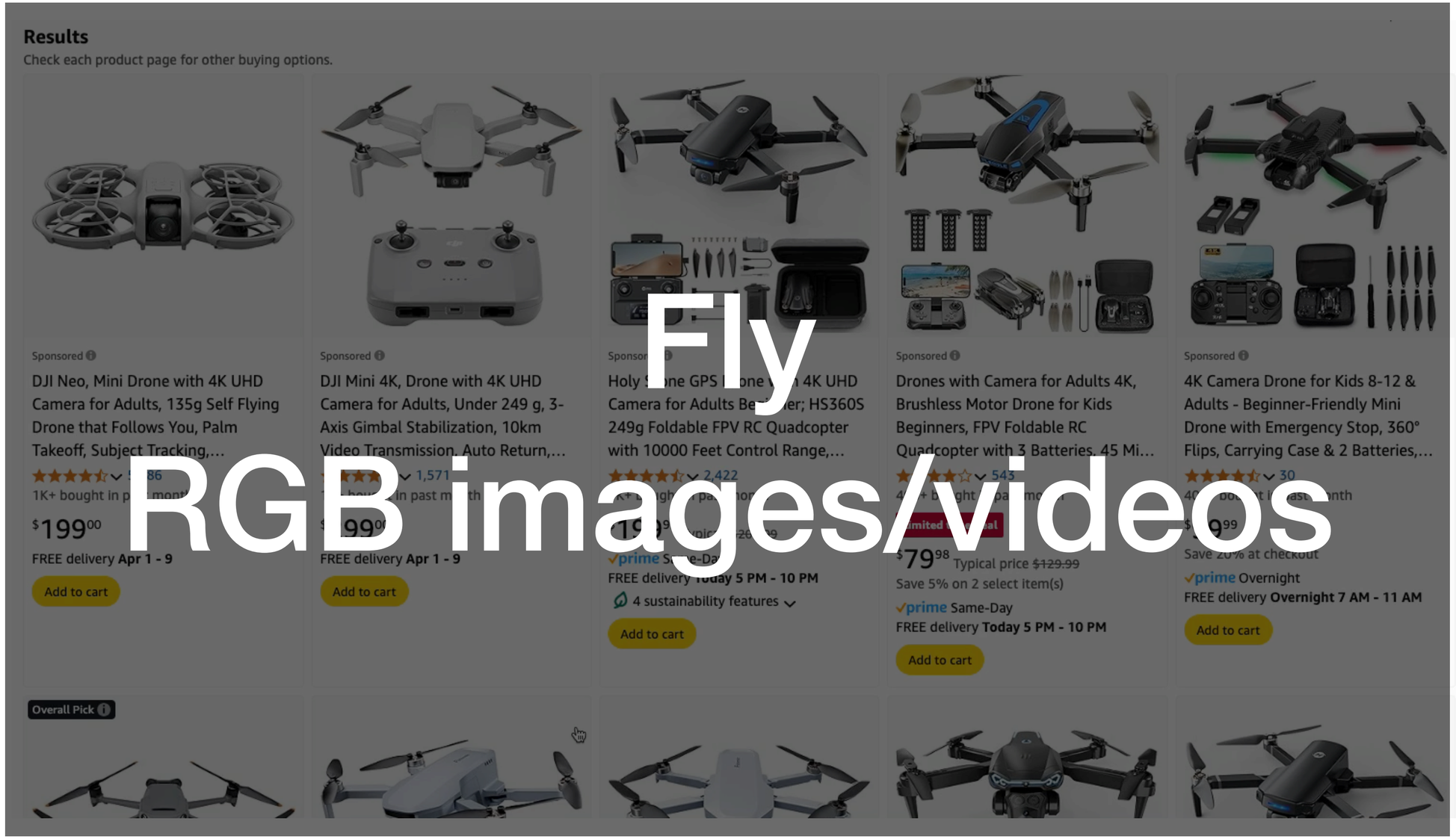
POI-infused
3D Indoor Map

FlyMeThrough

Structure from Motion With Commodity Drone

Annotation On Video Frames

POI-infused 3D Indoor Map



Fly

RGB images/videos

FlyMeThrough

Structure from Motion With Commodity Drone

Annotation On Video Frames

POI-infused 3D Indoor Map

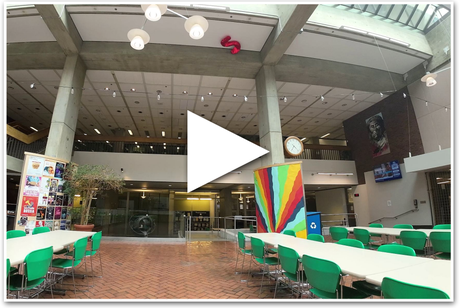
FlyMeThrough

Structure from Motion With Commodity Drone

Annotation On Video Frames

POI-infused 3D Indoor Map

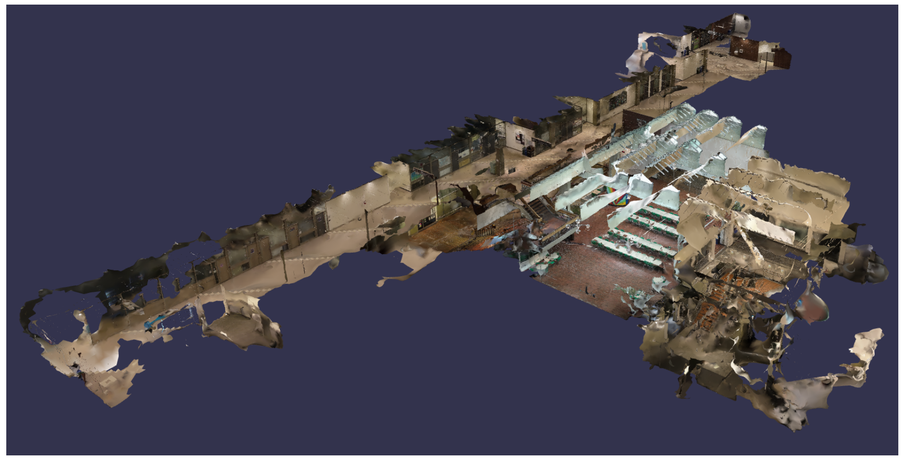
Commodity RGB Drone



Video

Frames

Camera Extrinsics



3D Reconstruction

FlyMeThrough

Structure from Motion With Commodity Drone

Annotation On Video Frames

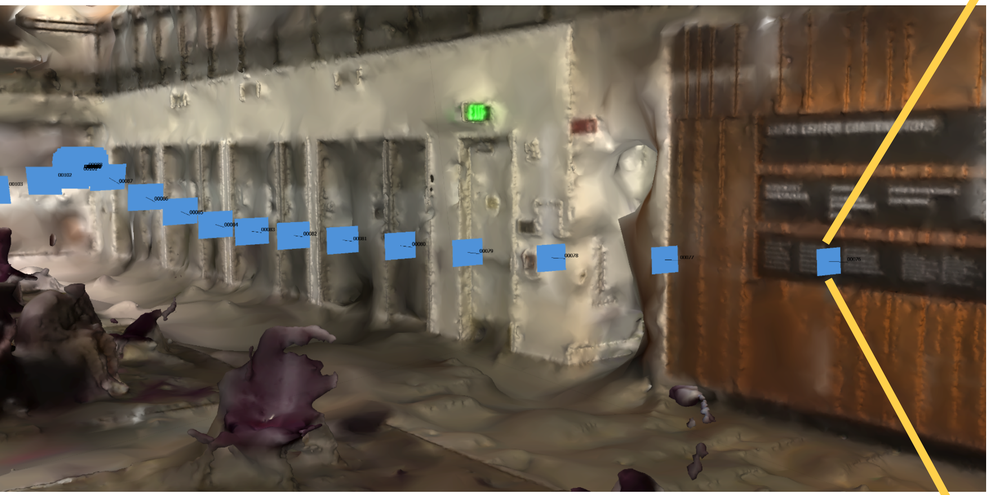
POI-infused 3D Indoor Map

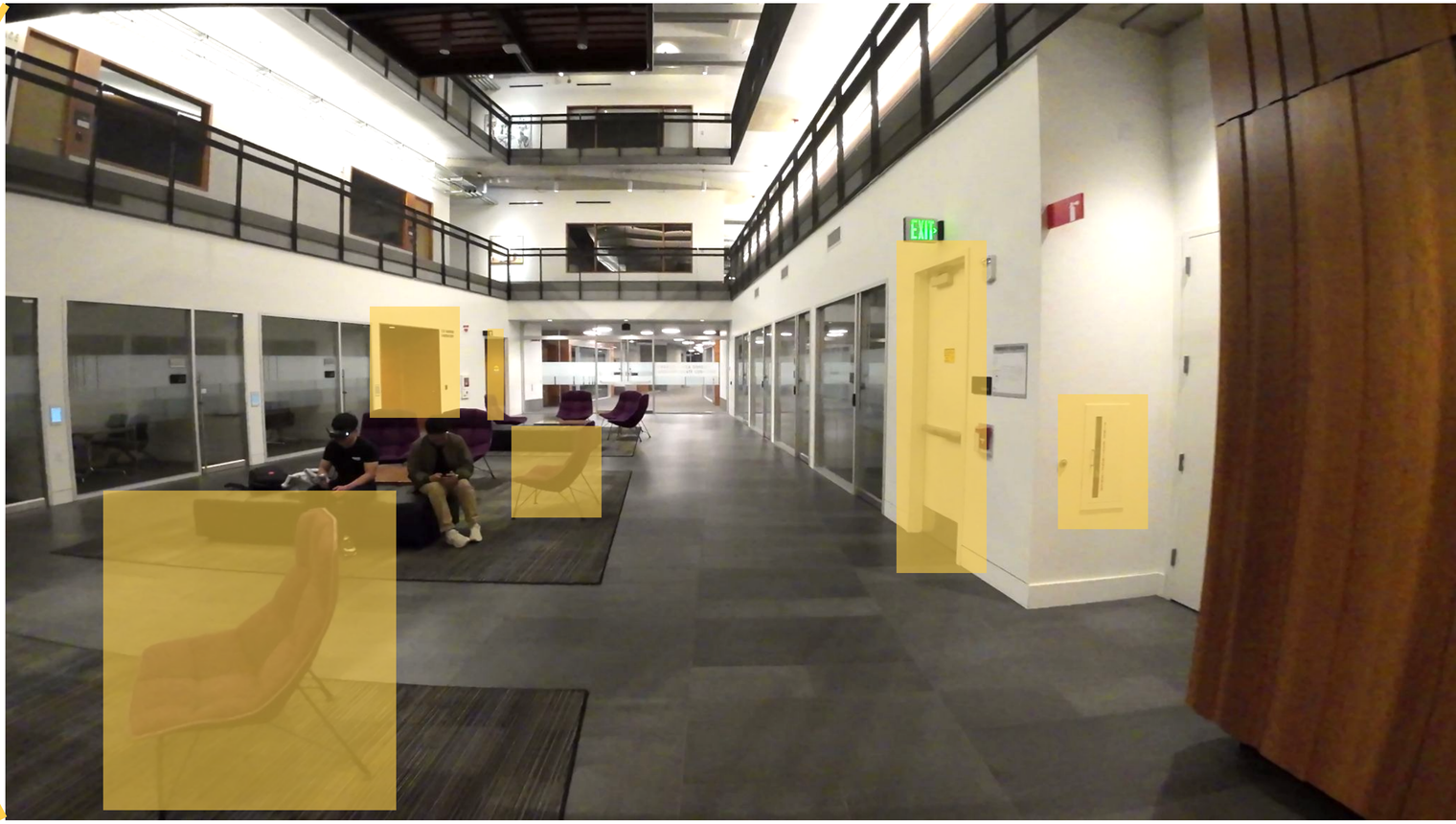
FlyMeThrough

Structure from Motion With Commodity Drone

Annotation On Video Frames

POI-infused 3D Indoor Map





Open Vocabulary

Contextual Knowledge

Visually Ambiguous

Annotation Results

- Entrance_2 — Frame: 4 — 4 boxes — View
- Door_1 — Frame: 4 — 1 boxes — View
- Stairs_1 — Frame: 4 — 8 boxes — View
- Front Desk_1 — Frame: 15 — 4 boxes — View
- Door_2 — Frame: 15 — 6 boxes — View
- Elevator_1 — Frame: 19 — 4 boxes — View
- Door_3 — Frame: 49 — 2 boxes — View
- Stairs_2 — Frame: 139 — 4 boxes — View
- Stairs_3 — Frame: 150 — 10 boxes — View
- Elevator_2 — Frame: 175 — Processing... — View
- Elevator_3 — Frame: 175 — 1 boxes — View
- Door_4 — Frame: 175 — View

Object Types

- Entrance — Add
- Elevator — Add
- Stairs — Add
- Restroom — Add
- Door — Add
- Ramp — Add
- Front Desk — Add

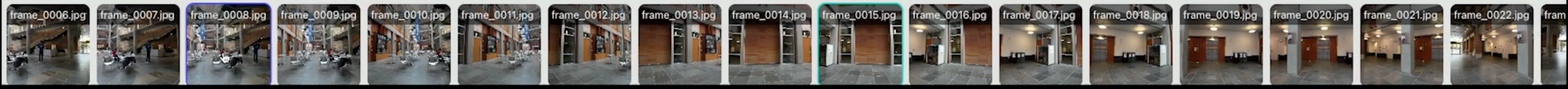
New type name — Add

Select an object type to start annotating

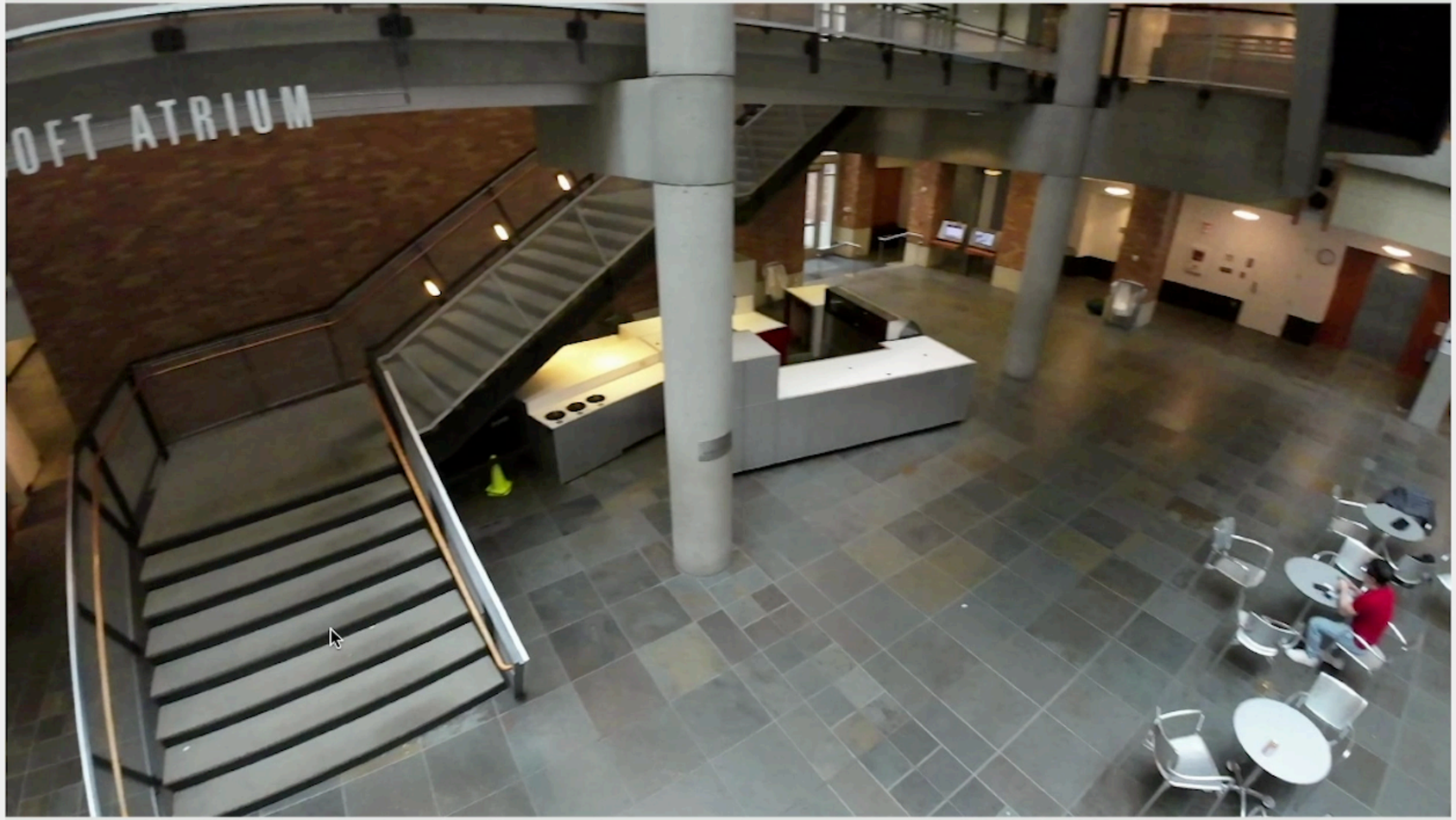
Final Actions

Review Video

Finish Annotation



Annotation Results



Object Types

- Entrance — Add
- Elevator — Add
- Stairs — Add
- Restroom — Add
- Door — Add
- Ramp — Add
- Front Desk — Add

New type name — Add

Stairs_1 — description of this object

Clear Points | Remove Annotation

Confirm Annotation

Final Actions

Review Video

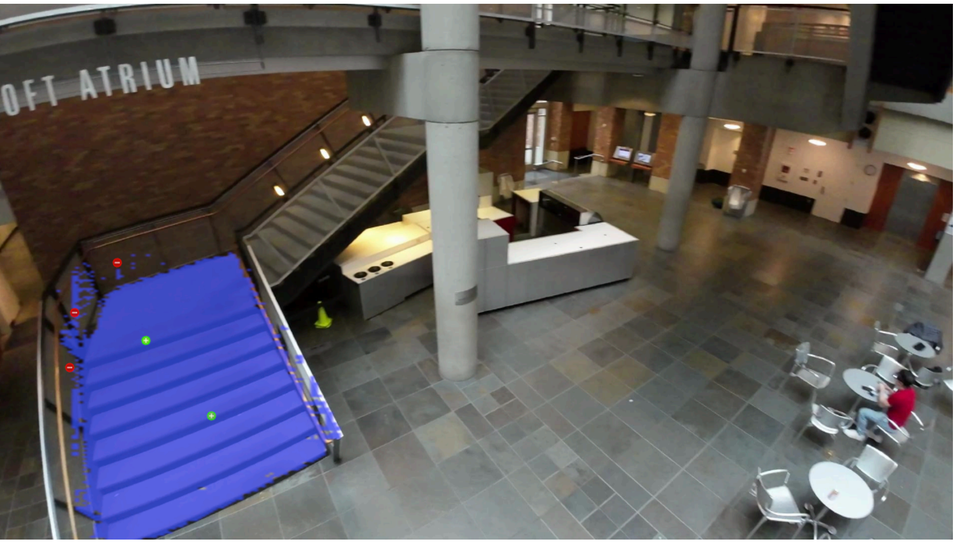
Finish Annotation

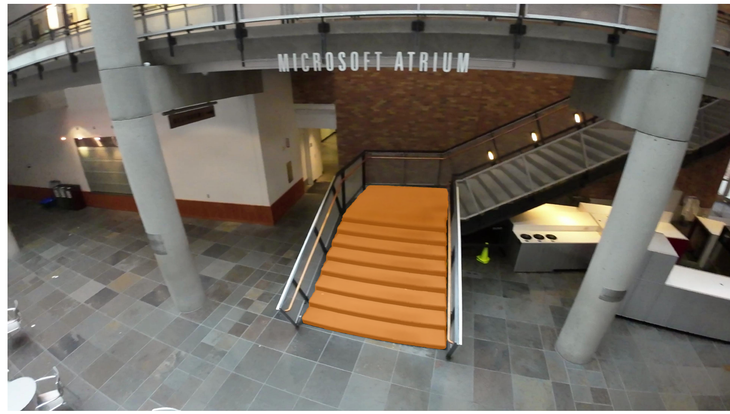
FlyMeThrough

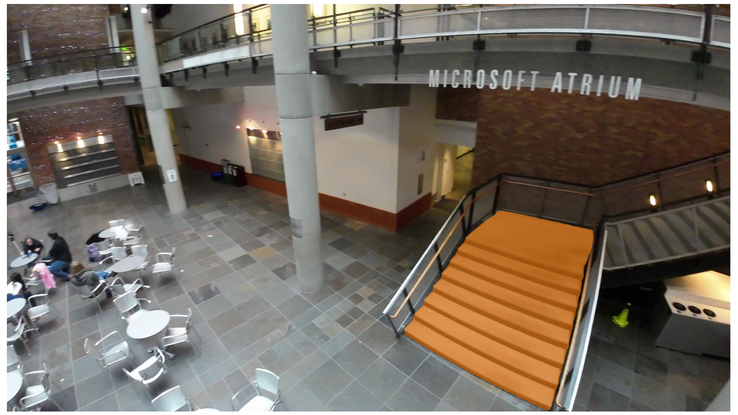
Structure from Motion With Commodity Drone

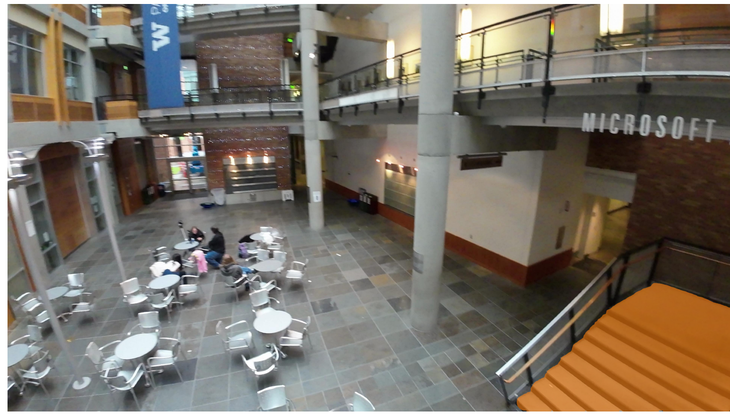
Annotation On Video Frames

POI-infused 3D Indoor Map



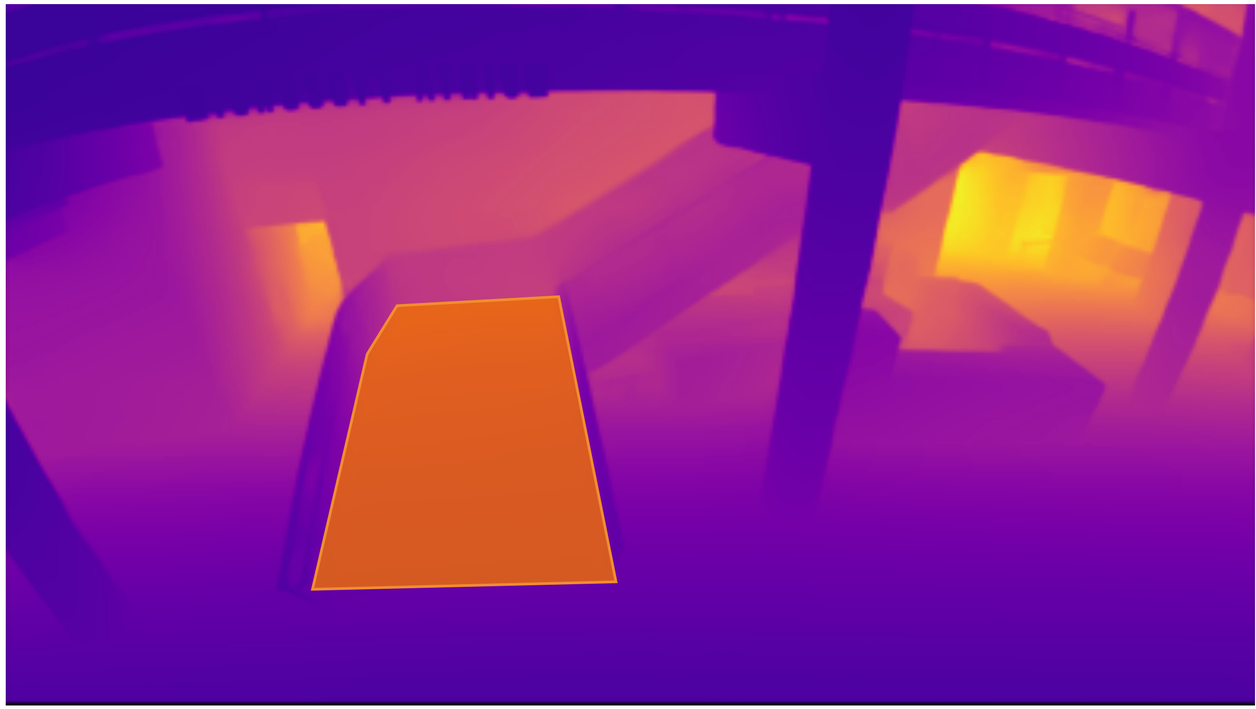




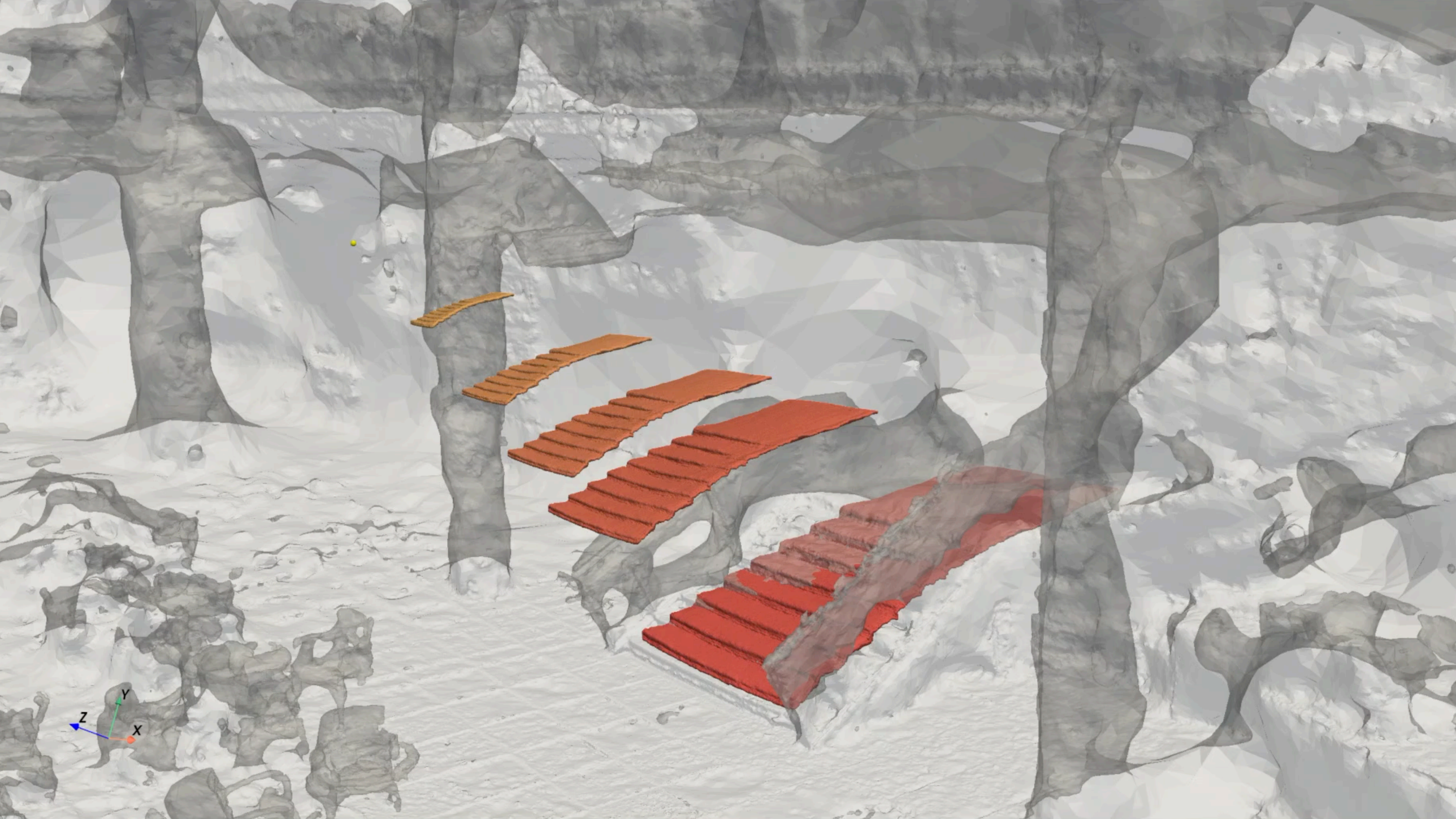


FlyMeThrough

Structure from Motion With Commodity Drone ❯ Annotation On Video Frames ❯ POI-infused 3D Indoor Map



Depth-guided Ray-casting

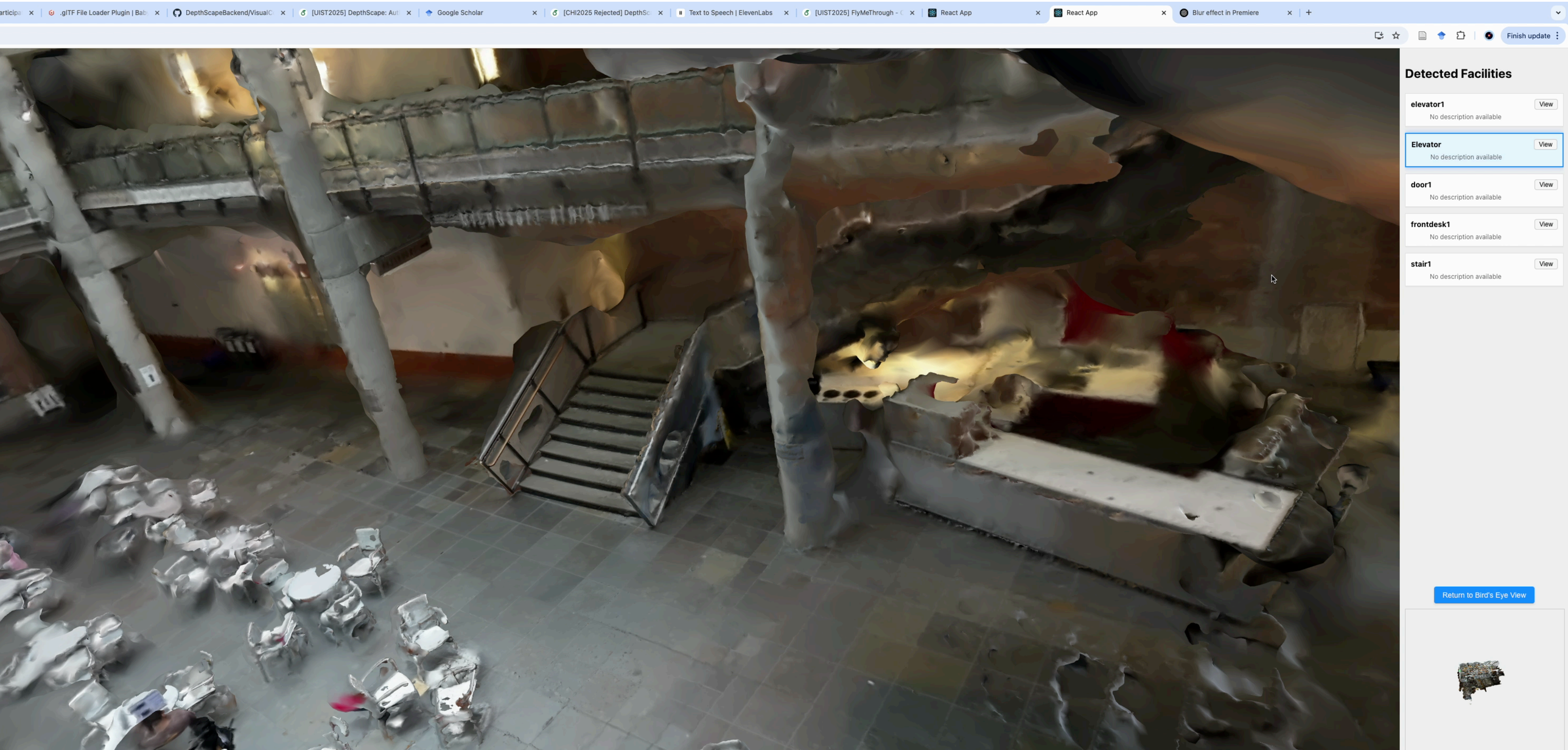

Y
Z
X

FlyMeThrough

Structure from Motion With Commodity Drone

Annotation On Video Frames

POI-infused 3D Indoor Map



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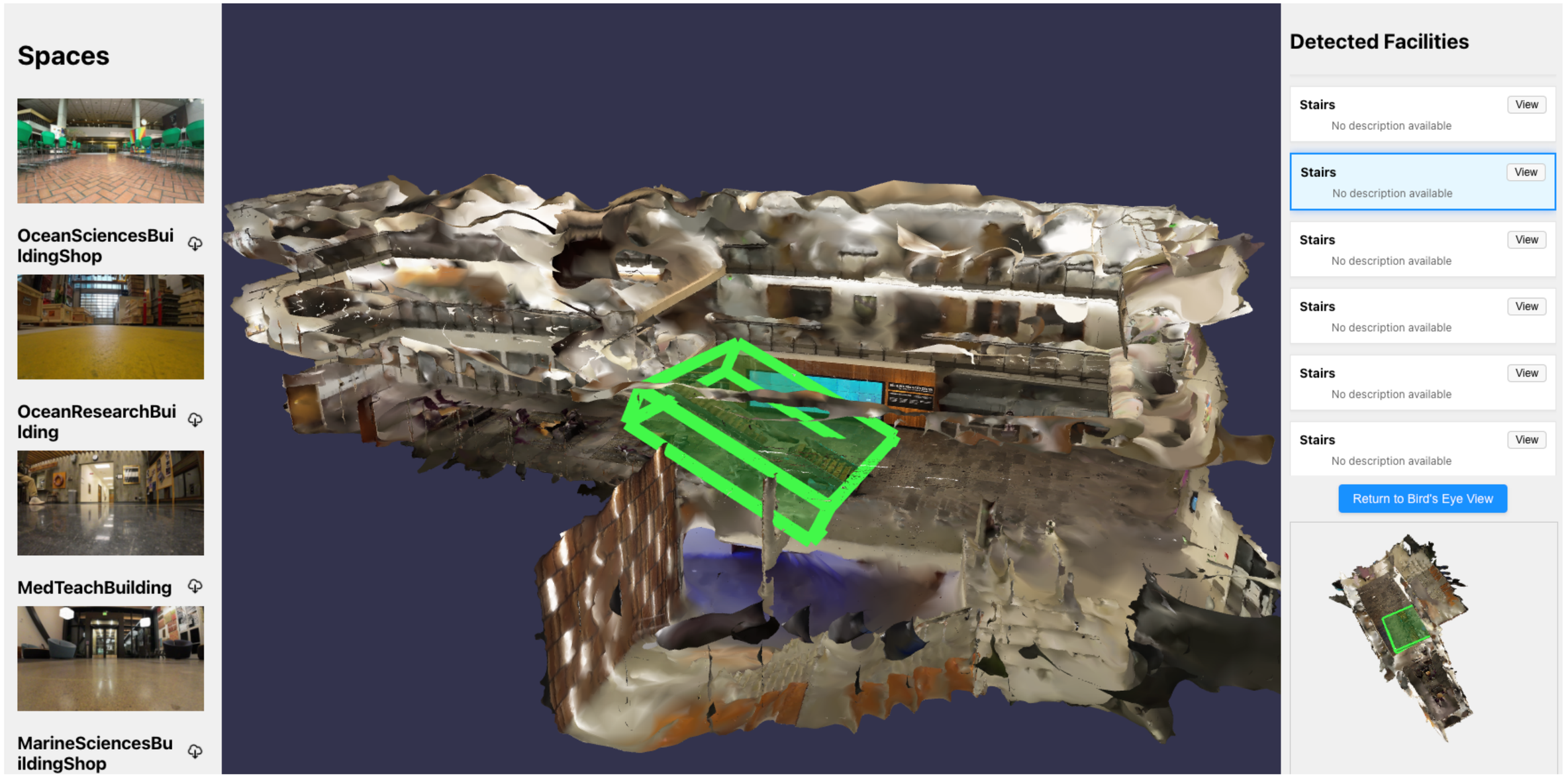
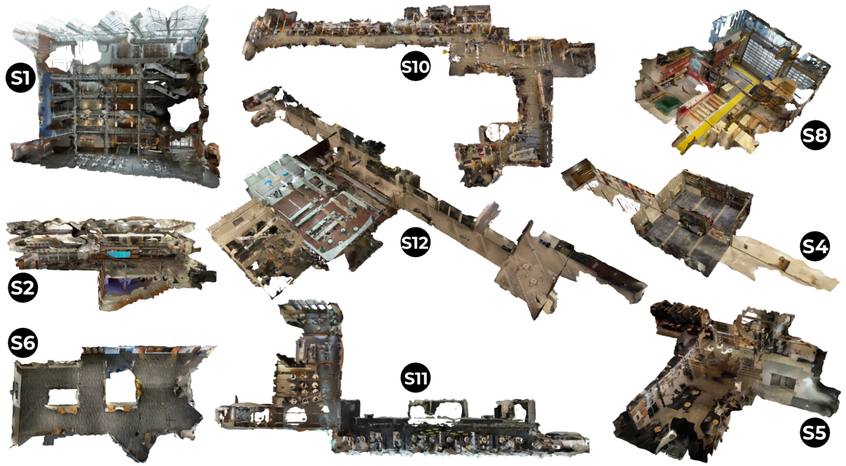
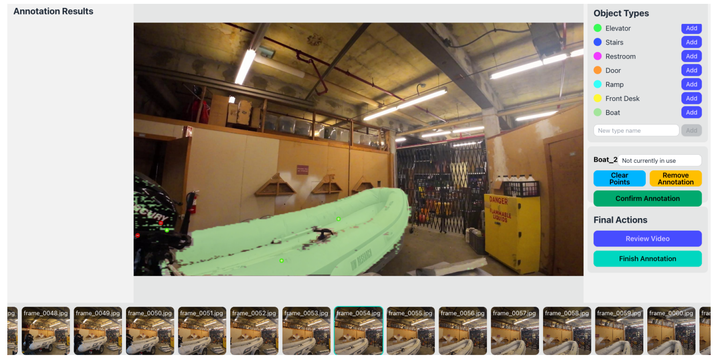
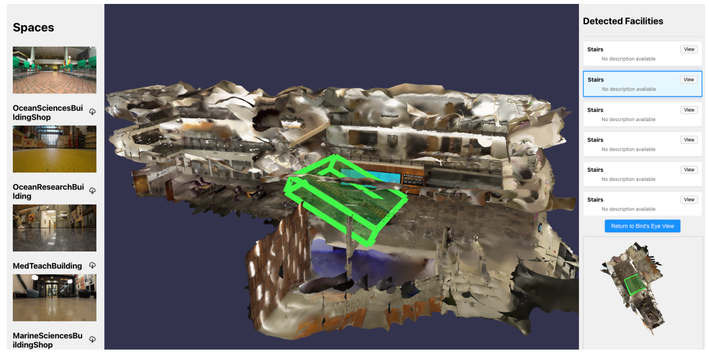


Evaluation







> Common spaces would be [appropriate to scan]. Like we could do the hallways and large atria.

> maybe it's best to blur people's faces before annotation

Performance Across Spaces

Interface Usability

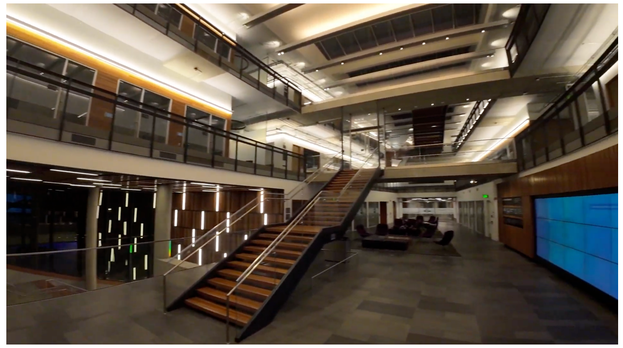
Opportunities & Challenges

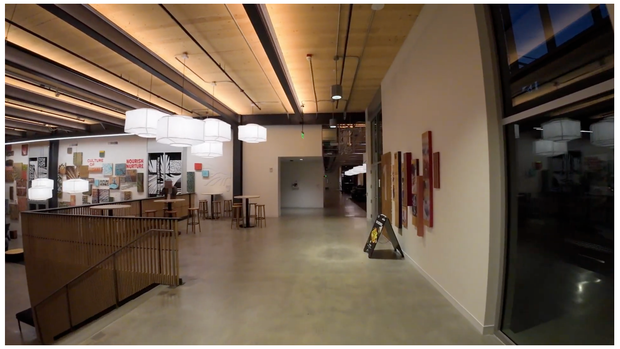
Evaluation

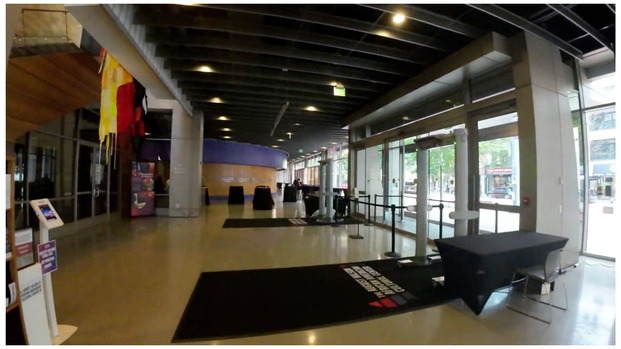
Performance Across Spaces

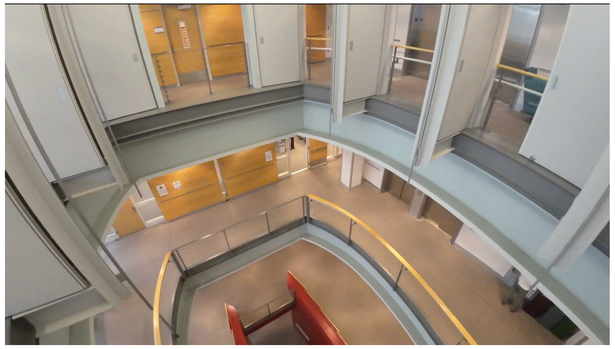
Interface Usability

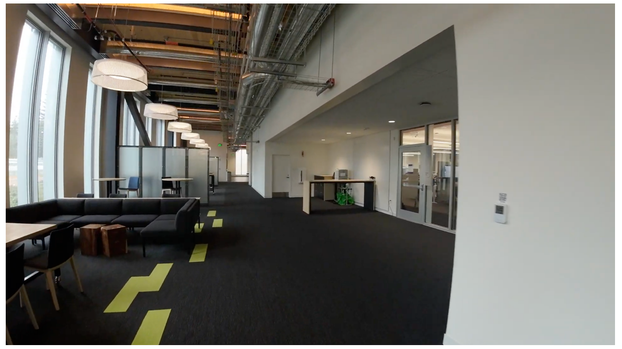
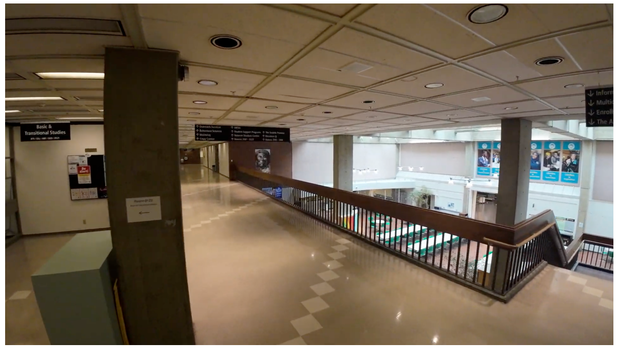
Opportunities & Challenges





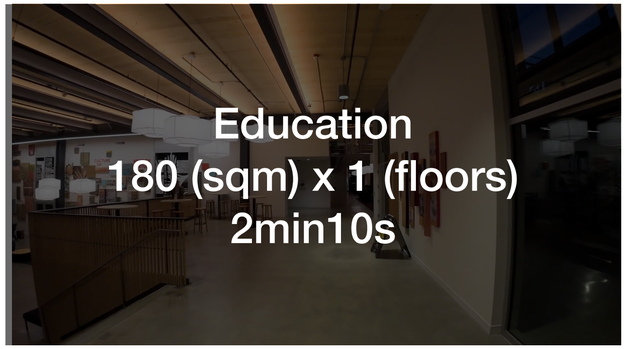


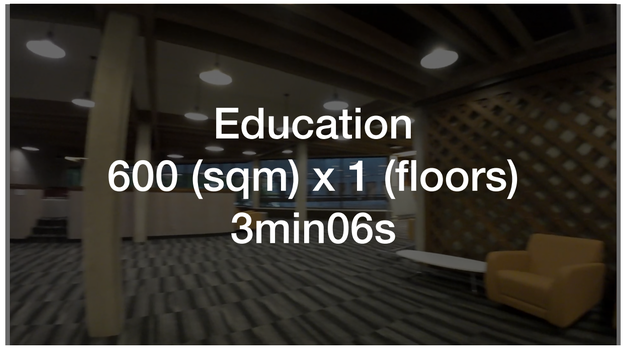


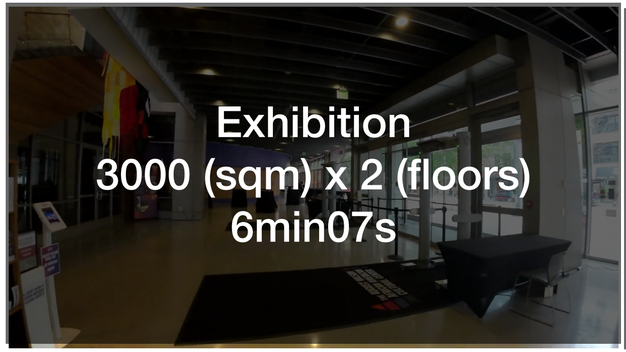



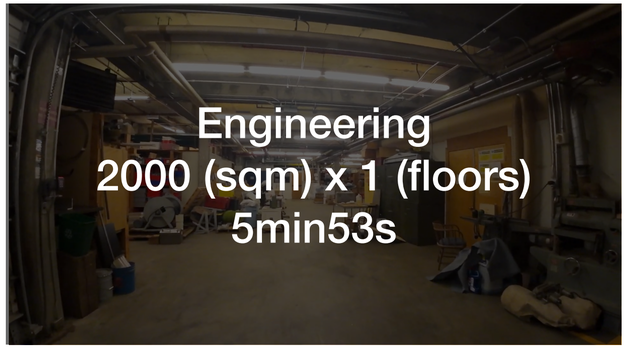
Evaluation

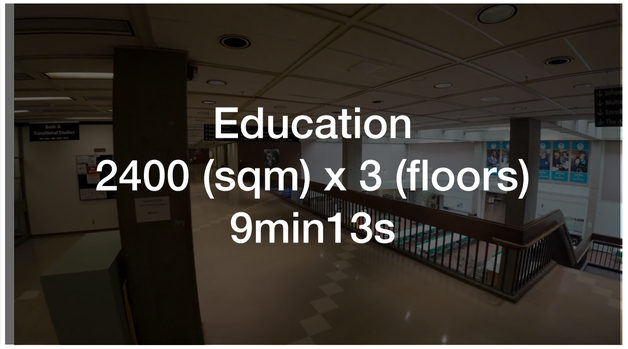
Performance Across Spaces ❯ Interface Usability ❯ Opportunities & Challenges









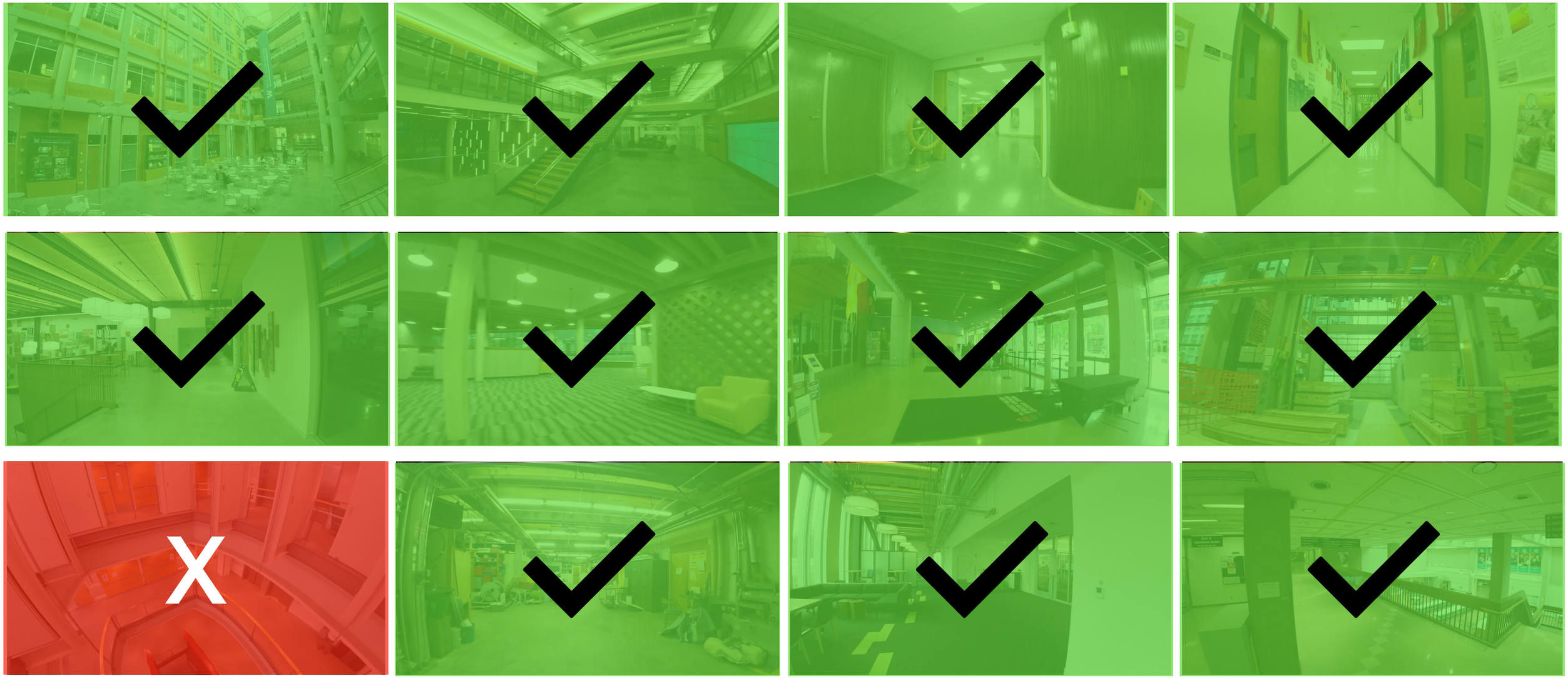


Evaluation

Performance Across Spaces

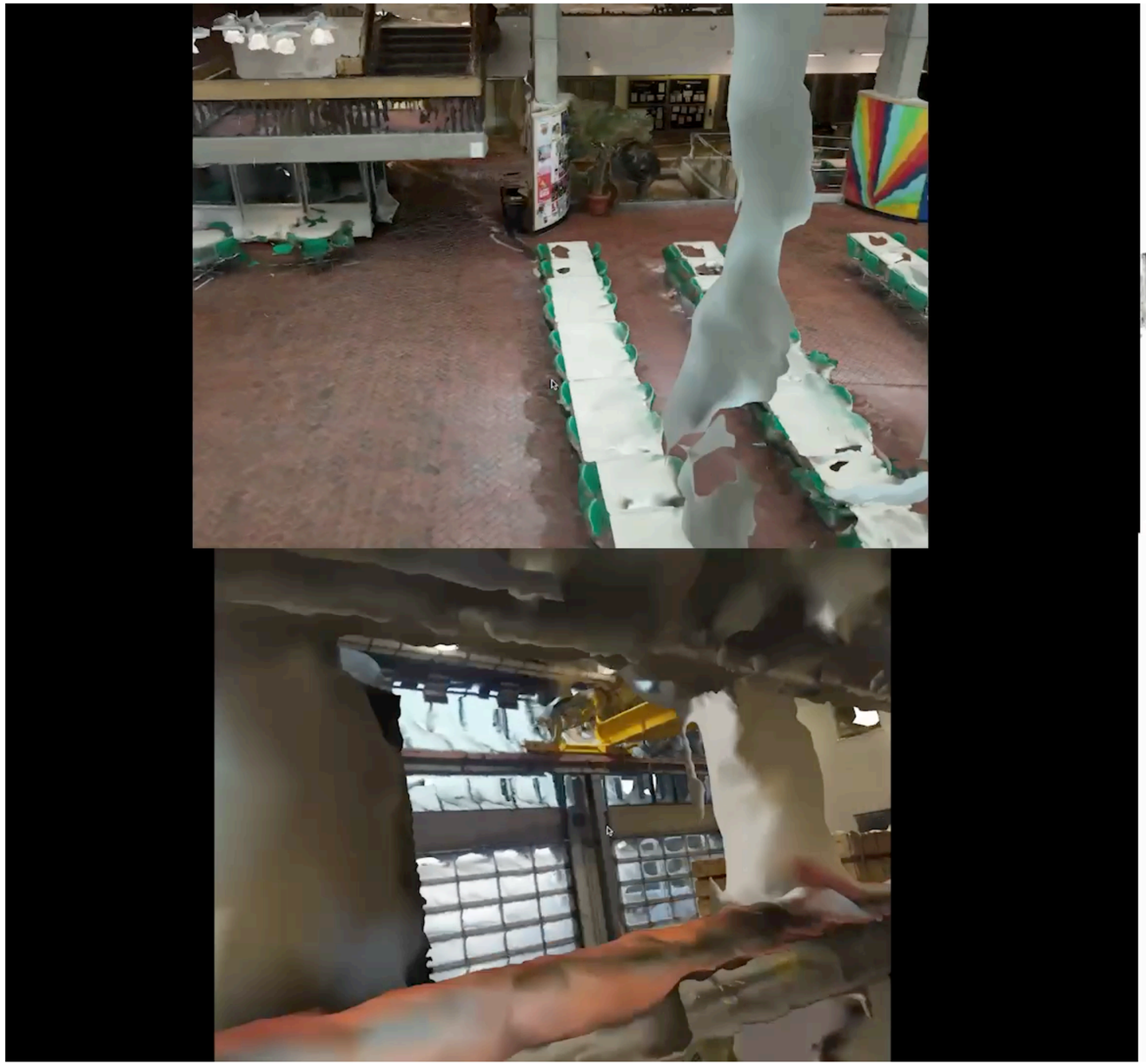
Interface Usability

Opportunities & Challenges



Evaluation

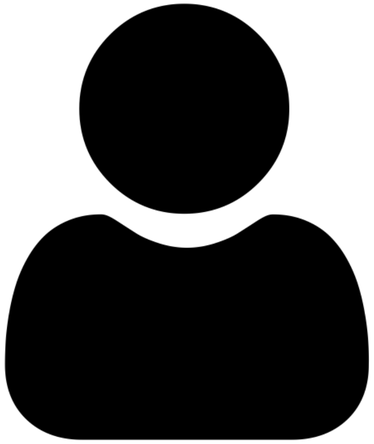
Performance Across Spaces ❯ Interface Usability ❯ Opportunities & Challenges



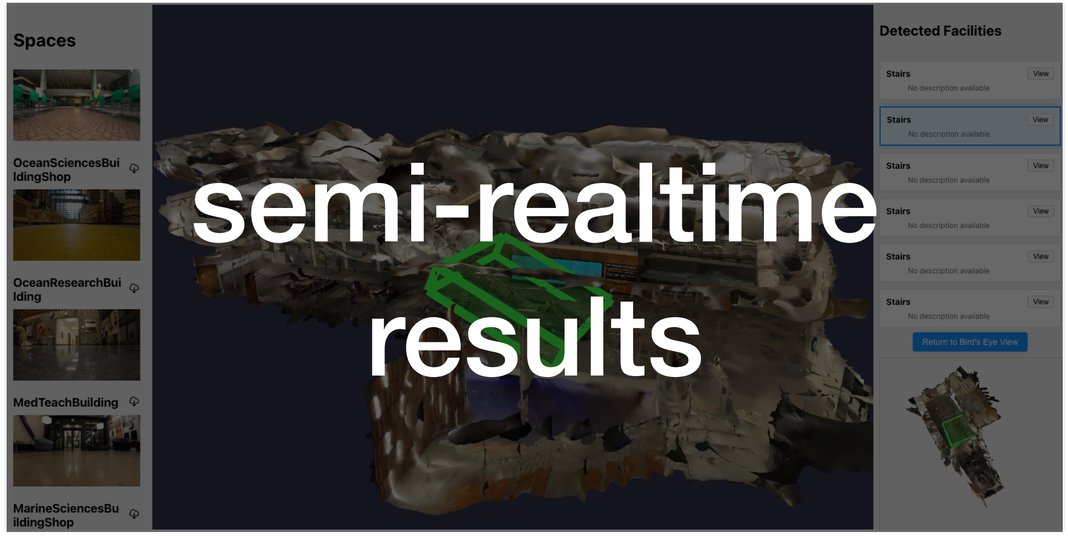
Evaluation

Performance Across Spaces ❯ **Interface Usability** ❯ Opportunities & Challenges

5 building managers



5 building users



Evaluation

Performance Across Spaces › Interface Usability › Opportunities & Challenges

- Interfaces are easy to use.

> Pretty easy to use
> - M2 & O5

> Not complicated at all
> - M5

Easy to use:
6/7

Model quality:
5/7

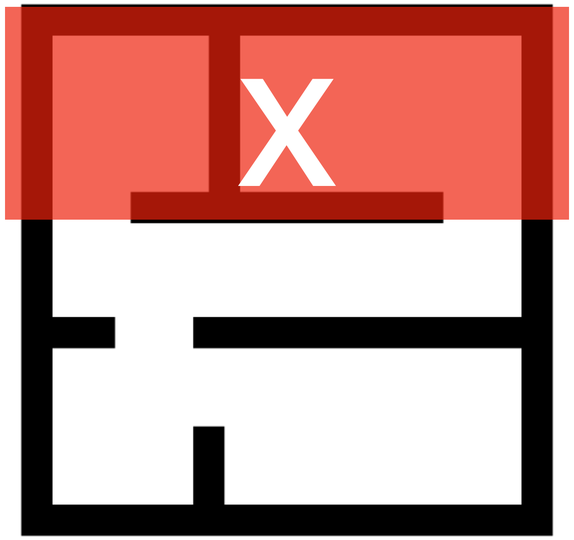
91.7% annotation
Success

71.5% POI
High quality

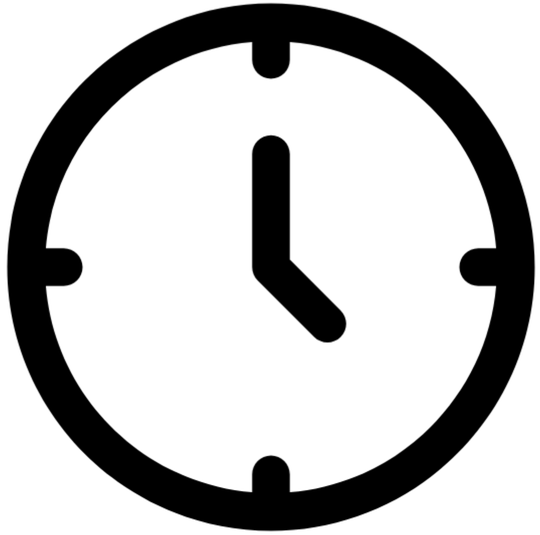
Evaluation

Performance Across Spaces ❯ Interface Usability ❯ Opportunities & Challenges

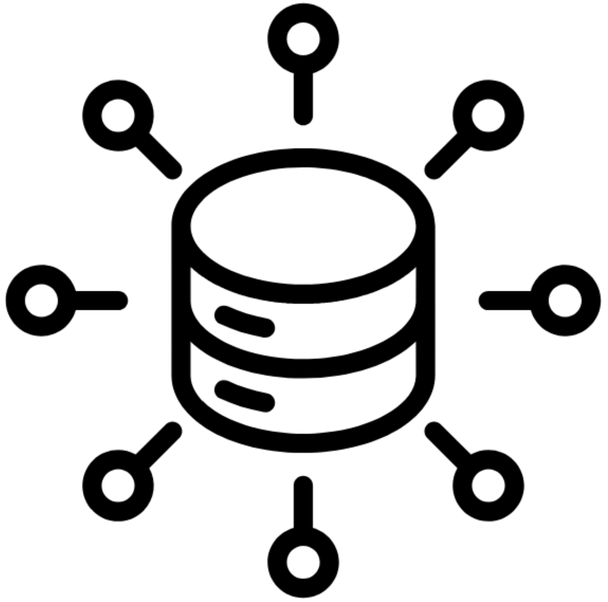
- Participants are **relatively relaxed** about the indoor drone fly.
- **Privacy** emerged as a key concern but can be mitigated by:



Spatial Exclusion



Temporal Minimization



Data Management

Evaluation

Performance Across Spaces

Interface Usability

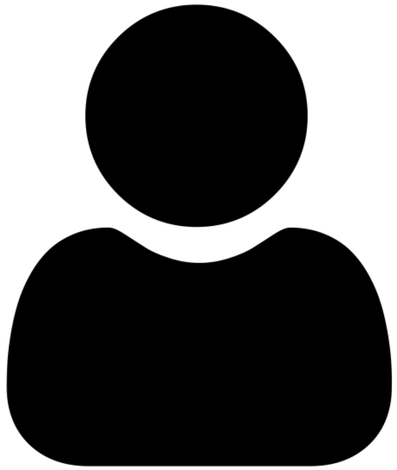
Opportunities & Challenges

Space Planning

Remote Inspect

Utilization Analysis

Assets Management



Navigation

A11y Eval

Safety & Util

Evaluation

Performance Across Spaces ❯ Interface Usability ❯ Opportunities & Challenges

Low-cost

Open vocabulary

Community Driven

Make indoor maps a **common resource**, not the privilege of a few.

PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

MAKEABILITY LAB

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FlyMeThrough

Human-AI Collaborative 3D Indoor Mapping with Commodity Drones

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Project Page & Code