

# DroneOpticStudio: Dense Reconstruction of Moving Actors in the Wild

**Goal:** Dense 3D reconstruction of moving actors in natural environments with multiple flying cameras



NSF awards: 2024173 & 2022894, Project title: Dense 3D reconstruction of moving actors in natural environments with multiple flying cameras  
2022 NRI & FRR Principal Investigators' Meeting  
April 19-21, 2022

# DroneOpticStudio: Impacts



Bio-mechanics of  
People & Animals

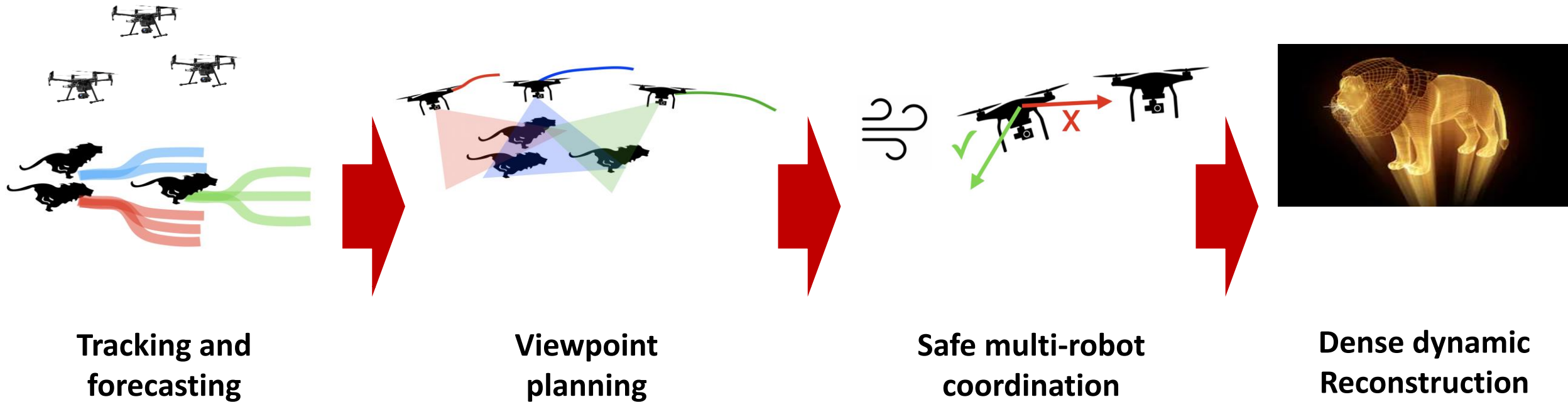


Cultural Preservation

Social Interactions



# DroneOpticStudio: System





# Multi-Object Tracking in Crowds

**Objective:** Track multiple targets with occlusion, crossover and diverse motion pattern

**Online and realtime tracking:**

1. Association frequency is 300 FPS with a single CPU.
2. Robust to crowded scenes and camera view change.



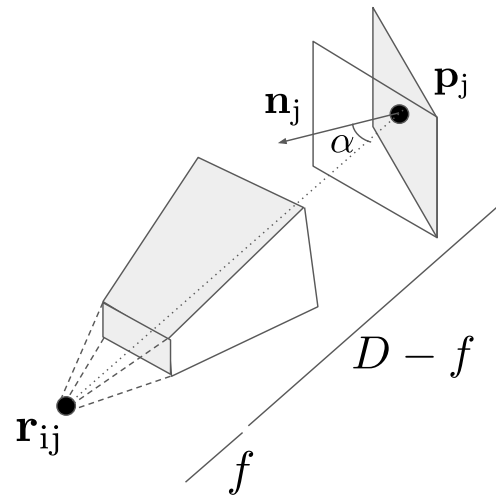
# View planning to improve Reconstruction quality

## View planning to acquire high quality images for multi-drone scene reconstruction

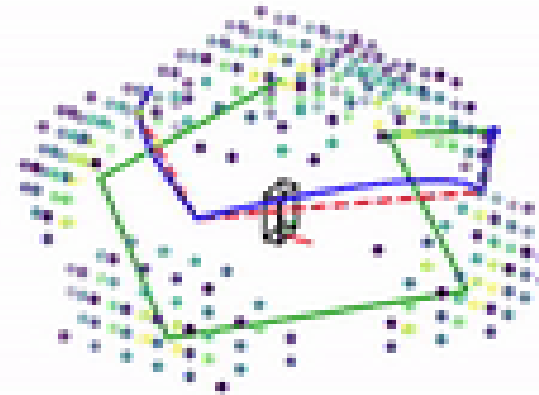


# View planning to improve Reconstruction quality

**Pixel-Per-Area (PPA)** is introduced as a proxy metric. The resulting path planning problem is formulated as an instance of the **Traveling-Salesperson Problem with Neighborhoods (TSP-N)** problem



$$\text{ppa} = \frac{\text{the projected area on the image plane}}{\text{its actual area.}}$$



Define neighborhoods based on PPA values. The **visiting order** is shown in **green**, **TSP-N path** in **red**, and **geodesic path** in **blue**.



# View planning to improve Reconstruction quality

## 4D High fidelity reconstruction for dynamic actors



Drone 1

Drone 2

Drone 3



Reconstruction



Coverage



Strike forward Jog



Silly Dancing



Flair



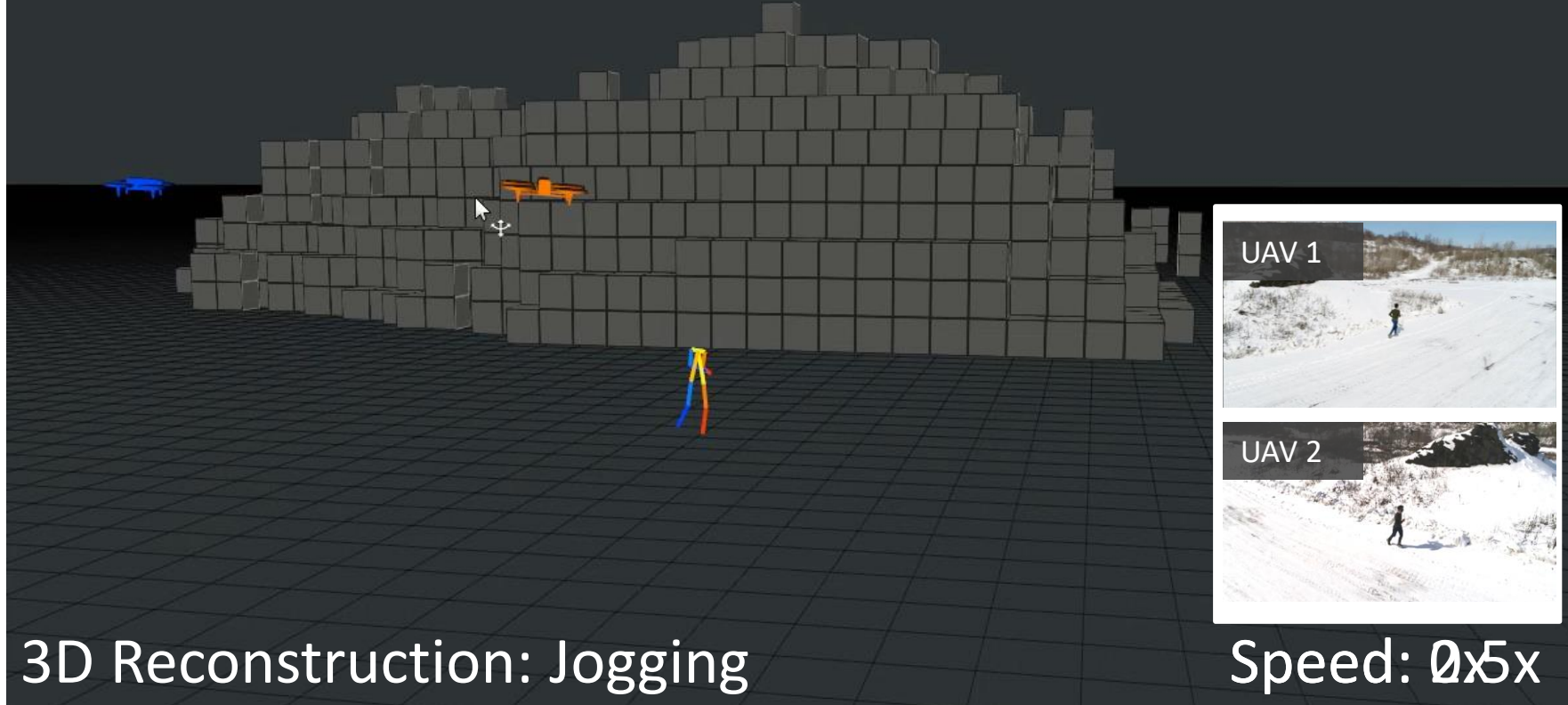
Hip Hop Dancing



Walk in Circle

# Aerial collaboration for pose reconstruction

A multi-UAV system that reconstructs 3D human poses in unscripted scenarios

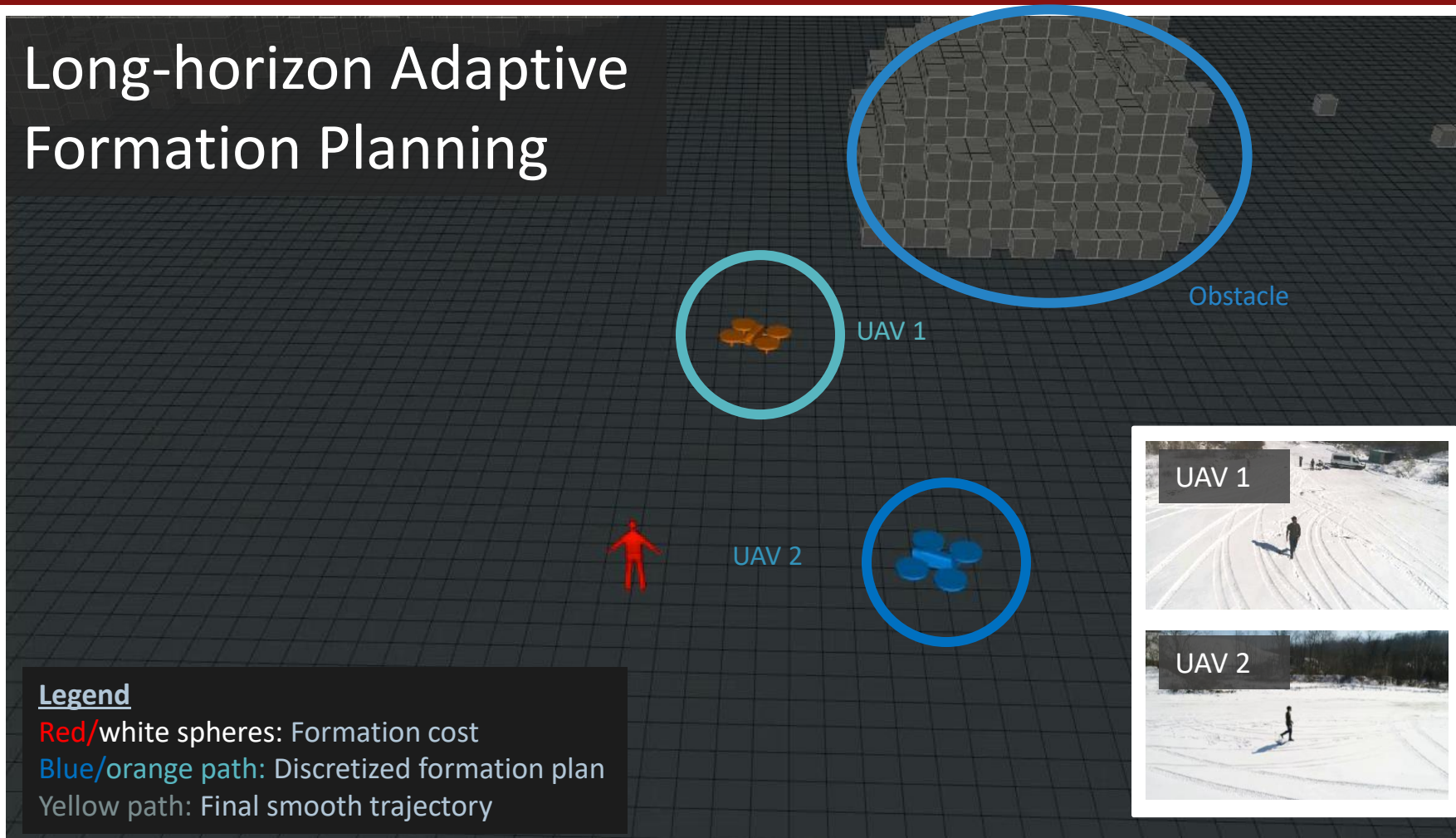


Cherie Ho, et al., *3D Human Reconstruction in the Wild with Collaborative Aerial Cameras*, (IROS, 2021). Website: <https://theairlab.org/multidrone/>



# Aerial collaboration for pose reconstruction

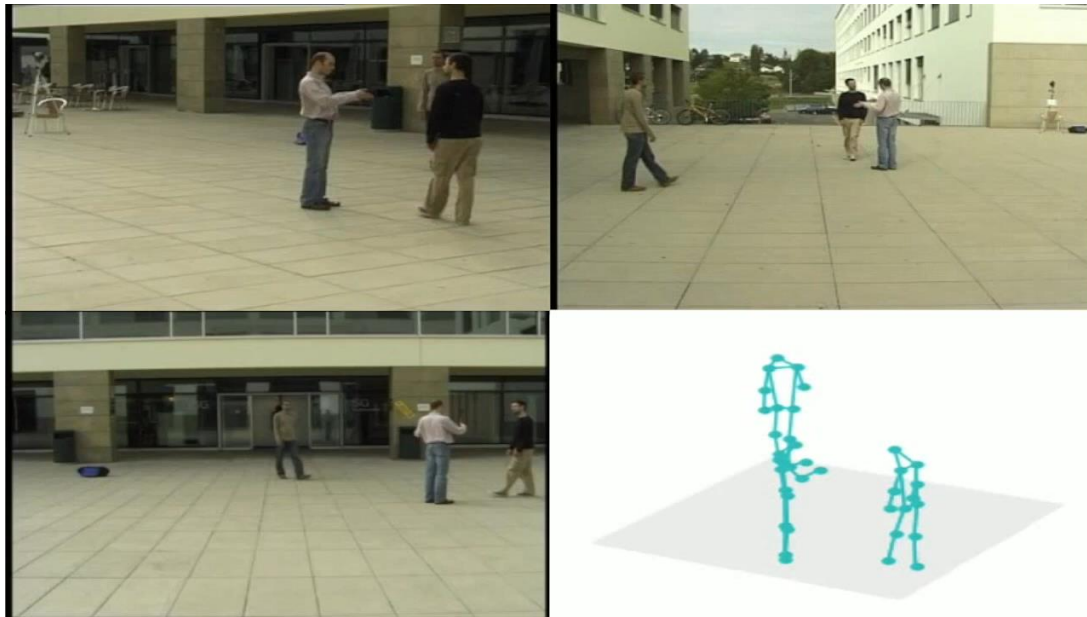
## Long-horizon Adaptive Formation Planning



Cherie Ho, et al., *3D Human Reconstruction in the Wild with Collaborative Aerial Cameras*, (IROS, 2021). Website: <https://theairlab.org/multidrone/>

# Multi-view multi-person 3D pose estimation

## Campus

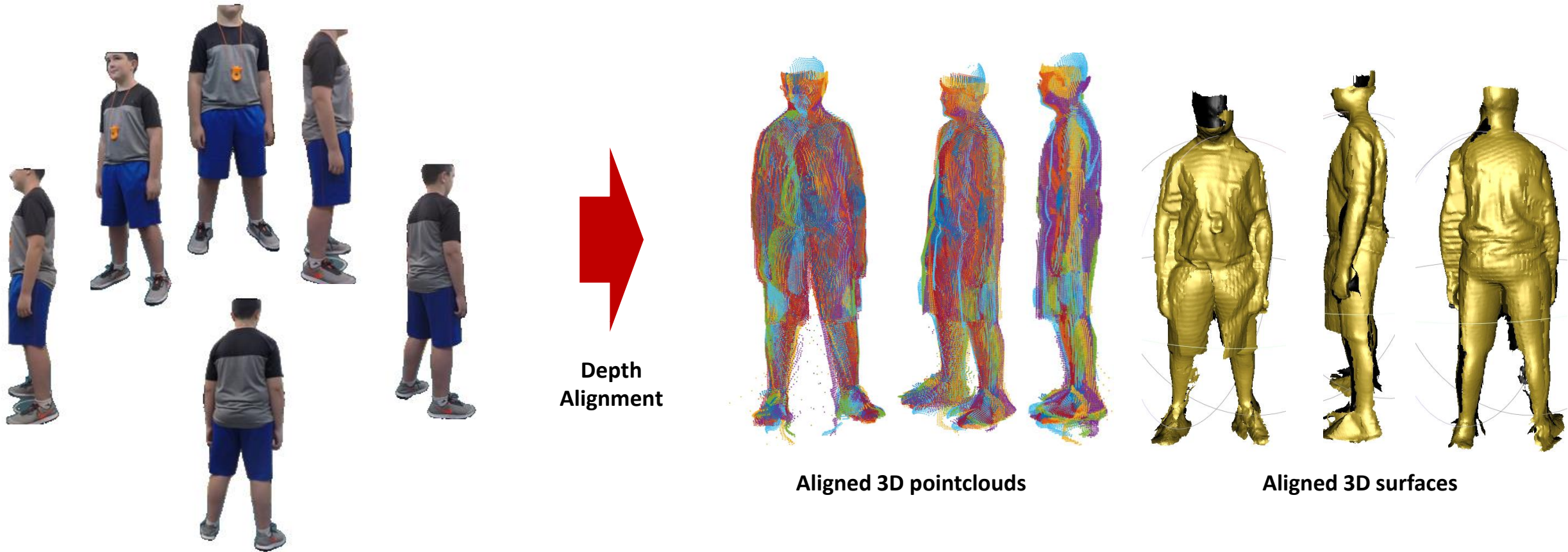


## Shelf



# Dense reconstruction: Multiview HDNet

**Problem:** From multi-view image, predict the dense 3D reconstruction of human body





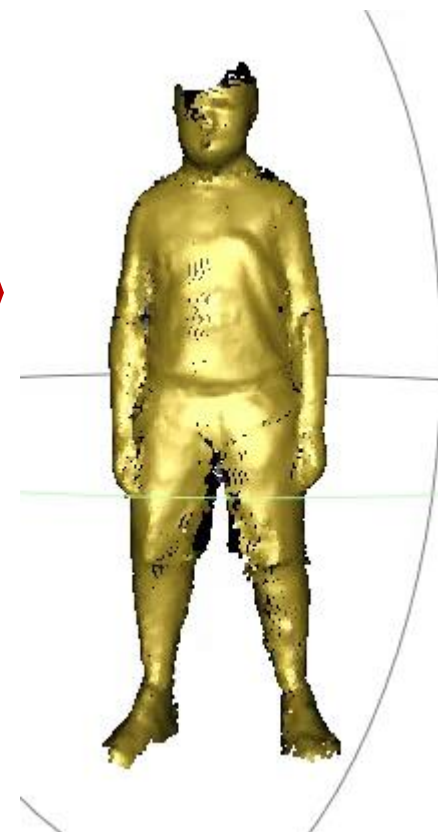
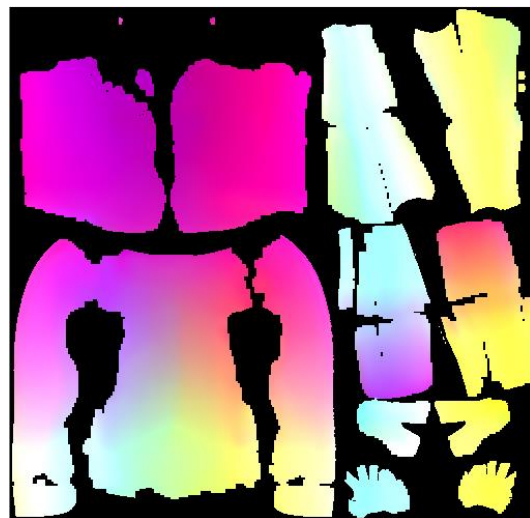
# Dense reconstruction: Multiview HDNet



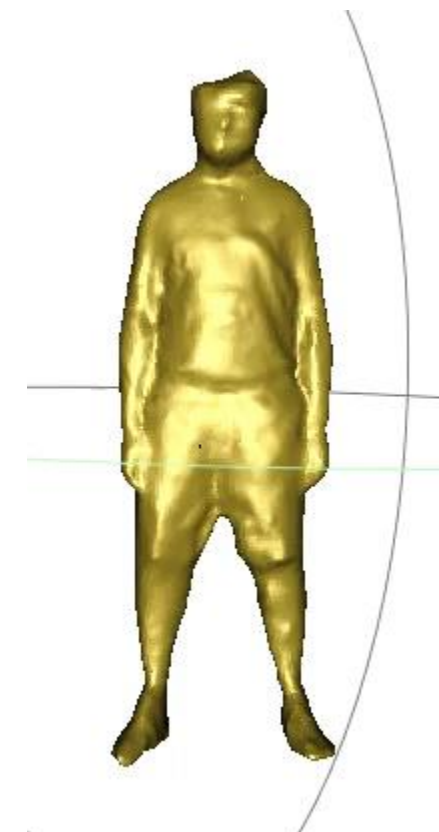
Aligned 3D pointclouds



Fusion in UV space



Fused geometry: pointcloud



Fused geometry: mesh

# Next steps

- **Field experiments and data collection**  
(multiple drones and actors)
- **Emphasize multi-drone, multi-actor**  
(tracking, planning, and reconstruction)
- **Challenging scenarios**  
(around trees and buildings with occlusions)



**Above:** Group members during trip to field test site



# Principal Investigators and Organizations



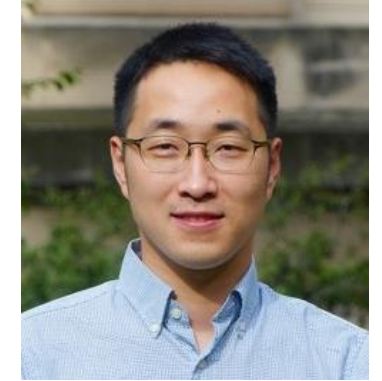
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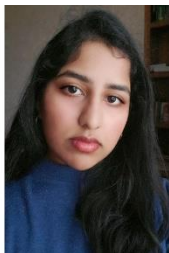
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