

# Concepts for Shuttle Car Autonomous Docking with Continuous Miner

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# Team

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- West Virginia Training and Conference Center



# Presentation Outline

- Objective and Overview
- Approach
- Small-scale Mock Mine and Equipment
- Sensor
- Navigation Strategy
- Status and Next Steps



# Objective and Overview

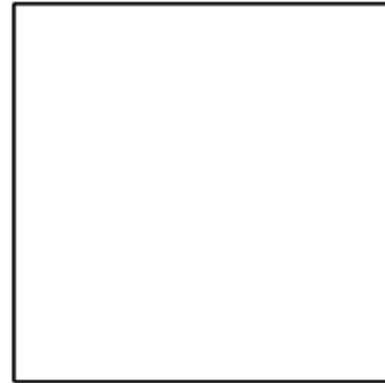
- Objective

Develop autonomous navigation concepts capable of navigating a shuttle car from the continuous miner change point to the continuous miner coal-discharge conveyor under various situations representing realistic mining conditions



# Mock Mine

- Simulate a small p  
wide entries/cross
- Constructed a 1/6<sup>t</sup>
  - 40 in. wide entries
  - 96 in. square pilla
  - One intersection
  - Roof and floor



(approximately) 20 ft.



# Mock Mine

- Co



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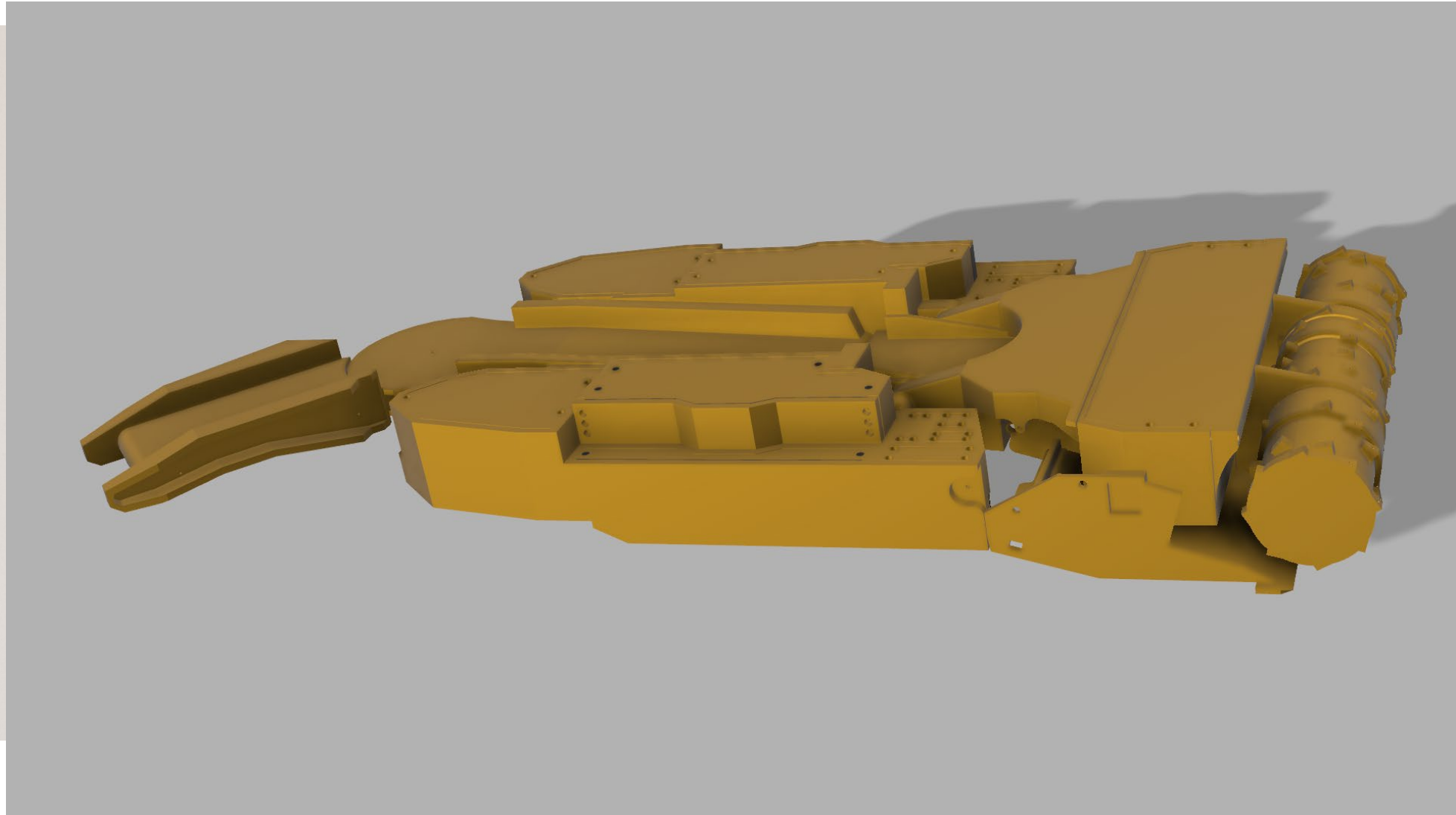


# Shuttle Car



# Continuous Miner

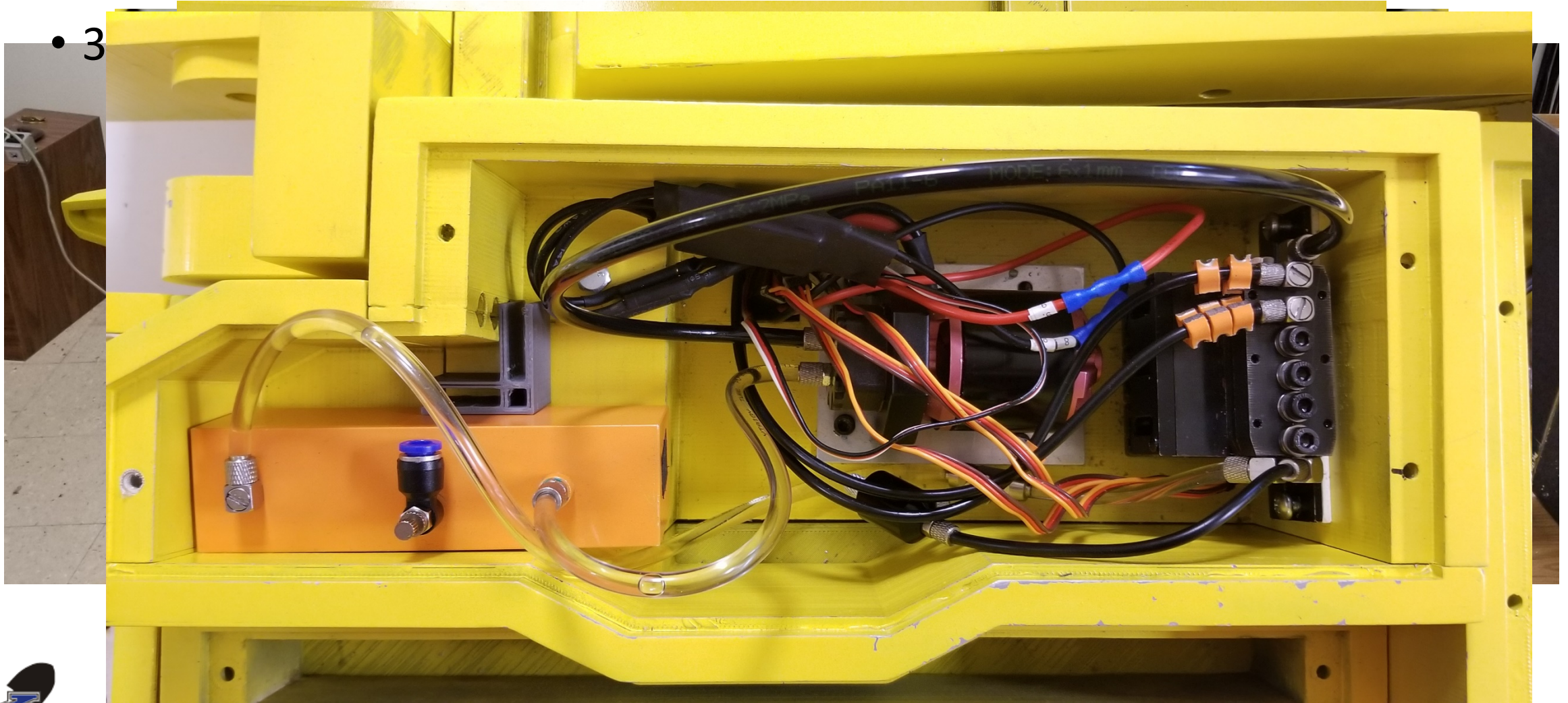
- 1/
- P
- C
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- C





# Continuous Miner

• 3



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# Continuous Miner

- Remote control functions
  - Electric tram (brushed dc motors)
  - Hydraulic control of discharge conveyor elevation
  - Electric control of discharge conveyor swing (servomotor)



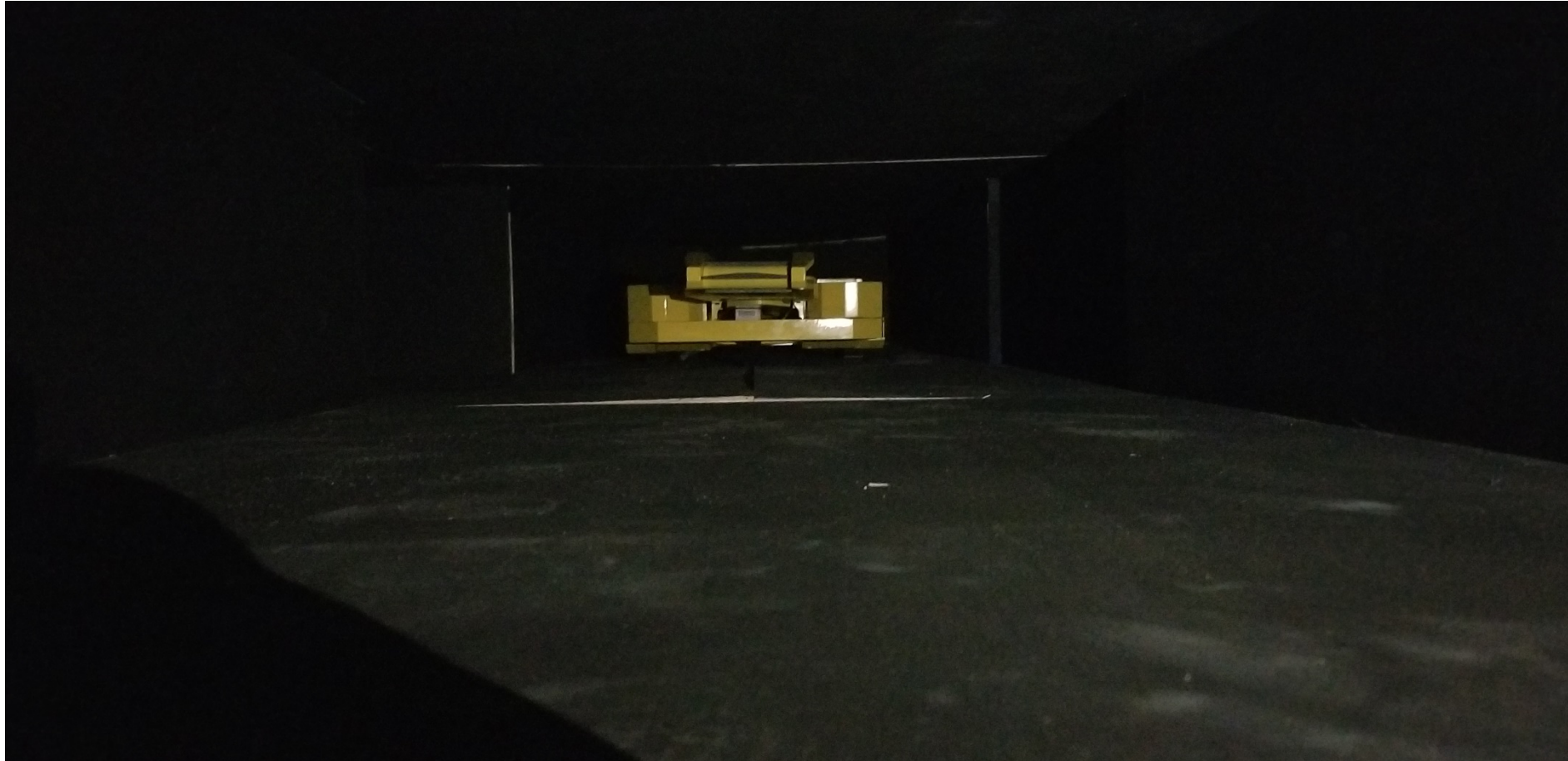
# Mine and Equipment



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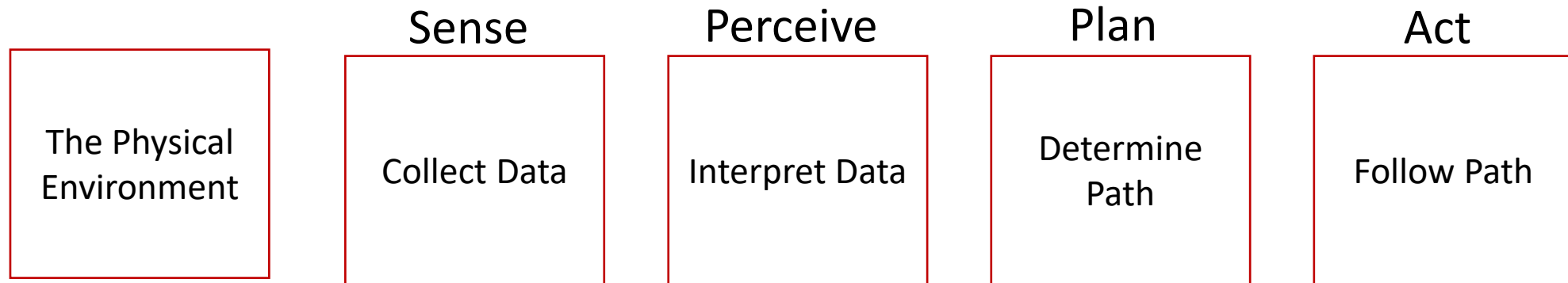
# Simulated Environment



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# Navigation Process



# Shuttle Car Sensor

- Intel RealSense D435i depth camera
  - Stereoscopic depth technology
  - Range: up to 10m, ideal range 0.3-3.0 m
  - Frame rate up to 90 fps
  - Depth field of view: 87° x 58°
  - Depth resolution: up to 1280 x 720
  - Includes IMU (inertial measurement unit)



# Depth Camera Location

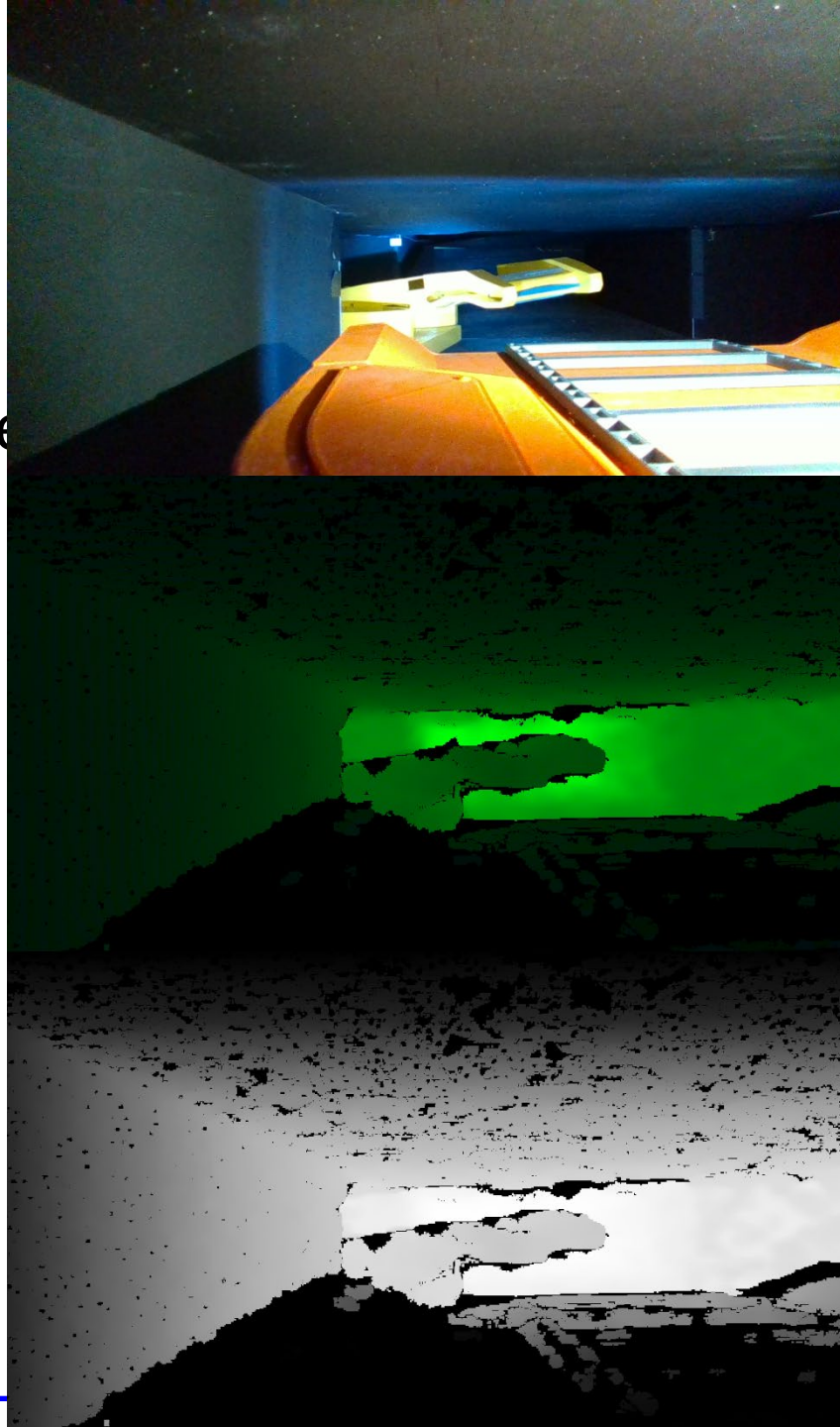
- No single location is ideal
- Currently using midpoint on shuttle car



PEN



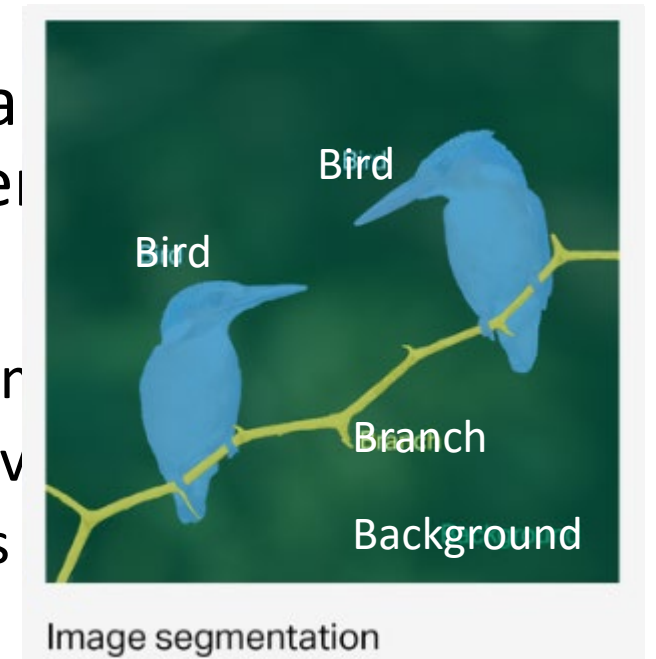
- Collect Image and de





# Image Annotation

- “the task of annotating an image with labels, typically human-powered work and in some cases, computer-aided work”
- Types of Image Annotation
  - Whole image classification – id what objects are in the image
  - Image object detection – determine the position of individual objects
  - Image segmentation – recognize and understand what's in an image and how pixels in an image are assigned to a class



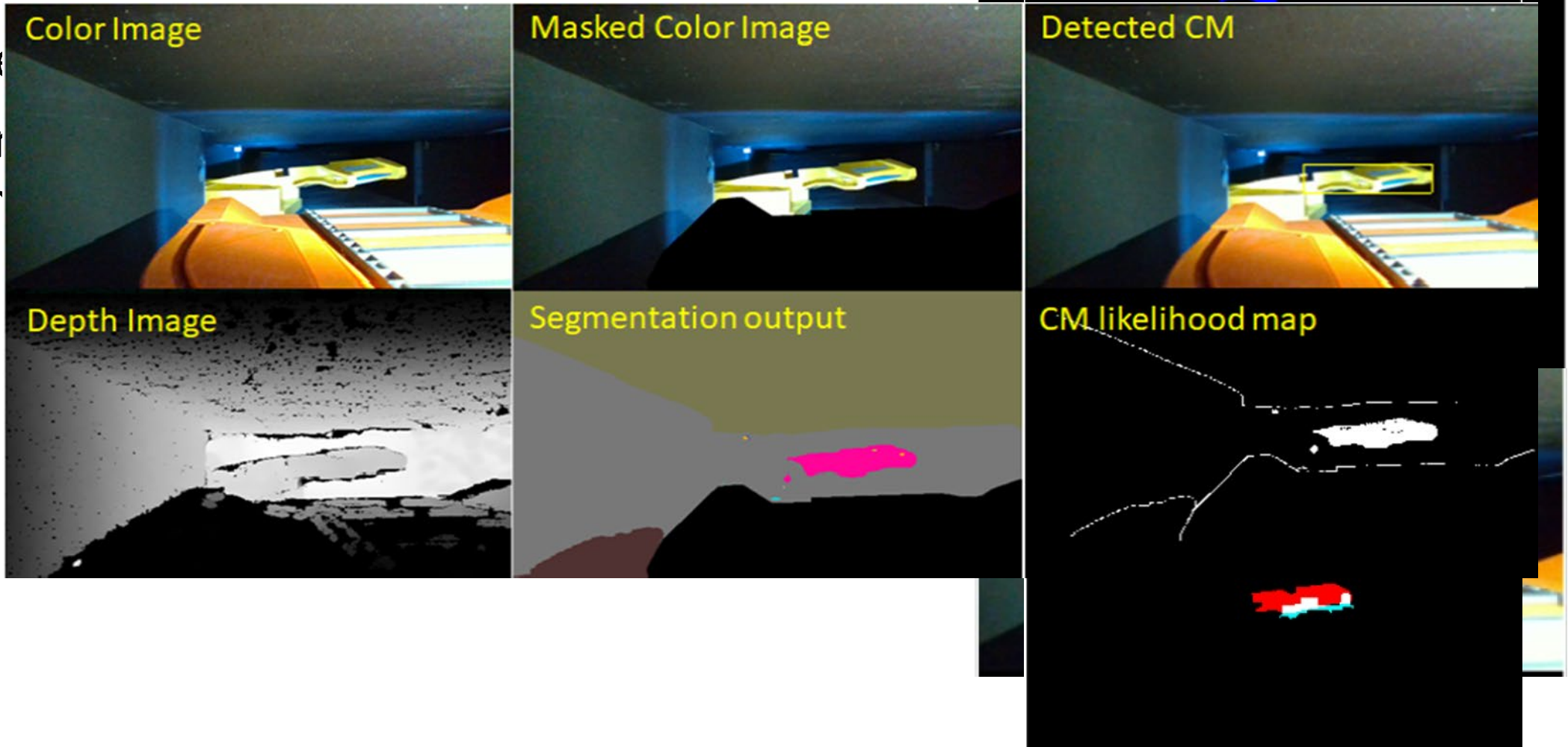
# Image Annotation

- LabelMe a
  - Develop
  - Open-so
  - User-frie



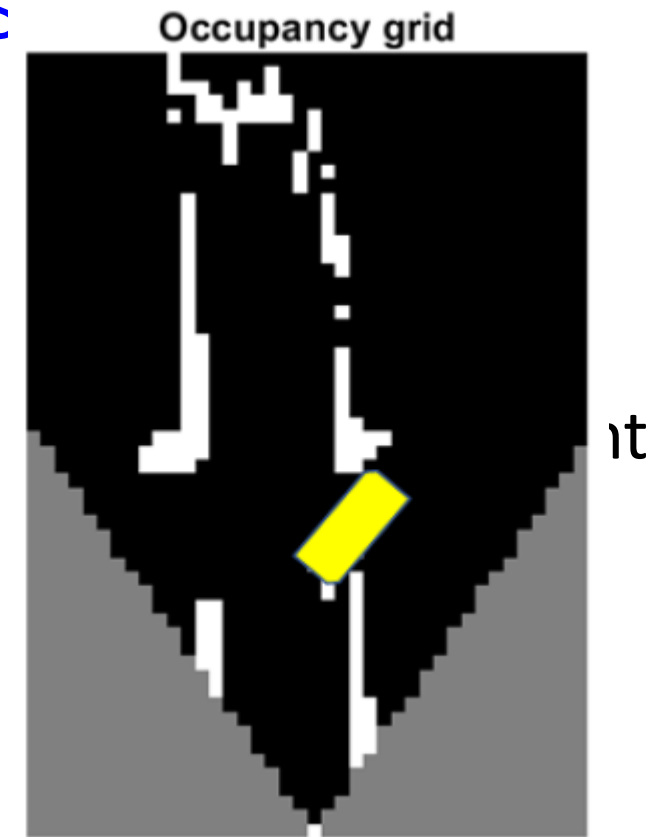
# Navigation Process

- Rece
- Segm
- ider

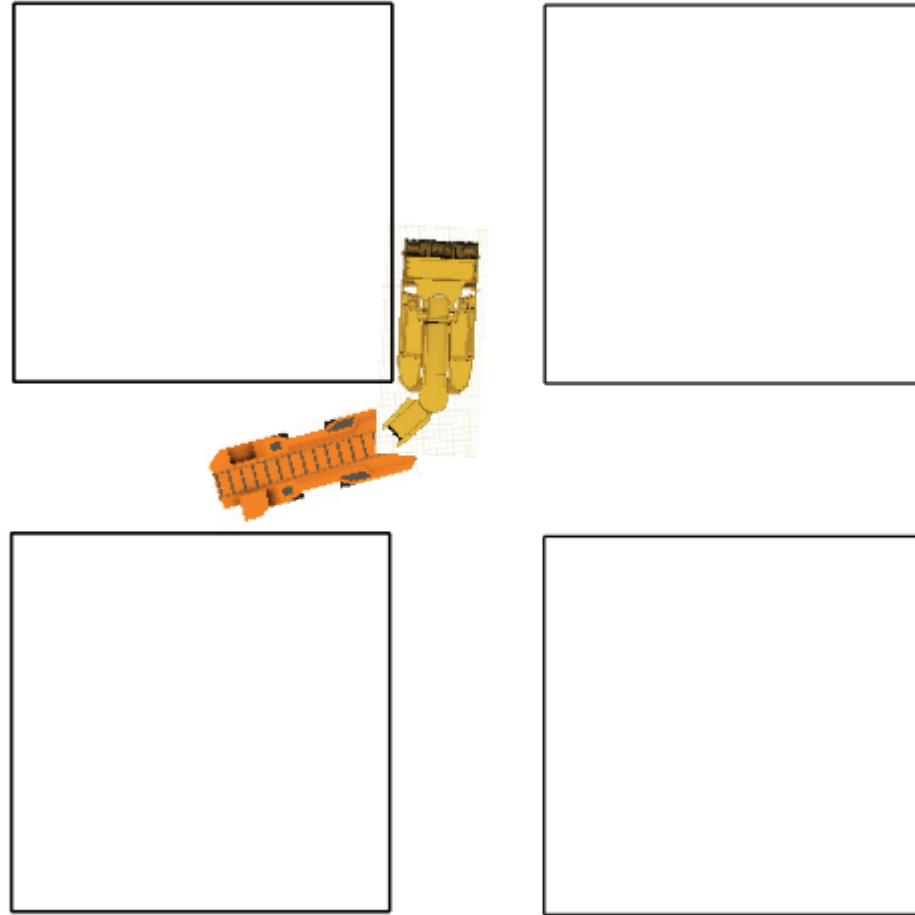


# Navigation Process

- Orientation of CM in the 3-D space
- Generation of point cloud and occupancy map
- Path planning on the generated occupancy map pose to the desired pose



# Navigation Process



# Status and Next Steps

At 1/6<sup>th</sup> scale

- All of the individual pieces are working
- Next – put all pieces together and begin testing

Full-scale

- Begin capturing images of full-scale equipment in realistic mine environment



# Questions?

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