

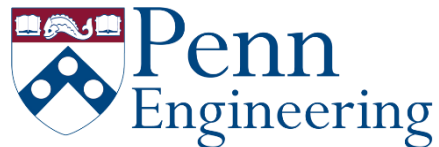
# Robotics

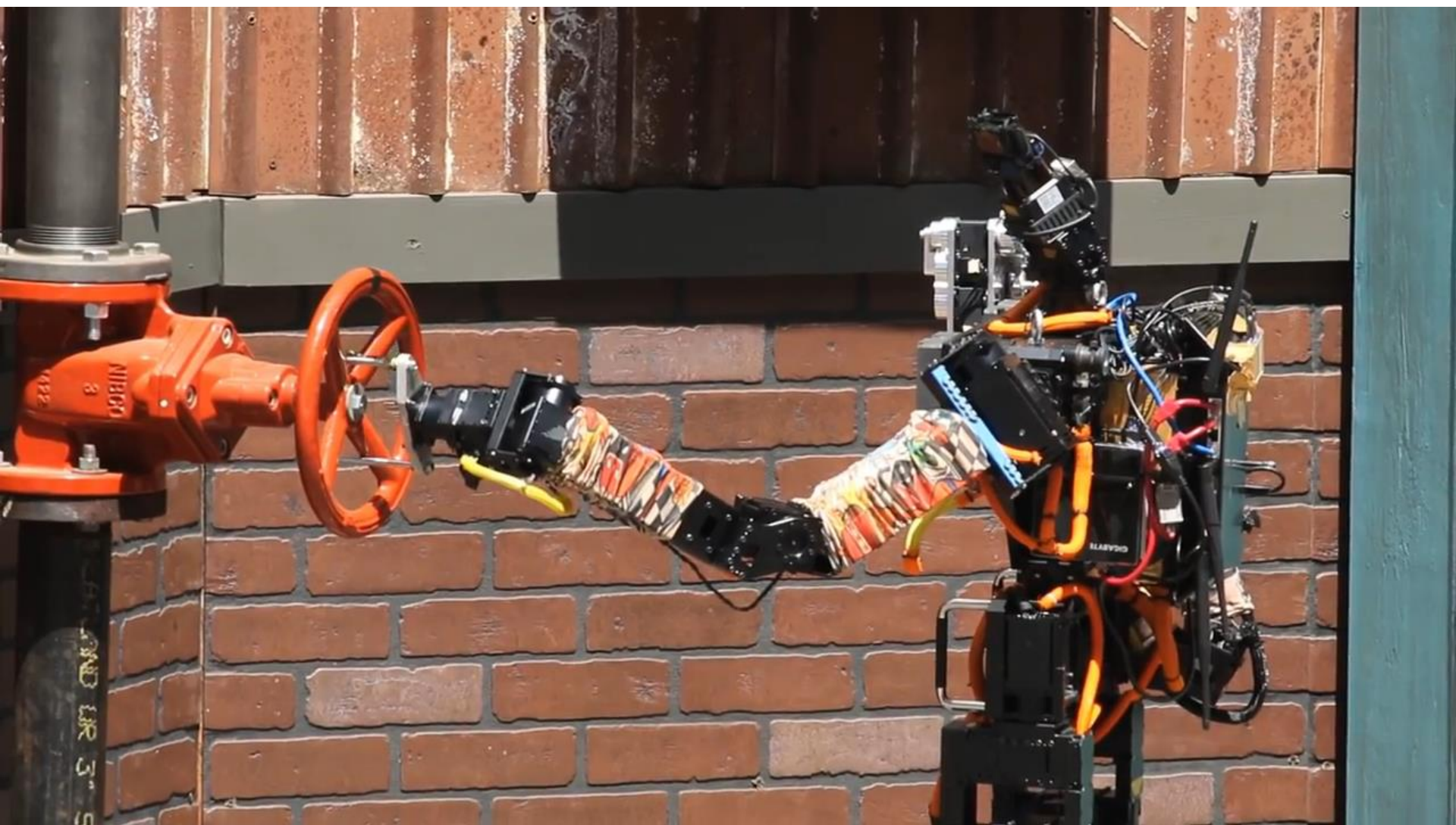
Estimation and Learning  
with Dan Lee

## Week 3. Robotic Mapping

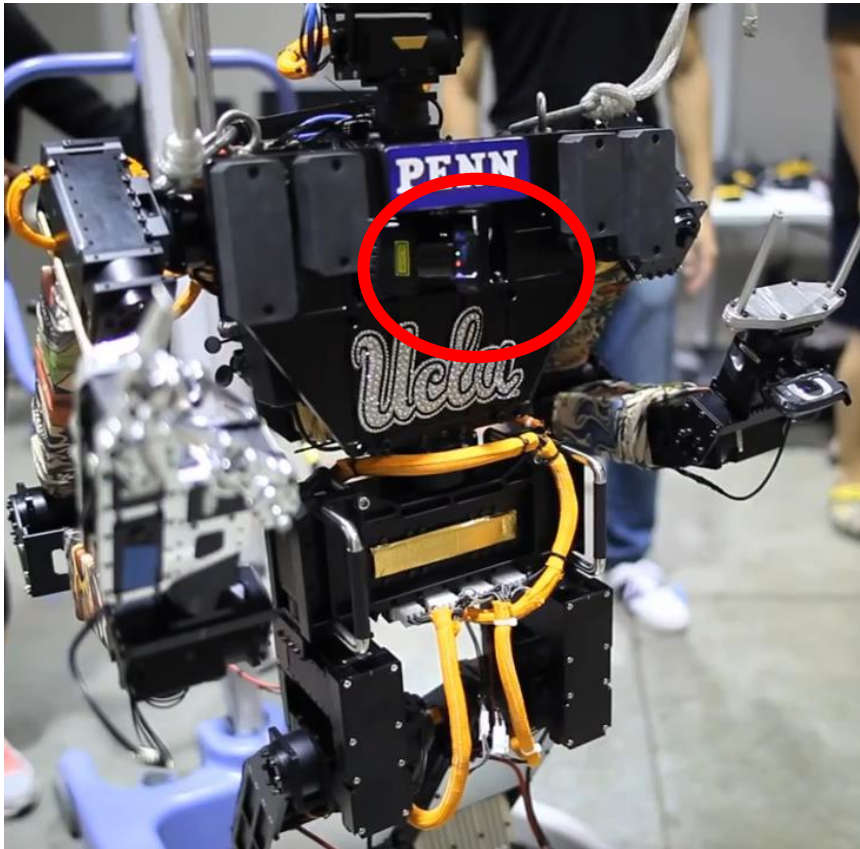
### 3.3 3D Mapping

#### 3.3.1 3D Sensors and 3D Map Representation

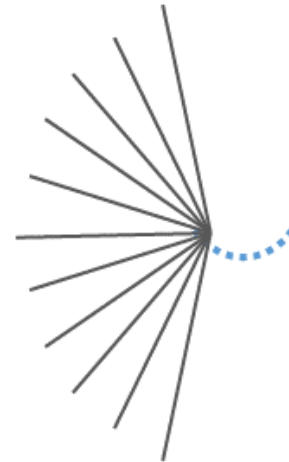




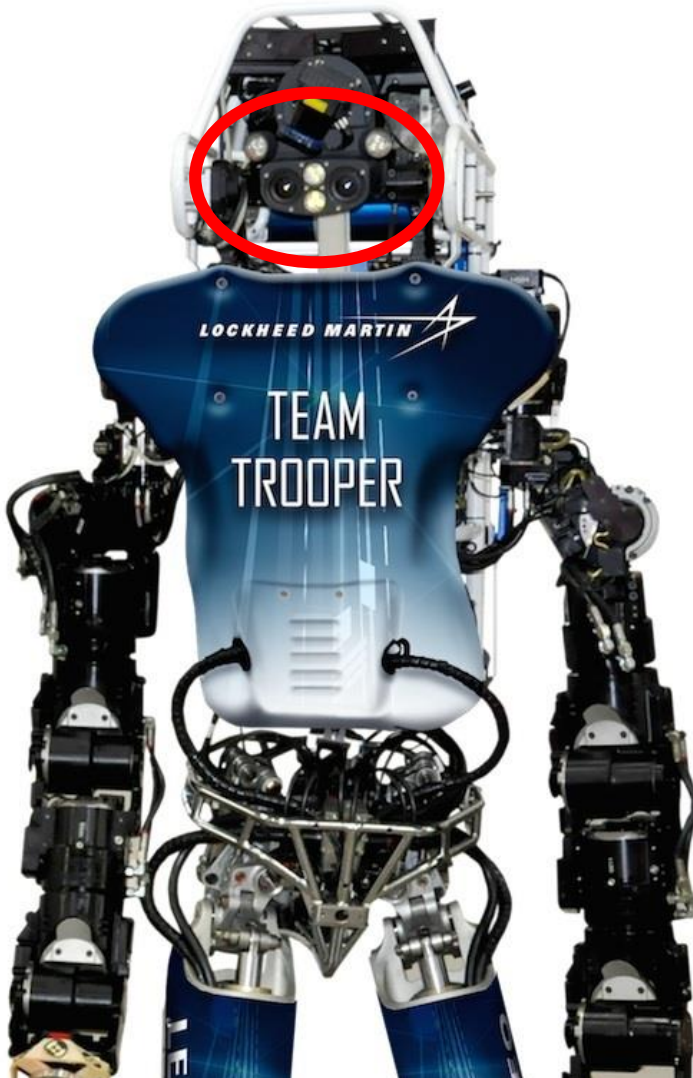
# Sensors for 3D Mapping



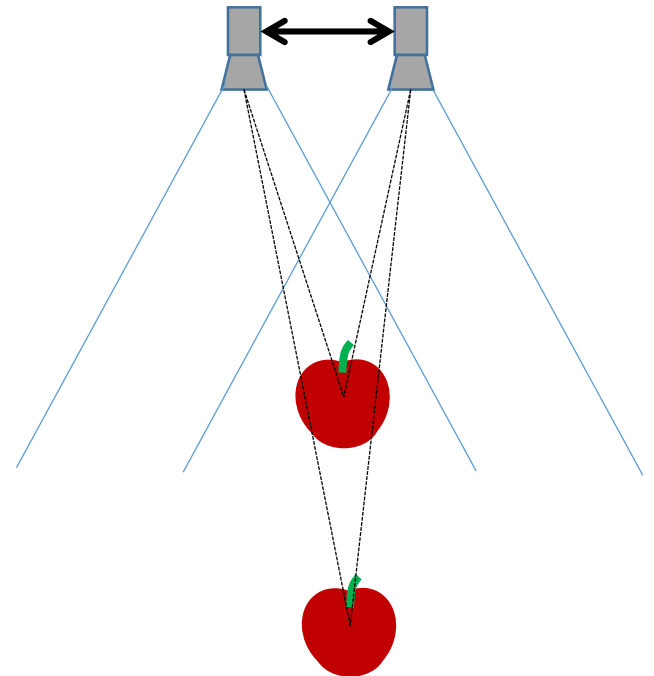
- **3D Range Sensor**



# Sensors for 3D Mapping

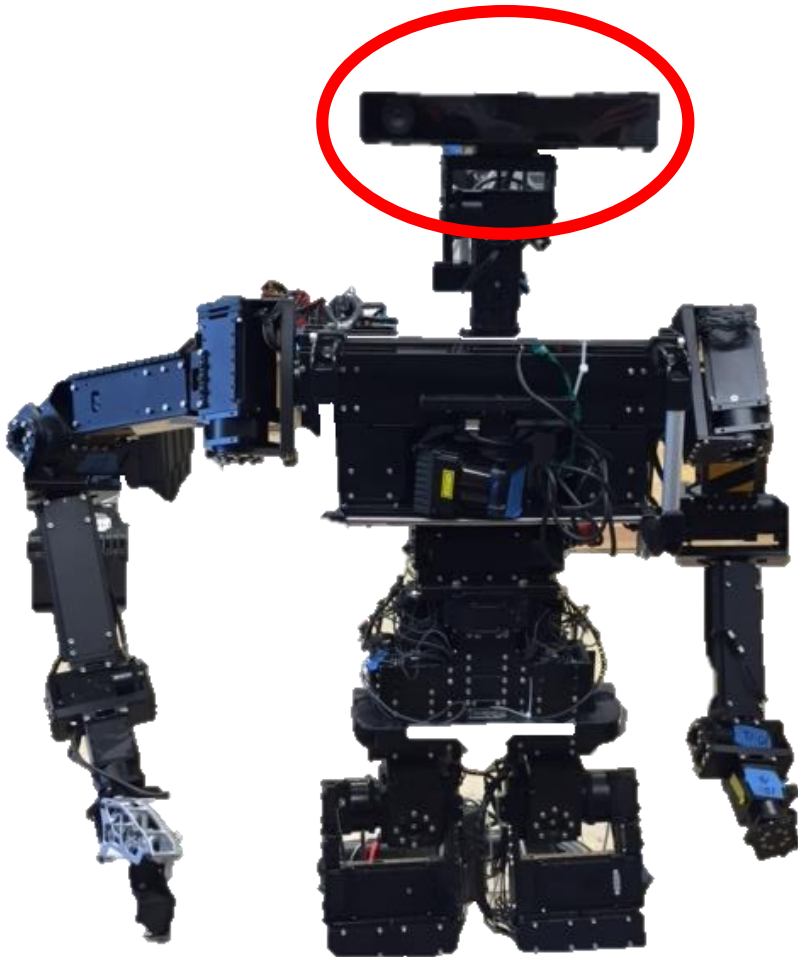


- **Stereo Camera**





# Sensors for 3D Mapping

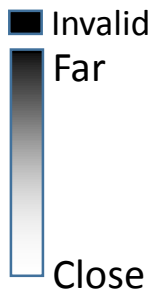
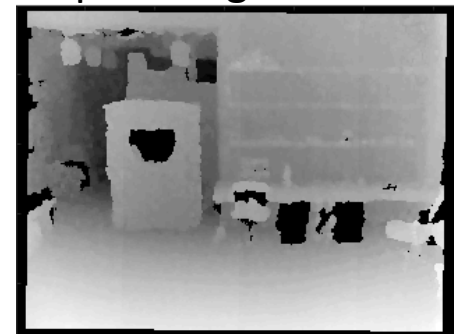


- **Depth Camera**

Scene

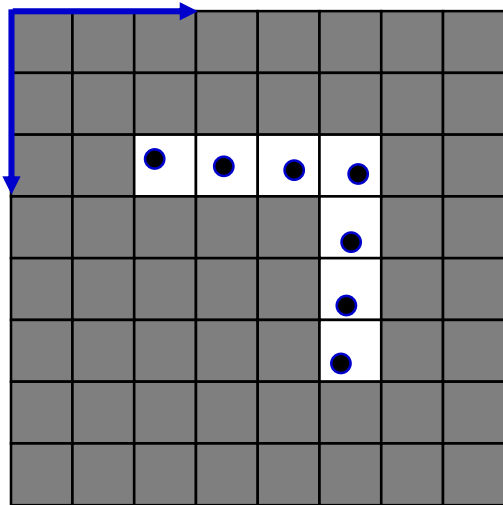


Depth Image



# Map Representation

Grid  
Representation



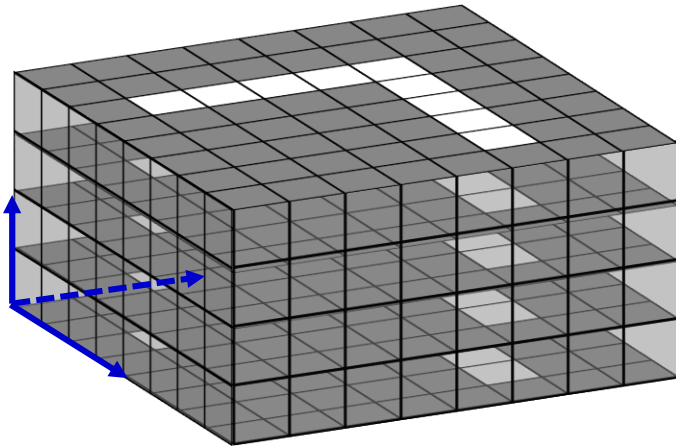
- Immediate access to a cell



- Requires Large memory  
(map size)  $\sim$  (map range) / (resolution)
- Lose information from discretization

# Map Representation

## Grid Representation



In 3D, most cells will be empty.



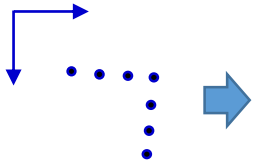
- Immediate access to a cell



- Requires Large memory  
(map size)  $\sim$  (map range) / (resolution)
- Lose information from discretization

# Map Representation

## List Representation



2.3, 2.3
2.5, 3.4
2.6, 4.6
2.7, 5.7
3.8, 5.5
4.8, 5.4
5.8, 5.2



- Takes long to search ( $O(N)$ )

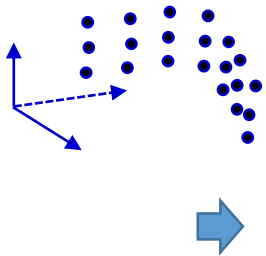


- Requires less memory  
(map size)  $\sim$ (# Occupied Points= $N$ )
- No discretization



# Map Representation

## List Representation



2.3, 2.3, 1.0
2.5, 3.4, 1.1
2.6, 4.6, 1.0
2.7, 5.7, 1.1
3.8, 5.5, 1.2
4.8, 5.4, 1.0
5.8, 5.2, 1.1
...



- Takes long to search ( $O(N)$ )

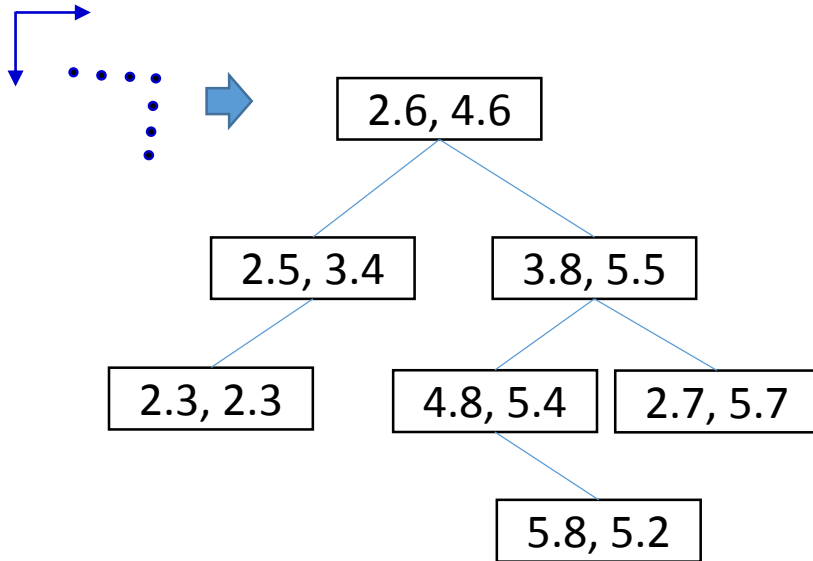


- Requires less memory  
(map size)  $\sim$ (# Occupied Points= $N$ )
- No discretization

In 3D,  $N$  is usually very large.

# Map Representation

## Tree Representation



- Reasonable search time ( $O(\log N)$ )



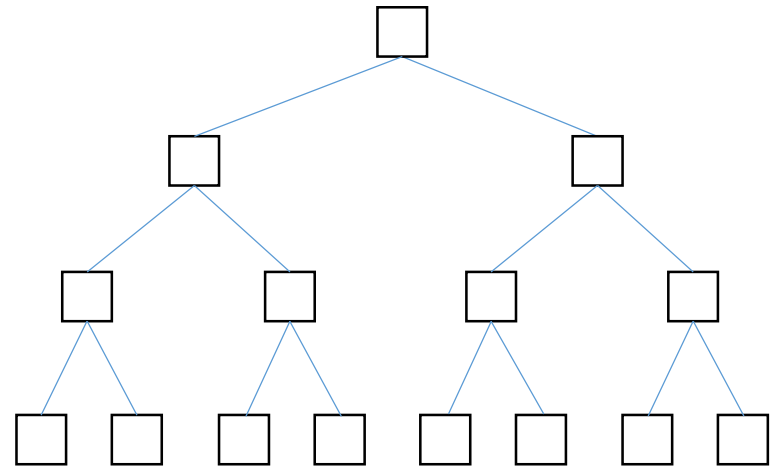
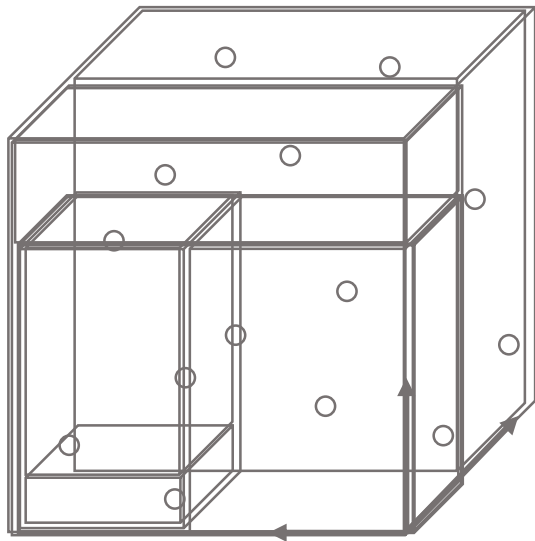
- Requires less memory  
(map size)  $\sim (\# \text{ Points})$
- No discretization

# 3D Map Representation

- Requires organized data structure for efficient maintenance of the map

# 3D Map Representation

- Example (1) *kd-tree*



# 3D Map Representation

- Example (2) Octree

