# Occupancy Grid by Floor Recognition

15-494/696 Cognitive Robotics

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# Overview

- Goal: Created an occupancy grid by recognizing empty floor and non-floor space

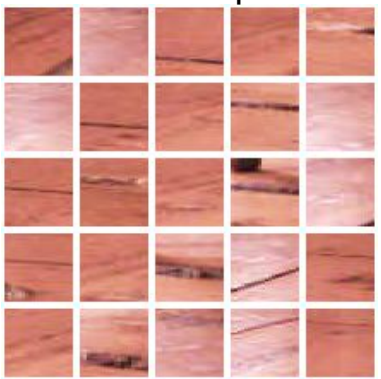
- Steps
  - Collected patches of empty floors for Cozmo to “learn” what an empty floor space is.
  - Created a classification method to differentiate patches between floor and non-floor.
  - Map location of the patch from Cozmo’s camera to world coordinates.
  - Display patches on occupancy grid to show Cozmo’s surroundings.

# Collecting Floor Patches

- Needed different angles and areas of the floor
  - Grabbed patches of color images while making an outward spiral motion.
  - This is its own FSM, so it can be run easily for any new floor surface.
- Size of patches: 40x40
  - Initial size of 9x9 did not capture enough texture details
- Number of patches: 50

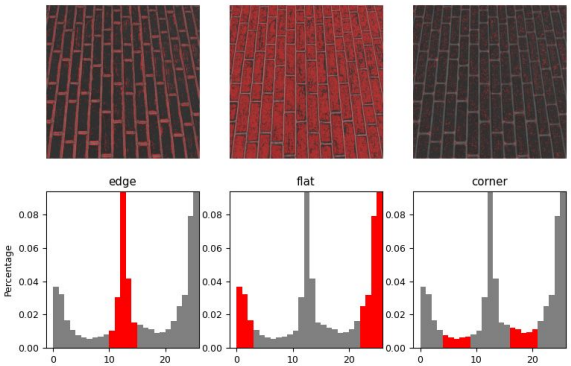
9x9 patches

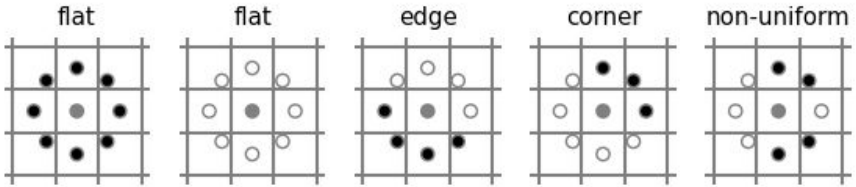
40x40 patches



# Floor Recognition Methods

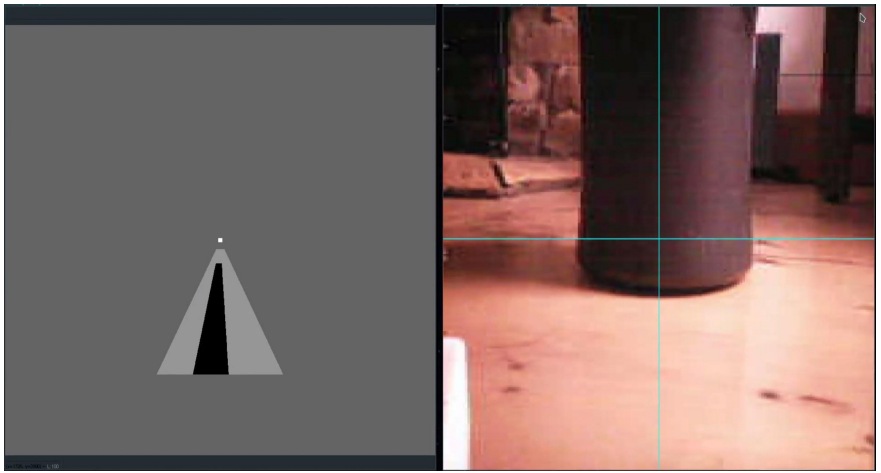
- Hue
  - Mean squared error value of average hue
- Local Binary Pattern (LBP) from scikit-image (skimage)
  - Used to detect textures in black & white image
  - Checks relative intensity between surrounding points around the center
  - Returns histogram of different features found in image
  - Compare between current patch vs sampled floor patches (average KL divergence)



# Occupancy Grid

- Used Cozmo's kinematics to map camera center to world coordinates, then to grid coordinates



- Grid details
  - 1 mm resolution (can be easily changed)
  - Legend:
    - Unexplored space (dark gray),
    - floor (light gray)
    - non-floor (black)
    - Cozmo's path (white)
  - Updated every camera frame
  - Distance of obstacles and "cliffs" determined by the distance of adjacent floor space

- Grid code can be plugged into any FSM, or used on the fly

# Results

- Accuracy
  - Able to classify most obstacles and non-floor spaces
  - Generally gets rough location of objects, but fails to locate their boundaries precisely
  - Method using LBP makes classification more suited for textured surfaces (i.e. wooden floors)

- Advantages
  - Able to accurately map surrounding areas of Cozmo
  - Easily adaptable to different floor surfaces (only requires new patch collection)
  - Real-time update of occupancy grid as Cozmo explores for each camera frame

- Limitations
  - High patches are mapped to very large floor areas
  - Difficulty detecting highly reflective/dark or transparent obstacles
  - Highly variant floor areas (damaged/stained) sometimes classified as non-floor

# Results: continued

- Before and after: Cozmo detects the mug that has been placed in front of him, but remembers that behind it the floor is clear
- When it’s placed further away, he can’t locate it as precisely