

Assignment 4: Classical CV

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1 Exercise 1: Spot the Mallet

1.1 Objective

The primary objective of this exercise was to design a robust computer vision pipeline capable of segmenting an orange mallet from video frames. The key challenge was ensuring consistent segmentation across varying lighting conditions (shadows vs. direct sunlight) and dynamic backgrounds (sand, rocks, and grass).

1.2 Pipeline

The solution was implemented using a processing pipeline consisting of four major stages: Pre-processing, Color Space Conversion, Thresholding, and Morphological Refinement.

1.2.1 Color Space Selection

We adopted the HSV (Hue, Saturation, Value) color space because:

- Hue (H): Isolates the color. The mallet consistently registered in the orange range regardless of illumination.
- Saturation (S): Critical for background separation. The sand (yellow/brown) has low saturation. The mallet has high saturation.
- Value (V): Allowed us to filter out noise without losing the mallet in shadowed regions.

1.2.2 Preprocessing

To reduce noise and smoothen the image, a Gaussian Blur with a 5×5 kernel was applied before segmentation. This smoothed the image, ensuring that the resulting mask don't consist disjoint pixels.

1.2.3 Thresholding Parameters

After multiple trials, the following HSV ranges were chosen:

Parameter	Min	Max
Hue	5	25
Saturation	90	255
Value	70	255

Table 1: HSV Threshold Values

1.2.4 Morphological Refinement

The raw binary mask contained salt noise (sand speckles) and pepper noise (holes in the mallet). We applied the following morphological operations:

1. **Opening (5×5 Kernel):** Erosion followed by Dilation. This successfully removed small white regions from the background.
2. **Closing (5×5 Kernel):** Dilation followed by Erosion. This filled small holes within the mallet caused by reflections on the mallet surface.

1.3 Observations & Failures

- The mallet was successfully segmented in most of the videos.
- **Limitations:** In some of the videos it segmented a large portion of floor also where there is some specific reflection or floor is dirty. Also it is not much good at the boundaries of mallet.



Figure 1: Final results

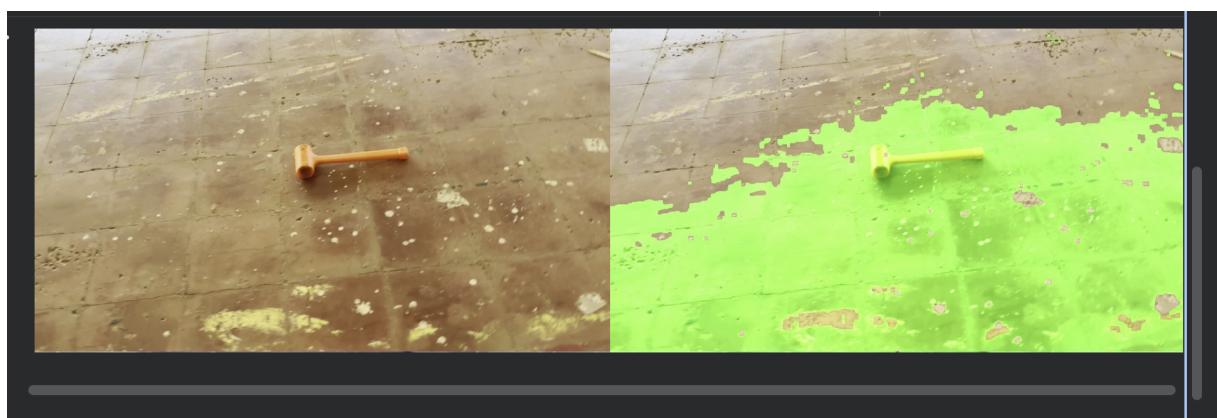


Figure 2: Failure case