Visual Target Segmentation and Identification

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1.1 Past Work

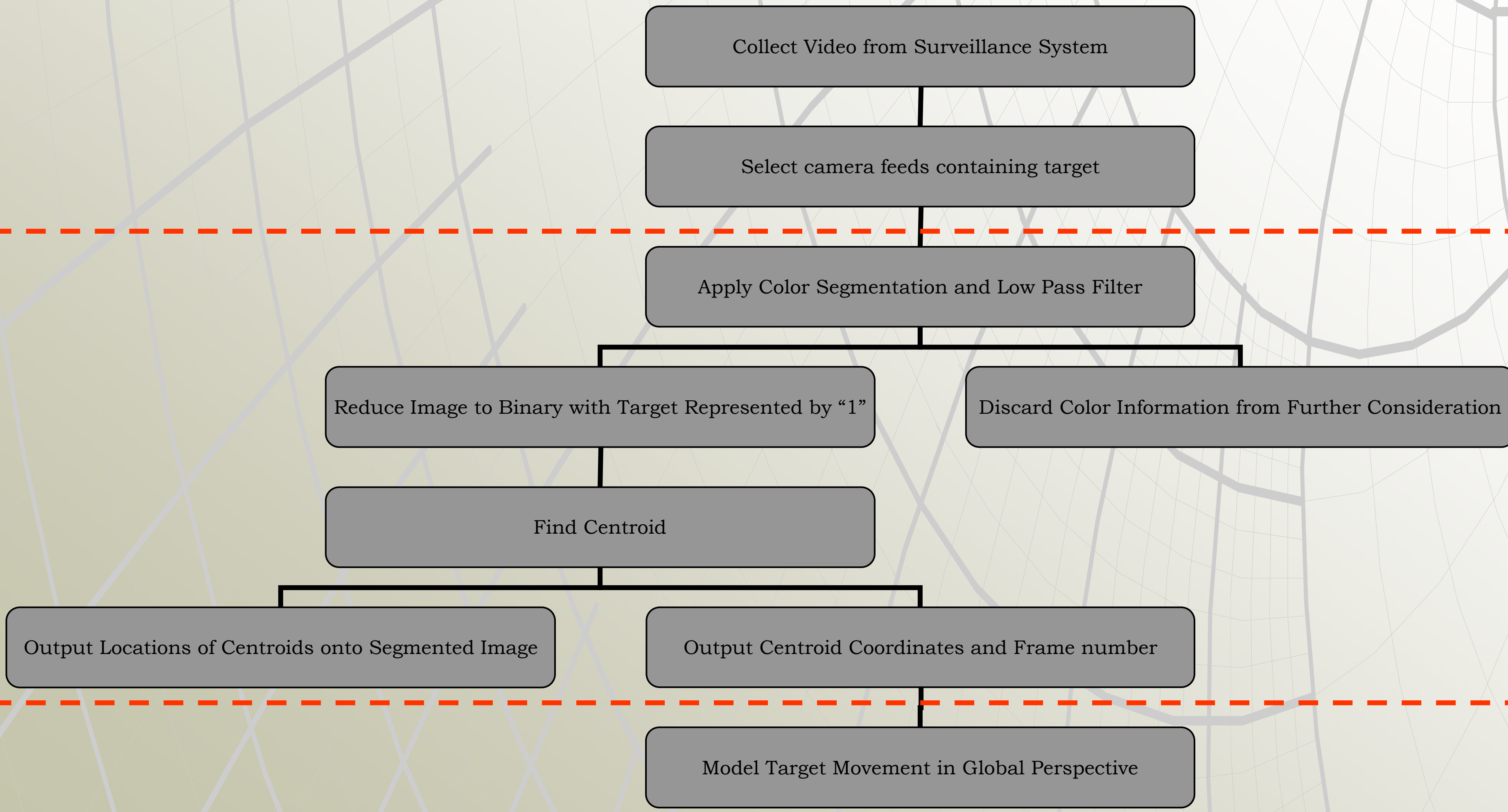
- Detecting Pedestrians Using Patterns of Motion and Appearance [Viola 2003]
  - Pedestrian detection on low resolution images
  - Uses appearance, motion direction, and motion magnitude filters to separate people from other video elements

- Finding (Un)Usual Events in Video [Zhong 2003]
  - Detection and classification of human activities
  - Frames not containing foreground images are dropped by comparison of frame to the background image
  - Binary mask created to isolate foreground elements in remaining frames

1.2 Motivation

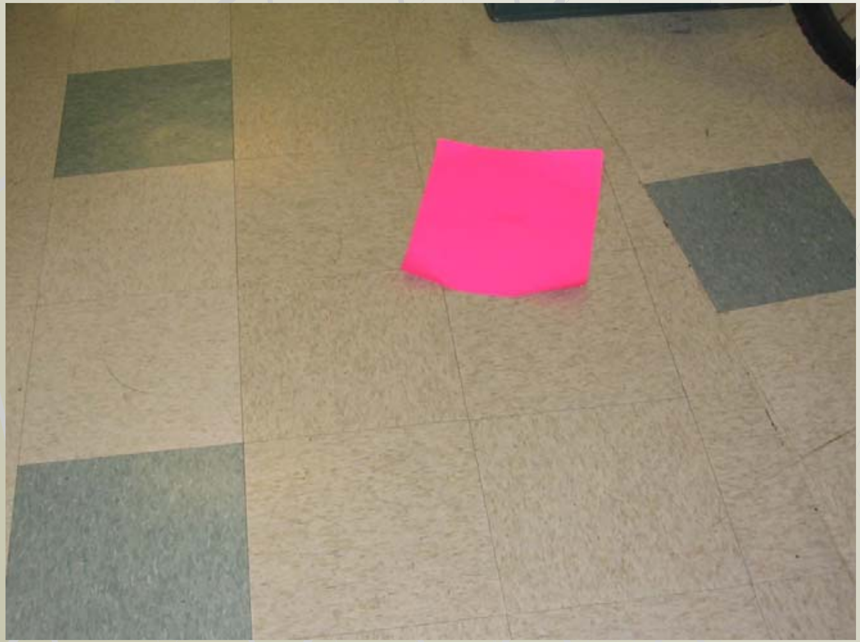
- Use of camera surveillance systems require analysis of the collected information
  - Human evaluation of events are time consuming and expensive
- Segmentation and Identifications of the visual target
  - Effectively represents desired information for further analysis

1.3 Problem Description



2.1 Controlled Environment

Still images in surveillance environment



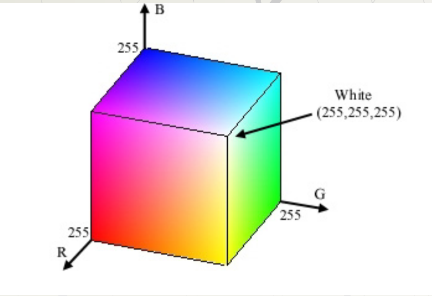
2.2 Uncontrolled Environment

- Video clip taken from existing camera network

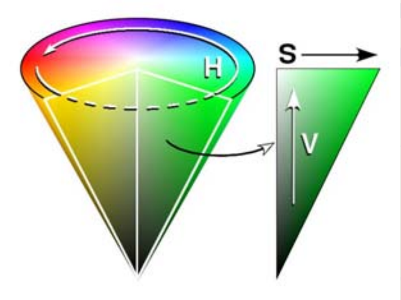
- Represented Challenges:
  - Occlusion
  - Reflection
  - Variation in Lighting Conditions

3.1 Explanation of Color Representation in Images

- RGB (red, green, blue)
  - Represented as 3 monochrome intensity images



- HSV (hue, saturation, value)
  - Closely mimics the way humans view color



- CMY (cyan, magenta, yellow)
  - Values are determined subtractive from RGB
  - Typically used for printing

3.1 RGB vs. HSV Color Mask

Segmentation using RGB Color (using 4 parameters)		
Segmentation using HSV Color (using 2 parameters)		

3.3 Smoothing Filter

- Provides noise reduction
- Slightly distorts shape

Pixels are re-valued using moving average value in a 5x5 matrix:

$$h[n] = (1/25)\big(g(n-2, m-2)+g(n-2,m-1)+g(n-2, m)\ldots g(n+2,m+2)\big)$$

Pixels are then returned to binary using:

$$(h[n] <= .1) = 0$$
$$(h[n] > .1) = 1$$

3.4 Other Methods

- Size filter
  - Identify targets by thresholding cluster size

- Motion filter
  - Implementation by detecting changes between image frames
    - $d_{ij}(x,y) = \{(1 \text{ if } |f(x,y,t_i) - f(x,y,t_j)| > T)\ ;\ 0 \text{ otherwise}\}$

4.1 Clustering for Multiple Targets

- Single target
  - Identified as all pixels with value ‘1’
- Multiple targets
  - Must differentiate between groups of pixels with value ‘1’
  - Check for connectivity
    - Change value for each new group of pixels

4.2 Centroid Calculation

Centroid calculation is given by:

$$M = \iint \sigma(x,y)\,dA$$

$$x_c = \frac{\iint x\,\sigma(x,y)\,dA}{M}$$

$$y_c = \frac{\iint y\,\sigma(x,y)\,dA}{M}$$

Centroid location = (x_c, y_c)

5.0 Results

- Output
  - Segmented image with marked centroids
  - Centroid locations by x and y coordinates and frame number

- Limitations
  - Targets sharing boundaries appear as one target
  - Cannot account for changes in elevation

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