Eyes Around The World – Learning to Cluster and Alert Live Webcams

Jee Ian Tam, Sean Rafferty

Computer Science Department, Stanford University, Stanford CA 94305

Objectives

- Develop an effective scoring algorithm to rank the most interesting webcams.
- Cluster webcams to find similar categories of webcams
- Use a ConvNet to identify objects in webcam images to improve filtering relevance.

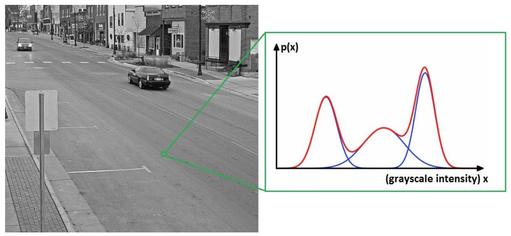
Scoring Algorithm Approach

- Uninteresting webcams : Low/No activity

- Interesting webcams : Increasing/High activity

Background Model

- Model background color of each pixel using a Gaussian Mixture Model (GMM)

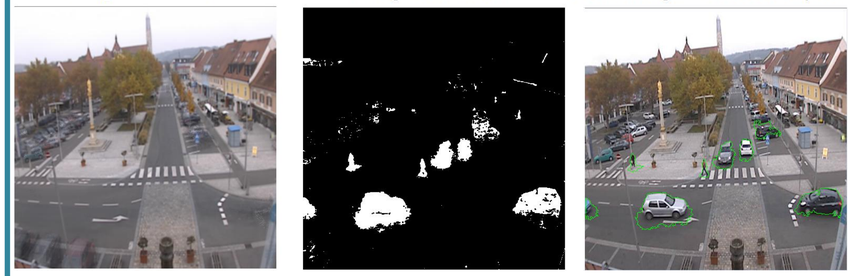


- GMM needed to account for multi-modal background distributions, single Gaussian insufficient for some backgrounds.
- Online unsupervised learning – Background model adapts to changes in illumination / objects.
- Parameters updated recursively based on last T number of frames as training data, adaptive number of Gaussians.
- OpenCV BackgroundSubtractorMOG2 model based on background subtraction paper by Z. Zivkovic
- Model classifies a pixel as background or foreground.

Object Detection

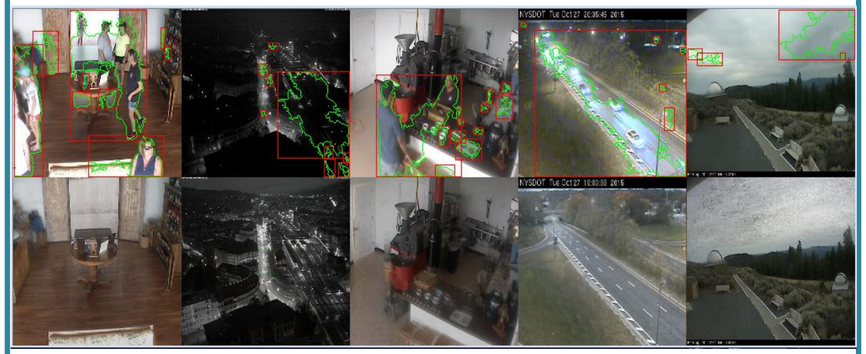
- Background Model returns foreground mask
- Fit contours around blobs in foreground mask, filtered by size to account for noise (overly small contours) and change in webcam global illumination / movement (overly large contours)

Background Model | Foreground Mask | Current image + Detected objects



Webcam Scoring

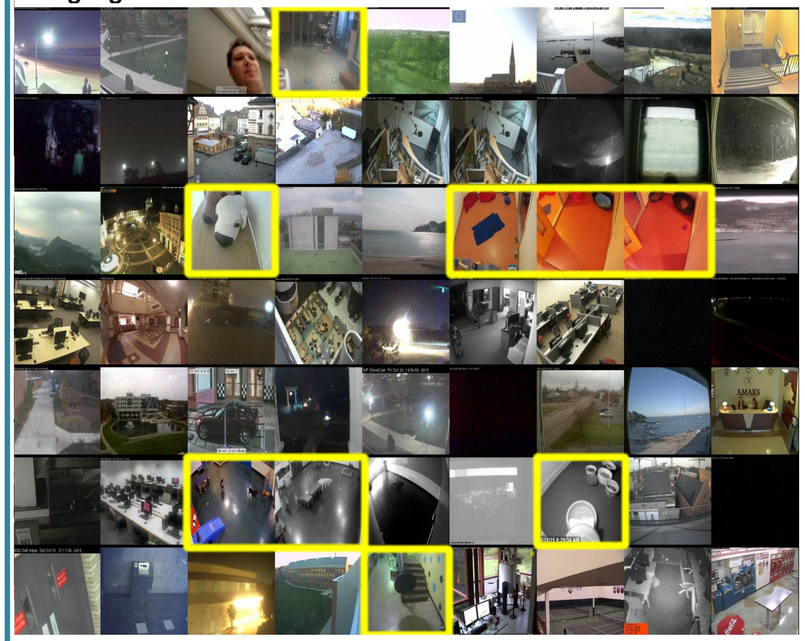
- Score = (total contour area %)/(total contour length)
- Max. area to show most/largest objects, Min. length to reward convexity (penalizes large noisy artifacts).
- Sample displays of Top 5 / 1000 webcams shown below. Background model shown beneath webcam images with highlighted objects.



Clustering Webcams

- Bag-of-features model used to represent images.
- Cluster SIFT descriptors from a subset of images to create visual vocabulary.
- Feature vector is a histogram of closest features in the visual vocabulary.
- K-means++ produced significantly better clusters than random initial clusters.
- Choice of K was observed to be important. Setting K too high resulted in noisy clusterings; setting K too low resulted in meaninglessly broad categories.

Highlighted Webcams from Animal-related Cluster



Convolutional Networks for Filtering

- Start with a convolutional network pretrained on the ImageNet dataset.
- Modify output layer to classify humans (blue), vehicles (red), and noise.
- Create custom dataset by labeling patches found using object detection.
- Train pretrained model on our custom dataset.
- Use classifier to filter out noise during object detection.
- Applications for webcam search and clustering.