IMAGE SEGMENTATION OF IITK SURVEILLANCE DATASET

CS783:Visual Recognition

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1 Problem and Approach

The objective is to cluster pixels of an image(Taken from IITK surveillance dataset) into salient image regions such as cars, buses, auto-rickshaws, bicycles, motorcycles, pedestrians and background.

2 Histogram Based Methods

2.1 Otsu

Otsu's algorithm searches for a threshold value that maximizes the variance between the two groups foreground and background, so that the threshold value can better segment the foreground from the background.

2.2 Renyi Entropy

Renyi entropy based segmentation is very useful when the object of interest is small compared to the whole image. Since there are small objects in our image we employed this method.

2.3 Adaptive Thresholding

Otsu's Method, a global thresh- old might not provide accurate segmentation. Adaptive thresholding helps solve this problem. In the adaptive thresholding, the image is first divided into small sub-images. Threshold value for each sub-image is computed and is used to segment the sub-image.

3 Region Growing Based Methods

3.1 Watershed Segmentation

7.3.1 Watershed Segmentation To perform watershed segmentation, a grayscale image is consid- ered. The grayscale values of the image represent the peaks and valleys of the topographic terrain of the image. The lowest valley in an object is the absolute minumum. The highest grayscale value corresponds to the highest point in the terrain. The watershed segmentation can be explained as follows: all the points in a region where if a drop of wa- ter was placed will settle to the absolute minimum are known as the catchment basin of that minimum or watershed. If water is supplied at a uniform rate from the absolute minimum in an object, as water fills up the object, at some point water will overflow into other objects. Dams are constructed to stop

water from overflowing into other ob- jects/regions. These dams are the watershed segmentation lines. The watershed segmentation lines are edges that separate one object from another.

4 Clustering based Methods

4.1 K-means

The k-means algorithm is an iterative technique used to partition an image into k clusters. The standard K-Means algorithm produces accurate segmentation results only when applied to images defined by homogenous regions with respect to texture and color since no local constraints are applied to impose spatial continuity. At first, the pixels are clustered based on their color and spatial features, where the clustering process is accomplished. Then the clustered blocks are merged to a specific number of regions.

We tried to segment the image in two classes namely foreground and background. Firstly, raw images were segmented. But to segment images, the indepth knowledge at pixel level is not required so we applied gaussian blur and then applied segmentation. This improved the results slightly.

The method gave decent result on some of the images but images having shadows, low light are segmented poorly.

4.2 Mean Shift

One drawback of K-means was that we had to specify number of clusters. Number of clusters may vary between images so specifying fixed clusters isn't the most practical way to go for image segmentation.
Mean-shift algorithm looks very similar to K-Means, they both move the point closer to the cluster centroids. But Mean-shift does not require number of clusters as specified by the user. We found that Mean Shift performs better on average than K-means.

5 Deep Learning based Methods

5.1 Image Segmentation by Back Propagation

This is a CNN architecture and its self-training process that enables image segmentation in an unsupervised manner. Using the backpropagation of the softmax loss to the normalized responses of convolutional layers, the proposed CNN jointly assigned cluster labels to image pixels and updated the convolutional filters to achieve better separation of clusters.

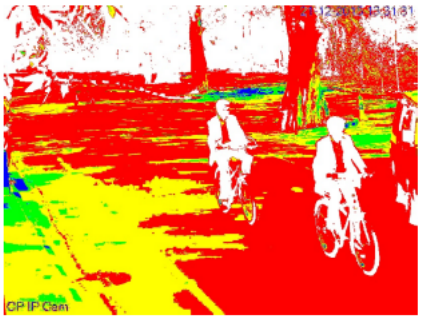
5.2 Wnet

This algorithm is based on concatenating together two fully convolutional networks into an encoder-decoder framework, where each of the FCNs are variants of the UNet architecture. Training is performed by iteratively minimizing the reconstruction error of the decoder along with a soft normalized cut of the encoder layer.

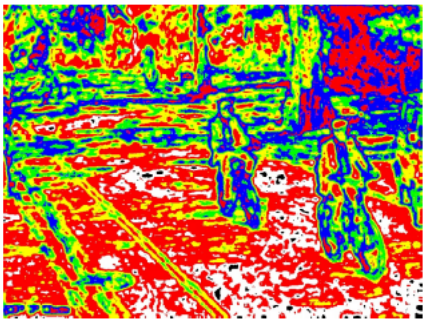
6 Results

6.1 Camera 2

Image Processing Based Methods



Otsu



Renyi

Adaptive Thresholding

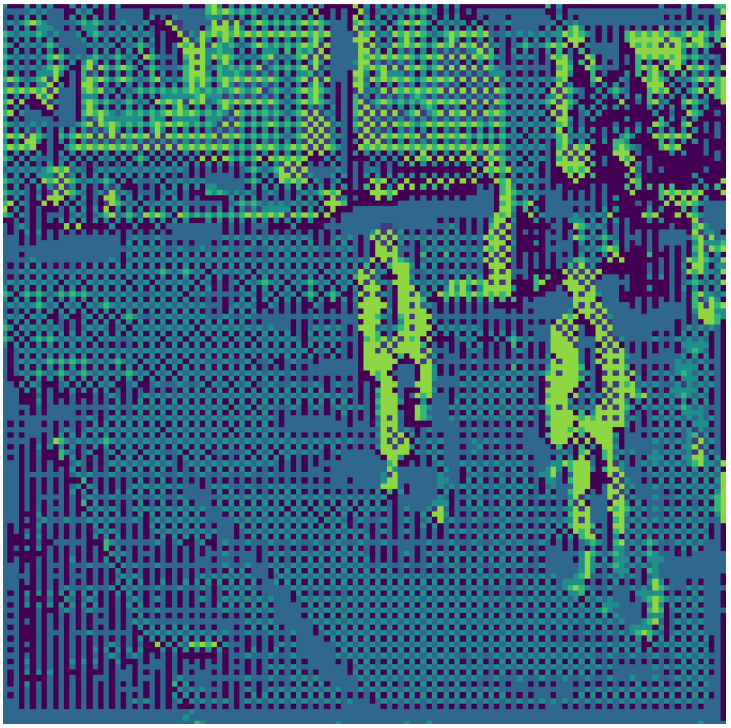
Watershed

Clustering Based Methods

K-means

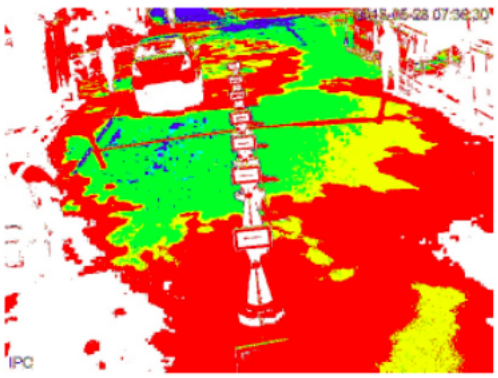
Means shift

Deep Learning Based Methods

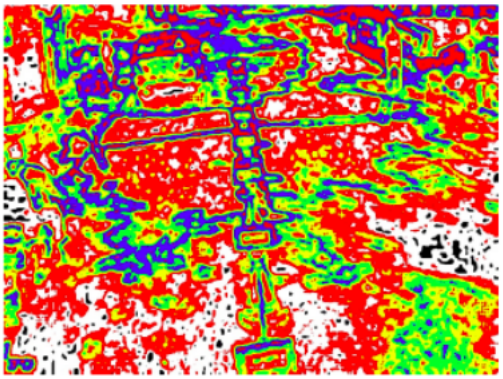


6.2 Camera 3

Image Processing Based Methods



Otsu

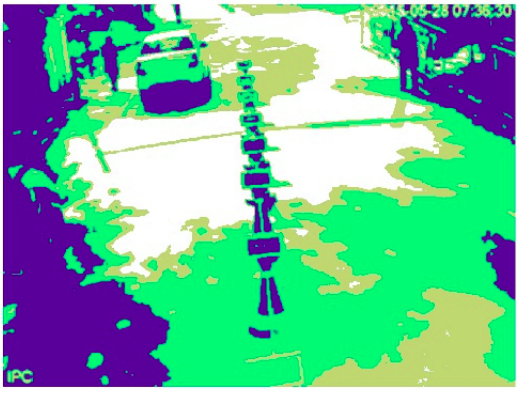


Renyi

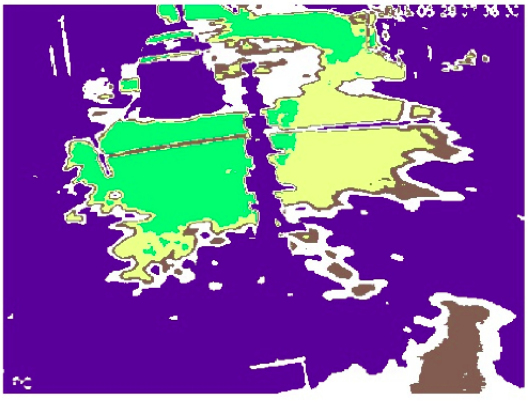
Adaptive Thresholding

Watershed

Clustering Based Methods

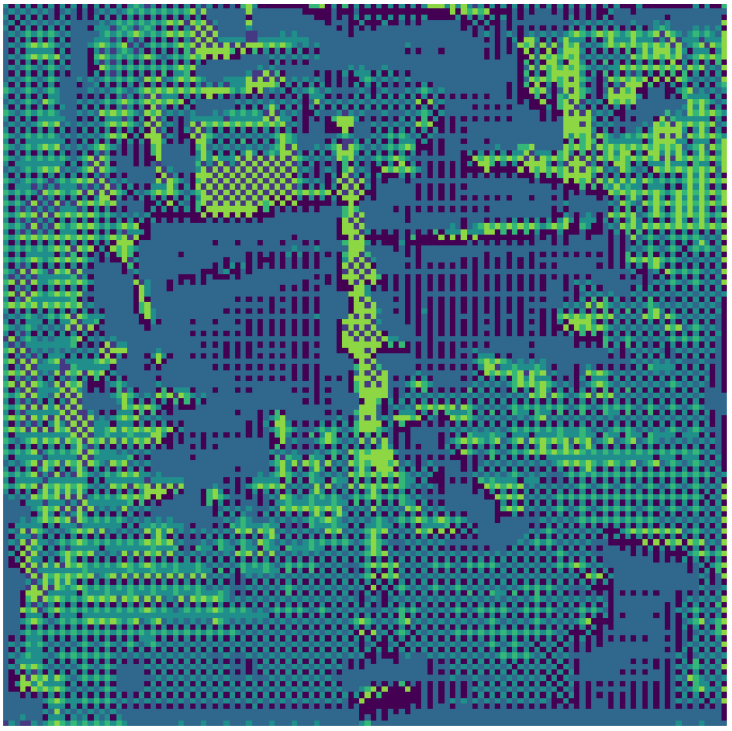


K-means



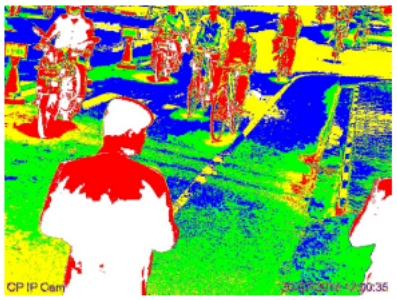
Means shift

Deep Learning Based Methods

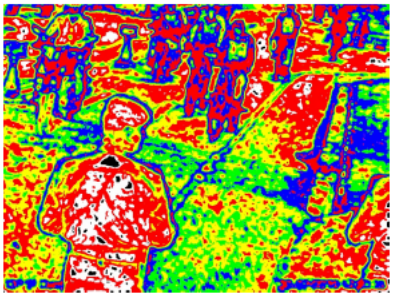


6.3 Camera 4

Image Processing Based Methods



Otsu

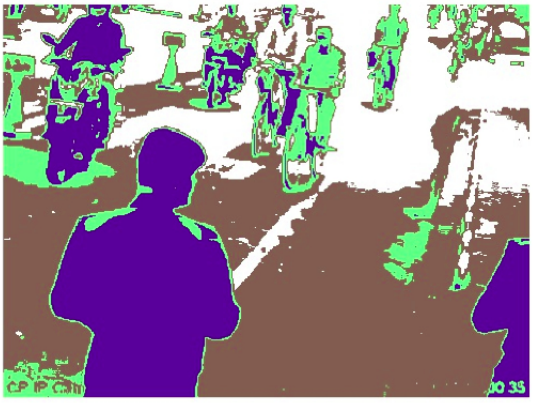


Renyi

Adaptive Thresholding

Watershed

Clustering Based Methods

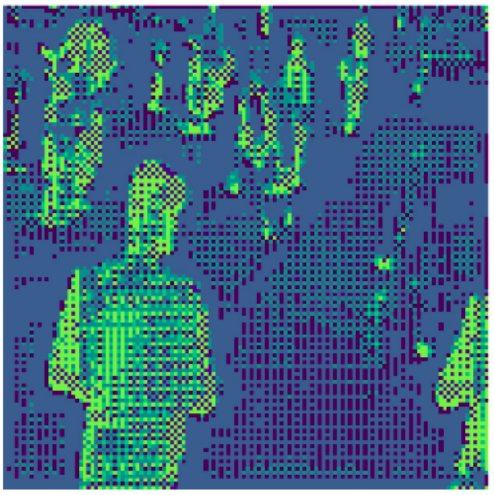


K-means

Means shift

Deep Learning Based Methods

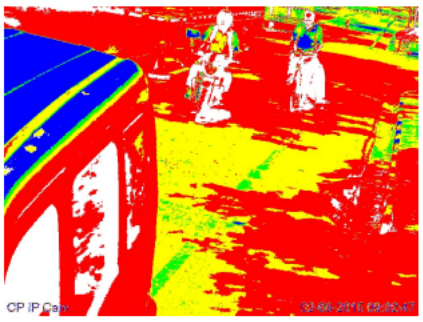
BackProp



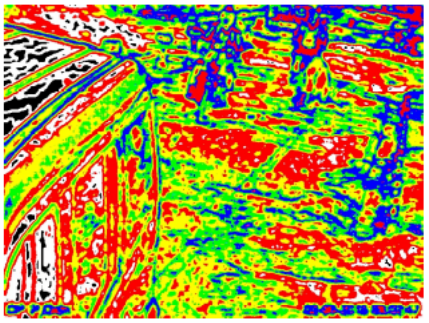
W-net

6.4 Camera 5

Image Processing Based Methods



Otsu



Renyi

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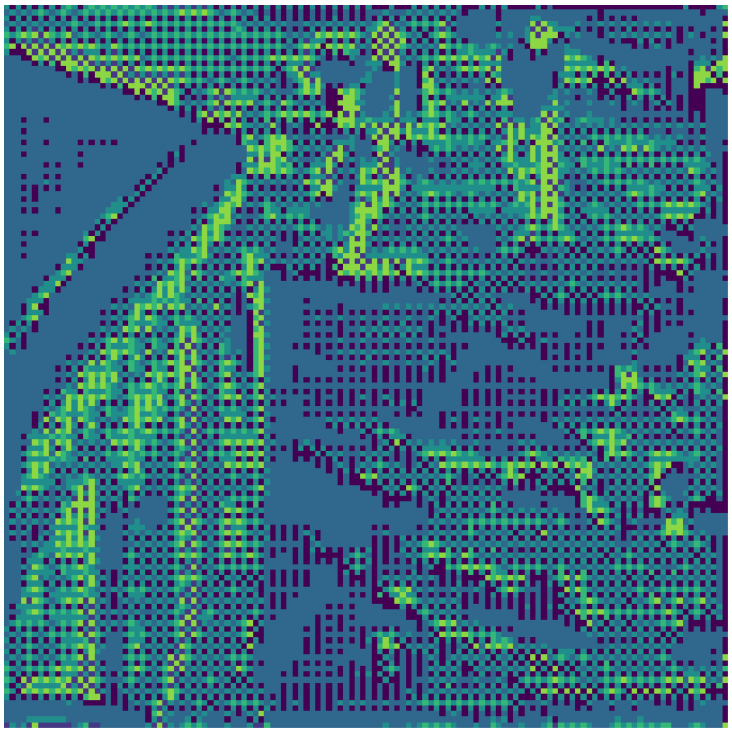

6.5 Results

It's not like a single method works for all. Each and every method perform good on some conditions and worse on other conditions. For example, Watershed segmentation works great on camera 4 but fails on camera 5. Similarily, otsu method works better on camera 5 but not so good on camera 4. We did not find very large improvement in segmentation by employing deep learning methods.The back propa-

gation performs exceptionally on camera 4 and clustering based methods give decent results on different camera situations.

Bibliography

[1] Xide Xia, Brian Kulis , *W-Net: A Deep Model for Fully Unsupervised Image Segmentation*,2017

[2] https://github.com/lwchen6309/unsupervised-image-segmentation-by-WNet-with-NormalizedCut

[3] Asako Kanezaki, *Unsupervised Image Segmentation by backpropagation*,2018

https://github.com/kanezaki/pytorch-unsupervised-segmentation