**DEPARTMENTOFINFORMATIONTECHNOLOGY**

**MADRASINSTITUTEOFTECHNOLOGY ANNA UNIVERSITY – CHENNAI**

**AD23402 COMPUTE-VISION APROJECTREPORT**

**MEAN-SHIFT SEGMENTATION**

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# SubmittedBy:

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**Meanshift segmentation in COMPUTER VISION**

### ****Title****

**Mean Shift Image Segmentation**

### ****Aim****

To implement and understand the Mean Shift clustering technique for segmenting images into meaningful regions without predefining the number of clusters.

### ****Statement****

Image segmentation is a crucial step in image analysis used to partition an image into segments or regions. Mean Shift, a non-parametric clustering method, is applied to group pixels based on feature similarities by finding the modes of the feature space.

### ****Theory and Concepts****

* **Image Segmentation**: Divides an image into parts to simplify analysis and highlight structures.
* **Mean Shift**:
  + A **non-parametric** and **iterative** technique.
  + Utilizes **kernel density estimation** to find high-density regions (modes) in feature space.
  + **Does not require prior knowledge** of the number of clusters.
* **Pixel Feature Distribution**: Visualizes pixels climbing "hills" in density space, each hill representing a cluster.

### ****Algorithm****

Given a distribution of N pixels in feature space:

1. Initialize the mean mi=fim\_i = f\_imi​=fi​ for each pixel iii.
2. Repeat for each mean mim\_imi​:
   * Place a window of size WWW around mim\_imi​.
   * Compute the centroid mmm within the window.
   * Update mi=mm\_i = mmi​=m.
   * Stop when the shift is less than threshold varepsilonε.
3. Declare mim\_imi​ as the mode.
4. Assign all pixels with the same mode to the same cluster.

### ****Results and Summary****

* **Visual Quality**: Compared to methods like K-means and graph cut, Mean Shift yields smoother segmentation with clearer boundaries.
* **Advantages**:
  + No need for predefining cluster numbers.
  + Can detect clusters of **arbitrary shapes**.
  + **Robust to noise** and outliers.
* **Limitations**:
  + High **computational cost**.
  + Sensitive to **bandwidth parameter**.
  + **Scalability** issues with large or high-dimensional datasets.

### ****Conclusion****

Mean Shift is a powerful segmentation tool offering dynamic, noise-robust clustering with smooth region boundaries. Despite its computational demands, its flexibility and ability to find arbitrary cluster structures make it highly useful for image analysis, object tracking, and scene understanding.