

## PROJECT 2: CONTENT BASED IMAGE RETRIEVAL

**Aim:** The main aim of the project is to implement Content Based Image Retrieval which is one of the most important concepts of computer vision. The big companies are using this to compare the similarity between the images based on the feature vector of the Targeted image.

### Task 1: Baseline Matching

Here we have the mat file kernel of size 9\*9 which would take the value of the image from the middle part of the image. Here we have used the distance metrics as the parameter to calculate the minimum square distances and then retrieve the images from the databases. Here below is the Target image pic.1016.jpg



Based on the above Target Image following below is the Top three Images retrieved from the databases. Shown below is the screenshot of the images retrieved:

```
target: [640 x 512]      img: target_2452.prcv Assignments\Content Based Image
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0986.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0641.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0233.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0547.jpg
```

Below are the Images from the Databases:

Pic.0986.jpg



Pic.0641.jpg



Pic.0233.jpg



Name : Aakash Singhal (002761944)

Rishabh Singh(002767904)

### Task 2: Histogram Method:

Here in this method we have created the 3d color histogram of individual images and then we have compared the histogram intersection method as our distant metric to compare the target image and the feature image so that the images can be extracted from the databases. Here we have used the 3d histogram having 8 bins each. Here the feature vector is saved in the csv files and then it is read again and compared with the feature vector to retrieve the top three images from the same.

Below is the Target Image pic.0164.jpg



Based on the histogram images following is the screenshot of the top images obtained from the histogram intersection

```
image names: 1106
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0092.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0898.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0110.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0426.jpg
```

Following are the Images from the databases:

Pic.0092.jpg



Pic.0898.jpg



Pic.0110.jpg



Name : Aakash Singhal (002761944)

Rishabh Singh(002767904)

### Task 3: Multi-Histogram:

we have taken the 8bins each for the histogram and then used L2 normalized vector. Here we have used the histogram intersection as the distant metric to get the desired result for the same.

Below is the Target Image named *pic.0274.jpg*.



Below is the screenshot of the output of top three images:

```
image names: 1106
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0409.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0273.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0412.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0426.jpg
```

Below are the Images from the database:

Pic.0409.jpg



Pic.0273.jpg



Pic.0426.jpg



Name : Aakash Singhal (002761944)

Rishabh Singh(002767904)

#### Task 4: Texture Analysis

Here in this file, we have taken the combination of color and texture as the feature vector. In this texture we have used the Sobel feature to get the desired output image. Here we have used the magnitude and gradient filter to get the result. Here we have created a histogram of the combination of the magnitude and gradient. We have created the histogram and then we have compared the target image and feature image. Here the histogram intersection is considered as the distant metric.

Here below is the target image pic.0535.jpg.



1) Here in this the above Target Image is used run on Task 2 which is through histogram. Below is the screenshot of top Images:

```
Enhanced reading CSV file
image names: 1106
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0731.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0628.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0233.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0338.jpg
```

Pic.0731.jpg



Pic.0628.jpg



Pic.0628.jpg



Name : Aakash Singhal (002761944)

Rishabh Singh(002767904)

2) Here in this the above Target Image is used run on Task 3(multi histogram). Below is the screenshot:

```
image names: 1106
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0731.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0233.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0171.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0355.jpg
```

Below are the images for the same:

Pic.0731.jpg



Pic.0233.jpg



Pic.0171.jpg



3) Here in this the above Target Image is used run on Task 4(which is the texture and color). Below is the screenshot :

```
image names: 1106
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0731.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0732.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0628.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0741.jpg
```



Here in above we could observe the matches of a target image implemented on Task 2,3 and 4

### Task 5: Custom Design

Here in this custom design, we have taken two target images of our choice and created the feature vector for the same. Here we have somewhat used the extension of the Task 4. In this we have mainly focused on the middle part of the images as the object are more concentrated on this part.

Below is the Target Image 1 pic.0752.jpg



Here below is the screenshot of the Images like retrieved:

```
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0753.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0898.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0746.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.1107.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0880.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0890.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0904.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0239.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0220.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0750.jpg
```

Pic.0753.jpg



Pic.0746.jpg



Pic.0898.jpg



Name : Aakash Singhal (002761944)

Rishabh Singh(002767904)



Pic.1107.jpg



Pic.0880.jpg



Pic.0890.jpg



Pic.0904.jpg



Pic.0239.jpg



Pic.0220.jpg



Pic.0750.jpg

**Below is the Target Image 2 pic.0755.jpg**



Here below is the screenshot of the Images like retrieved:

```
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0334.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.1072.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0688.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0490.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0136.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0065.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0673.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0715.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0754.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0719.jpg
```

Name : Aakash Singhal (002761944)

Rishabh Singh(002767904)

Below are the images represented visually :



Pic.0334.jpg



Pic.1072.jpg



Pic.0688.jpg



Pic.0490.jpg



Pic.0136.jpg



Pic.0065.jpg



Pic.0673.jpg



Pic.0715.jpg



Pic.0754.jpg



Pic.0719.jpg

## Extensions:

Here we have implemented the Gabor filters which is the combination of gaussian smoothing and sinusoids waves. It is a linear filter as the output is the linear combination of the input image. Here in this we have used the 10 filters of different orientations and the variances in 1 2 and 4. Gabor helps to identify the ridges and the edges detector. Here we have implemented gabor on the middle part of the images.

Below is the equation of the Equation:

sigma is the standard deviation of the Gaussian function used in the Gabor filter.

theta is the orientation of the normal to the parallel stripes of the Gabor function.

lambda is the wavelength of the sinusoidal factor in the above equation.

gamma is the spatial aspect ratio.

psi is the phase offset.

ktype indicates the type and range of values that each pixel in the Gabor kernel can hold.

$$g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp\left(-\frac{x'^2 + \gamma^2 y'^2}{2\sigma^2}\right) \exp\left(i\left(2\pi \frac{x'}{\lambda} + \psi\right)\right)$$

Below is the First target Image pic.0016.jpg



Below is the result taking histogram as the distance metric:

```
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0020.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0019.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0017.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0014.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0208.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0873.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0872.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0197.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0395.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0088.jpg
```



Below is the result taking sum of squared distance as the distance metric:

```
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0020.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0326.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0377.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0378.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0017.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0014.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0019.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0025.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0208.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0653.jpg
```

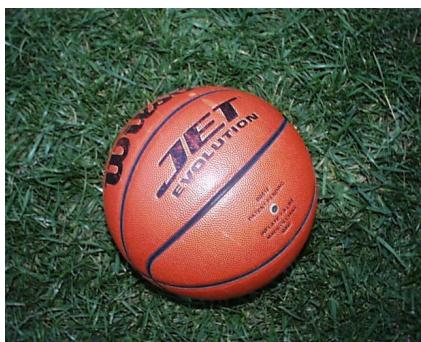
Name : Aakash Singhal (002761944)

Rishabh Singh(002767904)

Below are the Images:



Below is the Second target Image pic.0280.jpg



Below is the result taking histogram as the distance metric:

```
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0872.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0281.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0873.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0233.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.1029.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0951.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.1027.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0875.jpg
```

Name : Aakash Singhal (002761944)

Rishabh Singh(002767904)

Below are the corresponding Images;



Below is the result taking sum of squared distance as the distance metric:

```
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0281.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0872.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0873.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0607.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.1027.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0282.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.1029.jpg
E:\PRCV Assignments\Content Based Image Retrieval\olympus\olympus\pic.0951.jpg
```



## Learnings:

In this project a good understanding of the working of the concept of Content Based Image retrieval is being understood and successfully implemented. A good understanding of the working of different types of histogram was being understood and used as a feature component to retrieve images for the databases.

## Acknowledgements:

Following below are the details of the materials used for the images used:

- 1) OpenCV Documentation:  
[https://docs.opencv.org/3.4/d8/dc8/tutorial\\_histogram\\_comparison.html](https://docs.opencv.org/3.4/d8/dc8/tutorial_histogram_comparison.html)
- 2) Gabor Filter:  
<https://cvtuts.wordpress.com/2014/04/27/gabor-filters-a-practical-overview/>
- 3) Histogram :  
[https://docs.opencv.org/3.4/d1/db7/tutorial\\_py\\_histogram\\_begins.html](https://docs.opencv.org/3.4/d1/db7/tutorial_py_histogram_begins.html)