CSS5330 Pattern Recognition and Computer Vision

Project 2: Content-based Image Retrieval

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1. A short description of the overall project

In this project I learned about how to analyze and manipulate the images at a pixel level OpenCV in C++ language which includes performing tasks like pattern-recognition and matching. This project had a wide implementation of different kinds which includes implementing pattern matching using the rgb values of each pixel, using the histogram of the image, breaking the image into 4 parts and comparing the histogram, extracting the texture and color then comparing them, and also implemented Gabor filter on the entire image and also the middle portion of the image. I also implemented an image matching task by comparing a feature with the entire dataset and the matching images are obtained.

2. Images collected from the output of the filters

TASKS:

Task 1

Target images: 1016

Baseline Matching (shortcut : a)

Matching Image:

Feature vector: 9x9 square in the middle image

Distance Metric: sum of square difference



Task 2

Target images

Full Image histogram Matching (shortcut : b)

Matching Image

Feature vector: Entire image

Distance Metric: Histogram Intersection



Task 3

Target images : 0274

Multi Histogram Matching (shortcut : c)

Matching Image

Feature Vector: Split the image into 4 parts and calculate the 3d histogram of RGB color for each part and use 8 bins for each color and then Normalize the histograms

Distance Metrics: Histogram Intersection with equal weightage

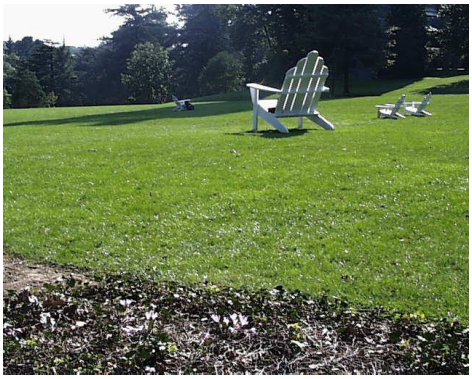


Task 4

Target images : 0535

Texture Matching (shortcut : d)
Matching Image
Feature vector: Entire image Texture
Distance Metric: Histogram Intersection





Texture and Color Matching (shortcut : e)
Matching Image
Feature vector: Entire image Texture and Color
Distance Metric: Histogram Intersection



Histogram Matching of the middle part of the image(shortcut : f)

Matching Image

Feature vector: Image middle part histogram

Distance Metric: Histogram Intersection



Texture Matching of the middle part of the image(shortcut : g)

Matching Image

Feature vector: Image middle part texture

Distance Metric: Histogram Intersection


Task 5

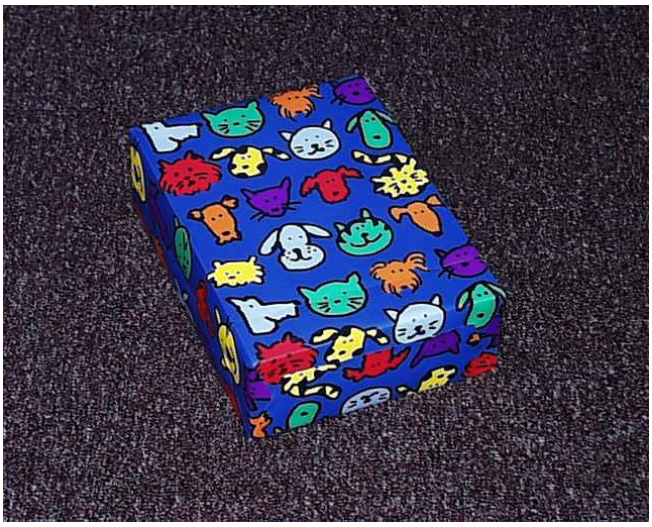
In task 4, I initially attempted to use both texture and color features. However, the results were not satisfactory and I believed that the background noise was the cause. After examining the database, I realized that most of the blue trash bins were positioned in the middle of the images. To address this, I divided the images into grids and focused only on the texture and color features of the middle section. The histogram intersection was used as the distance metric, and this method produced better results compared to analyzing the entire image. It was able to identify most of the other blue trash bins.

However, the algorithm would also sometimes display images of blue gift boxes or blue mailboxes with similar color and shape as the trash bins. The primary limitation of this algorithm is that it only works on images where the main object is located in the center, and texture analysis is more effective on straight lines rather than objects with irregular edges.

Target images

Texture and Color Matching of the middle part of the image(shortcut : h)
Matching Image

Feature vector: Image middle part Texture and color
Distance Metric: Histogram Intersection






Extension Task

Gabor Texture Matching of the image(shortcut : i)

Matching Image

Feature vector: Entire image Gabor filter on Texture

Distance Metric: Histogram Intersection

Gabor Texture and Color Matching of the image(shortcut : j)

Matching Image

Feature vector: Entire image Gabor Texture and Color

Distance Metric: Histogram Intersection

Multiple sub image Gabor Texture and Color Matching of the image(shortcut : k)

Matching Image

Feature vector: MUlti IMage Gabor Texture and Color

Distance Metric: Histogram Intersection

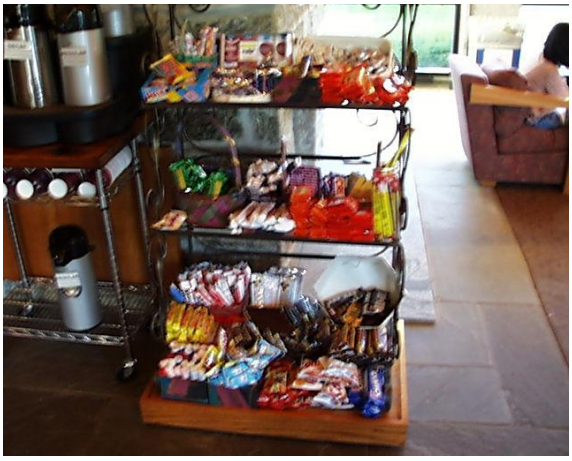


Gabor Texture and Color Matching of the middle part of the image(shortcut : l)

Matching Image

Feature vector: Image middle part Gabor Texture and color

Distance Metric: Histogram Intersection



3. Reflection of the learnings

In this project I got hands-on exposure to the Content Based Pattern Recognition. Especially doing computation with the pixel values was very useful to help me visualize the pattern matching operations

Some of the most important learning from this project are:

1. Implementing the image matching task my extracting features and then comparing distance between the RGB values of the database and target image
2. Applying Histogram matching by comparing the 3d histogram data and comparing them by using histogram intersection as distance metric.
3. I had also implemented histogram matching for multi image by dividing the image into sub images using histogram intersection as the distance matrix and then comparing it with the target image to extract the features.
4. In this project I also implemented the Gabor filter on texture, on texture and sobel filter color, on multi histogram on color and texture and texture and color on middle part of the image

4. Acknowledgement of the material

- HackerRank
- OpenCV Documentation
- Stackoverflow
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- W3 School
- Git
- Quora