

**Mini Project – PHASE 2**

For Course:

Machine Learning (BITS F464)

**Faculty:** Dr. Razia Sulthana

**Done By:**

2019A7PS0235U

AUM ASHOKBHAI BHATT

**Abstract**

The following research project focuses on *Image Feature Extraction* and its various methods. The project covers various papers published for the ongoing research *Image Feature Extraction* from 2016 onwards.

The main aim of this research is to search for three problem statements published in various journals *Computer Vision* and to solve them (in PHASE 2). The literature study consists of papers on different image feature extraction topics – Texture Feature Extraction from LBP, Iris Recognition Systems, Image Retrieval using histograms, Content Based Image Recognition (CBIR) using Color Histograms, plant disease recognition using decision trees, Dangerous Object Recognition, Lane Detection and Facial Expression Recognition.

In Phase 2 of the project, we are implementing CBIR using Global and Local Color Histograms for Color Feature Extraction of two images and find the similarity score between both images using Local Distance from Local Color Histogram.

**Introduction**

The world is moving towards digitization faster than ever as the information is shared among billions of users on the internet. In this digital age, a humungous amount of media dispersed contain some sort of visual imagery. Management and attribution of image data is difficult when dealing huge databases of images. In order to solve this issue, Computer Scientists have come up with various machine learning methods and algorithms which will help to automate these tasks.

One of the methods proposed is known as *Image Feature Extraction* which is part of *Image Processing* and *Computer Vision* in which various images are classified based on the content present in the image. The main task of *Image Feature Extraction* is to identify common patterns in images and classify/group them accordingly.

This project covers several Image Feature extraction techniques like *Bag of Words, Gabor Filtering, Kalman Filtering, etc.* and how different researchers have used them for solving practical problems.

**Literature Study**

Paper I: November 2015

**Texture Feature Extraction by Using Local Binary Pattern**

Local Binary Pattern is a method of Image Feature Extraction used for texture description. It works by finding signs of difference between a selected pixel called as the central pixel and its neighboring pixels. In this method, the we assign binary numbers to each neighboring pixel by comparing its value to the central pixel. The value of the center pixel is known as threshold value. If the neighbor’s value is less than the threshold then 0 is assigned to that pixel. If its greater than or equal to the threshold then 1 is assigned to it.

Once all the pixels are given a binary value, construction of a frequency histogram is done to obtain the binary pattern. Since there can be multiple different patterns in an image, there can be multiple binary patterns as well. After getting the pattern, each pattern dataset is divided into training set (75%) and test dataset (25%). Then the predicted pattern is taken as input and checked against the test dataset.

Paper II: June 2016

**Statistical Feature Extraction based Iris Recognition System**

This paper focuses on Iris Recognition System using Image Feature Extraction in machine learning. Iris (the colored part of eye which regulates amount of light entering the eyes) can be used as a biometric for authentication, just like fingerprints. Iris Recognition System is carried out in three stages as follows:

1. Image Preprocessing

Iris localization is done for focusing on only iris by discarding unwanted areas around it. Then the image of the iris is changed from cartesian coordinates to polar coordinates (Iris Normalization). Then image enhancement takes place for adjusting the light and brightness related issues.

1. Feature Extraction

Important features of the iris are extracted using variety of transformations (Gabor Filters, wavelet transform, Hilbert transform).

1. Matching

The data obtained is then compared with the template iris image of the user.

Paper III: August 2016

**Image retrieval by addition of spatial information based on histograms of triangular regions**

As discussed in the previous paper, CBIR can be performed using Color Feature Extraction methods and Texture Feature Extraction Methods. This paper solves one of the major issues *lack of spatial information* highlighted in the CBIR process using Color Histogram. Spatial information is important as it gives the 3-dimensional spatial arrangements of objects to 2-dimensional images. We as humans can easily perceive these arrangements by looking at them but computers cannot do that.

The method used is *Bag of Features (BoF)* in which visual vocabularies are formed from visual words that are located at the reduced clusters obtained from drawing out local features at a dense scale from the image. This BoF obtained is provided with spatial information by splitting the image into triangular regions from corner to corner followed by making histograms for each triangular pieces of the image. The image is usually split into 2 triangles along one of the diagonals called *Level 1* and then spilt into 4 triangles along both diagonals called as *Level 2*. Once we have the histograms for all triangles in both levels are added to the inverted index of BoF in turn adding spatial information about the various objects in the image.

Paper IV: September 2016

**A Review on Feature Extraction Techniques in Content Based Image Retrieval**

Content Based Image Retrieval (CBIR) is a form of image retrieval in which images are searched and fetched based on various features present in the image. It is a very efficient process of fetching similar images for a query made to a huge image database like social media platforms like Facebook and search engines like Google as it does not require any sort of metadata or context of image as input from user.

The following paper uses two techniques of CBIR to perform and construct the feature database:

1. Color Feature Extraction

In this extraction, we have several methods like:

* 1. Color Histogram
     1. Major Drawback: Lack of Spatial Information
  2. Color Correlogram
  3. Dominant Color Descriptor (DCD)
  4. Color Co-occurrence Matrix (CCM)

1. Texture Feature Extraction

Paper V: September 2016

**Intensity based feature extraction for tomato plant disease recognition by classification using decision tree**

The following paper discusses about infection recognition in tomato plants using Image Feature Extraction. This is done by categorization of images completely healthy and infected followed by performing Otsu’s segmentation is done for segmenting images based on color. Then extraction of feature descriptors takes place after which they are fed to three classifiers. Then the accuracy of the recognition is taken.

Paper VI: June 2017

**A New Approach of Content Based Image Retrieval Using Color and Texture Features**

This paper discusses all the new methods possible for both color and texture feature extraction used in Content Based Image Recognition. For color feature extraction, the researchers use the following techniques:

1. Color Moment Method
2. HSV based color histogram
3. Auto correlogram Method

For Texture feature extraction they use:

1. Gabor Wavelet Transformation
2. Wavelet Transformation

Paper VII: July 2018

**An analysis of Feature extraction and Classification Algorithms for Dangerous Object Detection**

This paper discusses how dangerous objects like guns, knives, or other weaponry can be detected using *Image Feature Classification* which can help in avoiding harmful accidents and incidents. This paper primarily focuses on detection of knives.

Four different classifier methods are employed for this:

1. Bag of Words

This method categorizes various features and calls them as *words* and collection of these words is called as *Visual Vocabulary* which is later used for classification. Then a histogram is made for classification from the *Visual Vocabulary*.

1. Histogram of Oriented Gradients
2. Support Vector Machine

The output of this supervised learning algorithm is a hyperplane (optimal) which helps in classifying new samples and data fed to it.

1. Convolutional Neural Network

Paper VIII: August 2018

**Lane Detection Based on Connection of Various Feature Extraction Methods**

Image Feature Extraction can also be used in road lane detection for various vehicular safety systems like *Lane Keeping Assist, Adaptive Cruise Control, Lane Departure Warning*, etc. Many modern-day vehicles like Tesla cars have cameras and sensors all around the car for detecting pedestrians, other vehicles and lanes.

The following paper presents a very sophisticated technology for lane detection which can improve the accuracy of detection in real-time settings. This method is executed by taking individual frames from camera’s video stream and then passing it through a preprocessing system which performs both color and texture feature extraction together. Then noise filtering of data is done for getting smooth and clear images using Gaussian filter for motion tracking. Then the area of the image in which we are interested is selected and lane detection is performed using Kalman Filtering and Hough Filtering techniques.

Paper IX: June 2020

**Facial Expression Recognition**

One of the applications of *Image Feature Extraction* is Facial Expression Recognition (FER). Data obtained from Facial Expression Recognition can be used for many purposes like learning the mood of the subject and use in biometric locks (example been iPhones face unlock). Mostly, there are seven basic facial expressions as given below:

1. Happy
2. Fear
3. Neutral
4. Sad
5. Anger
6. Disgust
7. Surprise

In order to perform Facial Expression Recognition, five general steps have to be followed (in the same order) as given below:

1. Image Preprocessing
2. Face Detection
3. Facial Component Revealing
4. Feature Extraction
5. Classification of Images

In Image Preprocessing, the image is first standardized in terms of dimensions, pixel density, size, etc. Then extraction of the face of the subject takes place removing undesirable objects from the image.

This is followed by Feature Extraction (the topic of the report) which is the most crucial step in Facial Expression Recognition. Different techniques can be employed to achieve this like Local Directional Number Pattern (LDNP) in which the appearance features are extracted. This is followed by the extraction of geometric features using Principal Component Analysis (PCA).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| References | Objectives | Problem Statement | Methodology | Dataset | Algorithm | Advantage | Disadvantage | Performance Measure - Value |
| I | Texture Feature Extraction by Using Local Binary Pattern | Extraction of texture features from images. | Local Binary Pattern |  |  |  |  |  |
| II | Statistical Feature Extraction based Iris Recognition System | Identification of Iris from images to be used for various purposes. | Gabor Filters, wavelet transform, Hilbert transform |  |  |  |  |  |
| III | Image retrieval by addition of spatial information based on histograms of triangular regions | Solving the problem of adding spatial information to color histogram feature extraction method. | Bag of Features |  |  |  |  |  |
| IV | A Review on Feature Extraction Techniques in Content Based Image Retrieval | Picking the best technique for color and texture feature extraction. |  |  |  |  |  |  |
| V | Intensity based feature extraction for tomato plant disease recognition by classification using decision tree | Identify and categories various plant diseases. | Decision Trees |  |  |  |  |  |
| VI | A New Approach of Content Based Image Retrieval Using Color and Texture Features | Finding local distance from color histogram and obtain similarity score between two images. | Global and Local Color Histograms. |  |  |  |  |  |
| VII | An analysis of Feature extraction and Classification Algorithms for Dangerous Object Detection | Finding of harmful objects from images. |  |  |  |  |  |  |
| VIII | Lane Detection Based on Connection of Various Feature Extraction Methods | Detection of road lanes for avoidance of accidents in vehicles. | Kalman Filtering Hough Filtering |  |  |  |  |  |
| IX | Facial Expression Recognition | Recognition of facial expressions for detection of mood and other factors. |  |  |  |  |  |  |

## Chosen Problem Statements and Objectives

1. **Problem:** Implementing CBIR using color histogram.

**Objective:** To solve the loss of spatial information in color histogram by implementing the triangular splitting approach.

1. **Problem:** Implementing CBIR using color histogram.

**Objective:** To obtain color histogram by implementing the Global and Local Color Histogram and find difference between a reference image and a test image.

1. **Problem:** Implementation of Dangerous Object Recognition.

**Objective:** To use Bag of Words method for feature extraction of dangerous objects.

1. **Problem:** Implementation of disease recognition in tomato plants.

**Objective:** To use decision tree for making the feature extraction model.

# Phase 2

# Discussion

**Chosen Problem:**

**To obtain color histogram by implementing the Global and Local Color Histogram and find difference between a reference image and a test image.**

## Implementation

The problem focuses on HSV based Global and Local Color Histogram formation as mentioned in Paper VI.

In this technique, to find similarity score between two images, first the images are resized to same dimensions and split into equal number of rectangular segments. This is followed obtaining the Global color histogram (GCH) each segment of the images. Then we calculate the Euclidean distance between each of the sections which is also known as *Global Distance* obtained from GCH as given below:

Where *A* and *B* are the two images and *i, j, k* are the values of HSV (Hue, Saturation, Value).

Then we find the *Local Distance* obtained from LCH (Local Color Histogram) which is equal to the sum of Global Distances for each section as given below:

Where *a* and *b* are the two images.

The implementation of the problem’s solution is done in *Python* using *OpenCV* library and *NumPy* library for python.

## Architecture Diagram

## 

## Algorithm of Program

**Step 1:**

Pass the reference image, test image, number of bins the image takes and number of divisions/segments the images should be split for LCH as a parameter to the function *LCH ()*.

**Step 2:**

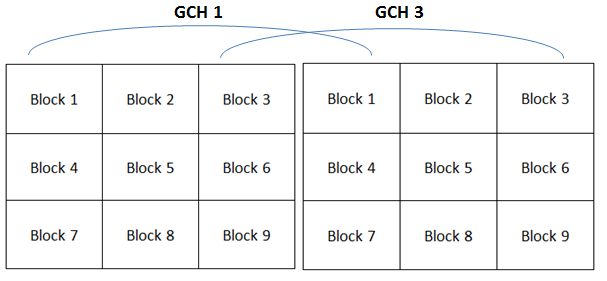
Take the images and resize both images to same dimensions by using OpenCV library method – *shape ()*.

**Step 3:**

Split each image into number of segments as given by the user and store those segments in separate lists for each image.

**Step 4:**

Run a loop on each of the list for calculating the *Global Distance* between each corresponding segment in both images.



**Step 5:**

Take the sum of all the calculated distances to obtain the *Local Distance*.

* Higher the value of the Local Distance, farther away/more differences are found between the images.
* Lower the value of the Local Distance, closer/less differences are found between the images.

## Results

Three images of an apple are taken for testing the program:

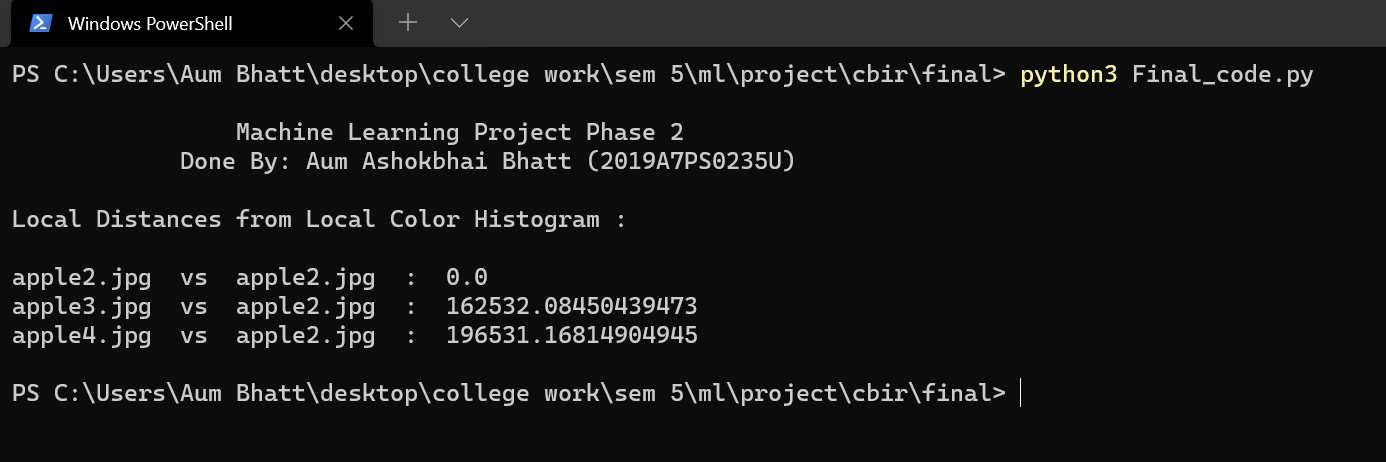


apple4.jpg

apple3.jpg

apple2.jpg

On comparing images *apple2.jpg* (reference image) with *apple3.jpg* and *apple4.jpg* (test images), the following Local Distances are obtained:



As we can see, higher the value for *Local Distances* in *LCH* (apple2.jpg vs apple3.jpg & apple2.jpg vs apple4.jpg), more the differences found between images.

Lower the value for *Local Distances* in *LCH* (apple2.jpg vs apple2.jpg – same images), lesser the difference between images.

## References

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2. Paper II: <https://www.ias.ac.in/public/Volumes/sadh/041/05/0507-0518.pdf>
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7. Paper VII: <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8412846&casa_token=6ZPBi4ENX1cAAAAA:kZn3xeURbVOODtiSNReytlR-0342Wr6VJ1_l44JeQ2FsogS_q15Mu0E_UJfxWmPLnx0HozRLU8HE>
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\*\*\* End \*\*\*