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MACHINE LEARNING AND IMAGE PROCESSING

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Abstract— In this review paper we have discussed the working of various machine learning algorithms and image processing methods. ML is a subfield of artificial intelligence, which is broadly defined as the capability of a machine to imitate intelligent human behavior. Artificial intelligence systems are used to perform complex tasks in a way that is similar to how humans solve problems. Here we train the machine with a lot of data and expect it to solve the problems which were not shown to it before based on the intelligence gathered from the fed data. Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to "learn" from large amounts of data.

Keywords—Image Processing, K-means Clustering, Histogram Equalization, Contour Detection And Tracing, Gray Level Co-occurrence Matrix (GLCM), K-Nearest Neighbour

I. INTRODUCTION

Image processing works along with machine learning and the complete work is divided into three phases. In this paper, we are using ML to give a solution to Plant Diseases or any such software which works on image processing.

In this method, we have divided the process into three stages Identify, Analyse and Verify with the Available database. These phases will be discussed later.

Now to integrate these machine learning and image processing features in any project we use algorithms.

They include K-Means clustering, Contour tracing, DWT (Discrete Wavelet Transform), GLCM(Gray Level Co-occurrence Matrix), CNN(Convolutional Neural Network). Segmentation, Histogram equalization and image pre-processing are the most important concepts related to it.

The key issues and challenges are identified by the researchers and the scientists, while analysing the process. Some of them are as follows:

1. The quality of the image must be high.
2. Publicly available Dataset requirement.
3. Noisy data affecting the image samples.
4. Through the process of segmentation, diseases or features or anomalies may be identified but the samples must undergo training and testing.
5. Classification is one more challenge, in the stage of detecting the things we want.
6. Colour of the image may be varied due to environmental effect. Variety of features and diversity is thee so it's difficult.

II. LITERATURE REVIEW

Lot of work has been devoted to the detection and extraction of features from image using image processing in the history and it continues to attract research to carry out their research work in this field.

Automatic crop disease detection using image processing and machine learning has been gaining prominence in recent years. Pre-processed by image resizing, contrast enhancement and color-space conversion. The K-Means

clustering for segmentation and feature extraction using GLCM is performed. Classification was made using multiclass performed color space conversion followed by enhancement process. The primary colors of leaves are converted into L∗A∗B∗. The K-Mean clustering algorithm is used for segmentation. The GLCM and SVM are used for feature extraction and classification respectively. Acquired images using digital camera and median filter is used for image enhancement. K-Mean clustering is used for segmentation. SVM is used for classification. Segmentation is done to get the areas of interest that is the infected region. It is done using k-Mean clustering algorithm, Otsu's detection converting RGB to HSI later segmentation is done using boundary and spot detection algorithm. Performed pre-processing by contrast adjustment and normalization. The GLCM is used for features extraction and classification.

III. Related work

Image Processing

Image processing is the process of transforming an image into a digital form and performing certain operations to get some useful information from it. The image processing system usually treats all images as 2D signals when applying certain predetermined signal processing methods.

Fundamental Image Processing Steps:

A. Image Acquisition:

Image acquisition is the first step in image processing. This step is also known as pre-processing in image processing. It involves retrieving the image from a source, usually a hardware-based source.

B. Image Enhancement:

Image enhancement is the process of bringing out and highlighting certain features of interest in an image that has been obscured. This can involve changing the brightness, contrast, etc.

C. Image Restoration:

Image restoration is the process of improving the appearance of an image. However, unlike image enhancement, image restoration is done using certain mathematical or probabilistic models.

D. Compression:

Compression is a process used to reduce the storage required to save an image or the bandwidth required to transmit it. This is done particularly when the image is for use on the Internet.

E. Segmentation:

Segmentation is one of the most difficult steps of image processing. It involves partitioning an image into its constituent parts or objects.

F. Representation And Description:

After an image is segmented into regions in the segmentation process, each region is represented and described in a form suitable for further computer processing. Representation deals with the image's characteristics and regional properties. Description deals with extracting quantitative information that helps differentiate one class of objects from he other.

G. Recognition:

Recognition assigns a label to an object based on its description.

IV. Proposed Algorithms

A. K-means Clustering (Based On Euclidian Distance):

- **Clustering** is one of the most common exploratory data analysis technique used to get an intuition about the structure of the data. It can be defined as the task of identifying subgroups in the data such that data points in the same subgroup (cluster) are very similar while data points in different clusters are very different.

- **K-means** algorithm is an iterative algorithm that tries to partition the dataset into *K* pre-defined distinct non-overlapping subgroups (clusters) where each data point belongs to **only one group**. It tries to make the intra-cluster data points as similar as possible while also keeping the clusters as different (far) as possible

- It assigns data points to a cluster such that the sum of the squared distance between the data points and the cluster's centroid is at the minimum. The less variation we have within clusters, the more homogeneous (similar) the data points are within the same cluster.

1. Specify number of clusters *K*.

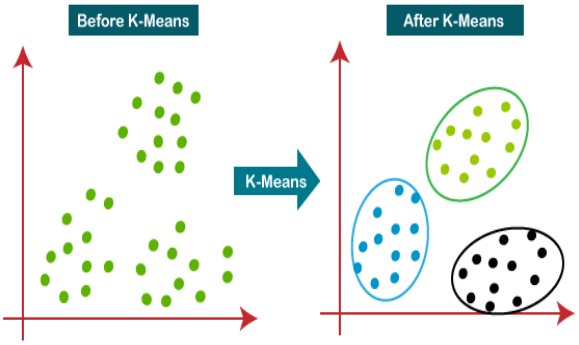
2. Initialize centroids by first shuffling the dataset and then randomly selecting *K* data points for the centroids without replacement.

3. Keep iterating until there is no change to the centroids. i.e. assignment of data points to clusters isn't changing.

- Compute the sum of the squared distance between data points and all centroids.

- Assign each data point to the closest cluster (centroid).

- Compute the centroids for the clusters by taking the average of all data points that belong to each cluster.



B. Histogram Equalization:

This method usually increases the global contrast of many images, especially when the image is represented by a narrow range of intensity values. Through this adjustment, the intensities can be better distributed on the histogram utilizing the full range of intensities evenly. This allows for areas of lower local contrast to gain a higher contrast.

Histogram equalization accomplishes this by effectively spreading out the highly populated intensity values which are used to degrade image contrast. The method is useful in images with backgrounds and foregrounds that are both bright or both dark. In particular, the method can lead to better views of bone structure in x-ray images, and to better detail in photograph that are either over or under-exposed.

A key advantage of the method is that it is a fairly straightforward technique adaptive to the input image and an invertible operator. So in theory, if the histogram equalization function is known, then the original histogram can be recovered. The calculation is not computationally intensive.

A disadvantage of the method is that it is indiscriminate. It may increase the contrast of background noise, while decreasing the usable signal.

Steps:

1. See the image matrix with the values of the grey levels which are the brightness or contrast of the pixels.

2. Count the number of pixels with the same grey values and then store it.

3. The highest grey value in the image will be represented with the exponent of 2 suppose 5 will need 2^3 i.e. 8 so plot that many points on graph staring from 0 to n-1.

4. Calculate the sum of all the grey scale values in the image recorded.

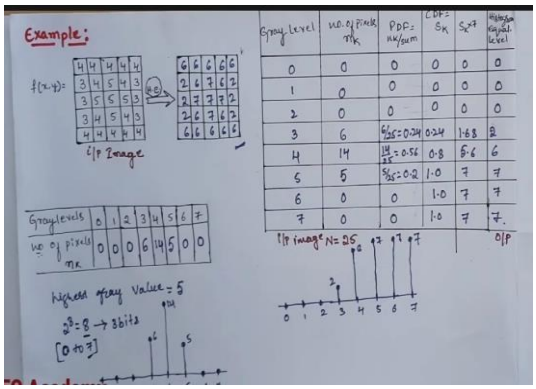
5. Each individual value of number of grey level will be divided by the sum and in this way PDF (Probability Distribution Function) will be calculated.

6. Take initial value of PDF as first CDF (Cumulative Distribution Function) and then keep adding the next PDF value into it and calculate the CDF.

7. All the CDF values will be multiplied by the highest grey level value. For 3 bits the max value can be 7 like that.

8. All of this values in step 7 will be approximated and now we have the Histogram equalization values.

9. Replace the values of previous grey level values of the pixels with new values and the image is equalized.



It is basically image enhancement so that more attention can be given to the features that needs to be extracted from the image.

C. Contour Detection And Tracing

Also known as border following or boundary following contour tracing is a technique that is applied to digital images in order to extract their boundary.

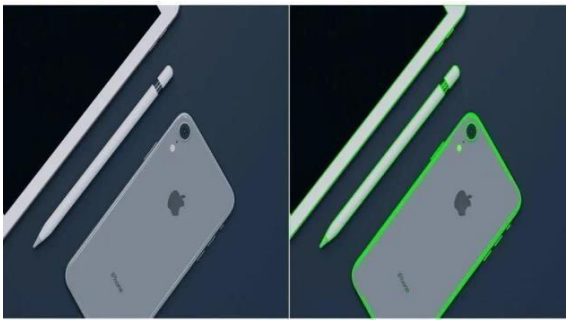
OpenCV makes it really easy to find and drawcontours in images. It provides two simple functions: **findContours() and drawContours()**

Also, it has two different algorithms for contour detection: **CHAIN_APPROX_SIMPLE** and **CHAIN_APPROX_NONE**

Steps for detecting and drawing contours in OpenCV

- **Read the Image and convert it to Grayscale Format**
  Read the image and convert the image to grayscale format. Converting the image to grayscale is very important as it prepares the image for the next step. Converting the image to a single channel grayscale image is important for thresholding, which in turn is necessary for the contour detection algorithm to work properly.

- ***Apply Binary Thresholding***
  While finding contours, first always apply binary thresholding or Canny edge detection to the grayscale image. Here, we will apply binary thresholding. This converts the image to black and white, highlighting the objects-of-interest to make things easy for the contour-detection algorithm. Thresholding turns the border of the object in the image completely white, with all pixels having the same intensity. The algorithm can now detect the borders of the objects from these white pixels.
- ***Find the Contours***
  Use the **findCountours()** function to detect the contours in the image.
- **Draw Contours on the Original RGB Image.**
  Once contours have been identified, use the **drawContours()** function to overlay the contours on the original RGB image.



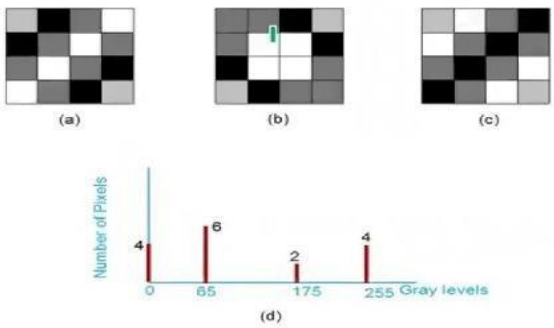
D. Gray Level Co-occurrence Matrix (GLCM)

Image texture gives us information about the spatial arrangement of color or intensities in an image. A simple one-dimensional histogram is not useful in characterizing texture for example, All three images have the Same histogram.

Hence a two-dimensional dependence matrix known as a grey-level co-occurrence matrix is extensively used in texture analysis.

The co-occurrence matrix captures numerical features of a texture.

Numerical features calculated from the co-occurrence matrix can be used to represent, classify, and compare textures.



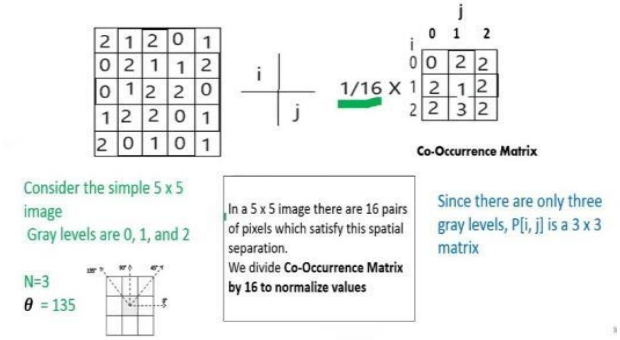
Computation of GLCM:

It has N*N(N= number of grey values)i.e. the rows and column represent the set of possible pixel values.

Computed based on 2 parameters.

d:Relative distance between the pixel pair.

0: Rotational angle. For ex. 45,135,0,90.



E. K-Nearest Neighbour (KNN)

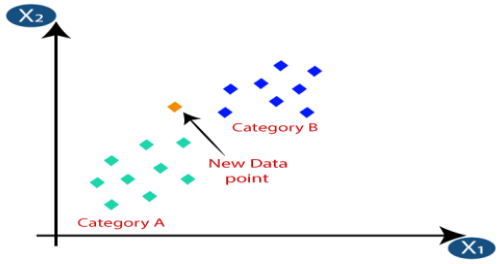
- K-NN algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories.
- K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using K- NN algorithm.
- It is also called a **lazy learner algorithm** because it does not learn from the training set immediately instead it stores the dataset and at the time of classification, it performs an action on the dataset.
- KNN algorithm at the training phase just stores the dataset and when it gets new data, then it classifies that data into a category that is much similar to the new data.
- **Example:** Suppose, we have an image of a creature that looks similar to cat and dog, but we want to know either it is a cat or dog. So for this identification, we can use the KNN algorithm, as it works on a similarity measure. Our KNN model will find the similar features of the new data set to the cats and dogs images and based on the most similar features it will put it in either cat or dog category.

How does KNN Work?

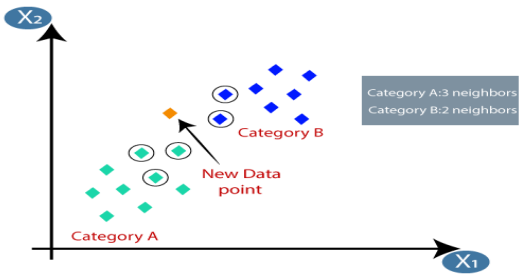
The KNN working can be explained on the basis of the below algorithm:

Step-1: Select the number K of the neighbours
Step-2: Calculate the Euclidean distance of K number of neighbours
Step-3: Take the K nearest neighbours as per the calculated Euclidean distance.
Step-4: Among these k neighbours, count the number of the data points in each category.
Step-5: Assign the new data points to that category for which the number of the neighbor is maximum.
Step-6: Our model is ready.

- Suppose we have a data point and we need to put it in the required category.



- Next, we will calculate the Euclidean distance between the data points i.e. $(x2-x1)^2 + (y2-y1)^2$



- As we can see the 3 nearest neighbours are from category A, hence this new data point must belong to category A.

V. Conclusion

The proposed model uses computer vision techniques including RGB conversion to grey, HE, K-means clustering, contour tracing is employed in pre-processing stage. GLCM is used to extract the informative features of the image samples. The machine learning approaches such as SVM, K-NN and CNN are used for classification.

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