International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2019 IJSRCSEIT | Volume 5 | Issue 2 | ISSN : 2456-3307
DOI : https://doi.org/10.32628/CSEIT195218

Comparative Study of Artificial Intelligence Techniques for Image Classification

Prashant Udawant[1], Atul Patidar[2], Abhijeet Singh[3], Atyant Yadav[4]

[1]Assistant Professor, Department of Computer Engineering SVKM's NMIMS/MPSTME, Mumbai, Maharashtra, India

[2-4]Department of Computer Engineering, SVKM's NMIMS/ MPSTME, Mumbai, Maharashtra, India

ABSTRACT

There are various applications of image processing in the field of engineering, agriculture, graphic design, commerce, historical research and architecture. This paper studies and compares most of the research works done in the field of image processing and machine learning for the purpose of image classification based on the features extracted from the image through different feature extraction techniques. The machine learning techniques studied in this paper are Convolution Neural Network (CNN), Support Vector Machine (SVM) and Fuzzy logic. The paper studies and compares these methods for their implementation in classification of digital images. Color based segmentation models are used to segment the specific features from image and categories them into different classes. First image preprocessing is done on the image to reduce the noise from the image. Then image segmentation and edge detection techniques are used to identify the objects in the image and extract the features through which the image can be labeled with a specific class.

Keywords : Pattern Recognition, Artificial Neural Networks, Machine Learning, Image Analysis.

I. INTRODUCTION

Nowadays because of the modern innovation in the field of technology especially in Artificial Intelligence, it make the life of a person more simple as we just need to train the machine on a dataset and later using the knowledge from the training dataset it can give optimal output for the new input dataset. Many latest innovations are based on image recognition as it is used in smartphone for facial recognition, diagnostic imaging in healthcare and driver drowsiness detector.

Image classification is used to identify the object from the clicked image, after identifying the object it identifies the color, size and shape of the object. The features extracted from image are used to classify the object to the group, which it resembles the most. Image classification is of two types:

Supervised classification: In this, the features are specified in advance, which help to identify the class to which the object comes under.
Unsupervised classification: In this, the features are not specified in advance and it learns based on the similar pattern, color or shape of the object and makes classes accordingly.
In this paper, we will be studying different techniques, which use Artificial intelligence and Image classification to identify the object and under which class it comes in. The techniques to be discussed are Support Vector Machine (SVM), Fuzzy Logic and Convolutional Neural Network (CNN).

II. IMAGE PROCESSING

A. Image Acquisition:

In the image acquisition task a specific image is selected. A digital camera with good resolution is required to capture a good quality image. The efficiency of the classification algorithm depends on the quality of the images in database, so the images should be of good quality. A training database of good quality images have to be taken to train the model. While taking the image the background and light conditions should be adjusted appropriately to ensure balanced contrast and brightness in the image.

B. Image Preprocessing:

In the next step the image is pre processed to suppress the unwanted distortion and enhance the image features for further analyzing. The RGB images are transformed into HSI color space representation. HSI(hue, saturation, intensity) color model is based on human perception and so is popular to facilitate the color specification in some standard way[2]. Hue means a color attributes that refers to the dominant color according to the perception of observer. Saturation is the relative purity that is the amount of white light added to hue while intensity is the amplitude of light. After the color space transformation the hue component is taken for further analysis while saturation and intensity are dropped.

C. Image Segmentation:

Image Segmentation can be used to make a simple representation which is meaningful and less complex to analyze. Image segmentation is the base for feature extraction and pattern recognition. It divides an image into various subdivisions. Segmentation is performed to separate the specific object or area in the image[3]. The various techniques for image segmentations are:

i) Region Based: In region based techniques the pixels related to an object are grouped but the area detected for segmentation should be closed. In this technique the boundaries are identified for segmentation of the image. In each step the pixel is taken and checked if it is related to the region of interest.

ii) Edge Based: Edge detection can also be used for image segmentation. In edge detection technique boundaries are identified to segment the regions of image. Various techniques for edge based segmentations are gradient, log, canny, sobel, lapacian, robert.

iii) Threshold Based: It is one of the easiest method for image segmentation. Here the threshold values are used for segmentation, which are obtained from the histogram of the original image. Threshold based method involve fewer computation when compared to other techniques. However threshold based techniques are no suitable for complex image.

iv) Clustering: Segmentation can also be done by clustering. A basic method for clustering based image segmentation is k-mean algorithm. Here we cluster all the pixels related to the region of interest to segment the image. The segmentation of image is purely based on the characteristics of image.

D. Feature Extraction:

After the segmentation is completed we have the desired object or area of the image as an output of segmentation process. We can use shape or textural feature extraction. In shape oriented featureextraction we use parameters like perimeter, color, eccentricity, area, solidity and axis length[5]. While is texture oriented feature extraction we use mean, correlation, contrast, energy, homogeneity, etc. There are various different methods for feature extraction apart from shape and texture based methods. In statistical method we use co-occurrence

matrix, grey level histogram, auto correlation features, etc.

III. SUPPORT VECTOR MACHINE

SVM is a linear as well as a non-linear classification technique. SVM use supervised learning models and algorithms to analyze data for classification and regression analysis. In supervised learning models the data which is to be given at input have to be labeled for effective classification. For linear classification a given data set of training examples, each entity should be marked as one of the two categories, an SVM algorithm assigns new unlabeled examples to one of the two categories[1]. It is a non-probabilistic binary linear classifier. An SVM model can be represented as points in space, mapped such that the examples of different categories are divided by a gap. This gap should be as wide as possible. The new unlabeled examples are mapped on this space and predicted to be of a category depending on its position with respect to the gap[4]. Non-linear classification can be done using kernel trick in which we implicitly map inputs into high-dimensional feature space.Formally we can say that a support vector machine tries to construct a hyperplane or a set of hyperplanes in a multi-dimensional space, which can be used for classification. The best separation is achieved when the distance between the hyperplane and the nearest points of each side in the plane is maximum. The complexity of computation for SVM does not depend on the dimensionality of inputs. The working of SVM is robust even if training example contains errors. However SVM requires large time for training and it is very difficult to understand the learned function and implementation of SVM for classification of more than two categories is very complex and time consuming.

IV. FUZZY LOGIC

The term fuzzy logic was introduced by LotfiZadeh of university of California in 1965.

Fuzzy logic works the same way as our brain work.[6] In Boolean system, the absolute truth value is 1 and the absolute false value is 0 whereas in fuzzy logic it takes imprecise or noisy data as input and produces output that range in between yes and no i.e maybe or maybe not. It is usually implemented in consumer products.

A. Membership function:

It is the degree to determine how the elements are related to the fuzzy set. In other word, 0 means not a member of the set, 1 means strong member of the set and in between 0-1 is the degree of membership of the set.[7]

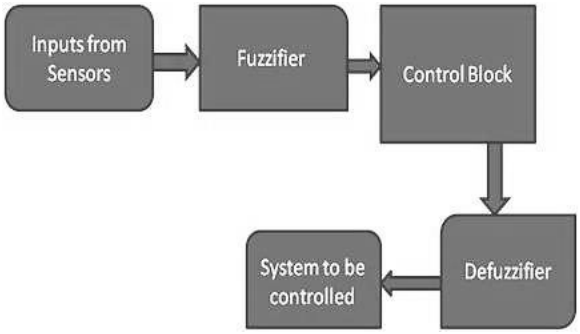

Figure 1: Fuzzy inference system.

B. Steps

The input to the system is in the format understandable by the humans after this the input is fed to the Fuzzifierwhich transforms the given input into the format understandable by the system.[8] Then the transformed data is fed to the control block, whichis defined with the set of rules, the best solution for the given input is selected. After successful selection, the output is converted into format understandable by the humans using Defuzzifier.Then the result is displayed on the system.[9]

C. Applications of fuzzy logic are:

- Business
  It helps in decision making and personnel evaluation.
- Defense
  It is used for target recognition under water, on land and air.
- Electronics
  It is used in washing machine for water level detector, air conditioning for auto cooling system, etc.
- Stock market

D. Advantages of Fuzzy Logic System:

- It is compatible with imprecise or noisy data.
- It is easy to construct and understand.
- It resembles human reasoning and decision making which makes it efficient.
- Little memory is required because it uses little data to describe it.

E. Disadvantages of Fuzzy Logic Systems:

- There is no systematic approach to solve a given problem.
- Proof of its characteristics is difficult or impossible in most cases because every time we do not get mathematical description of our approach.
- Accuracy is compromised because the data used are precise as well as imprecise.

F. Fuzzy logic operators

Fuzzy logic works with participation esteems such that copies Boolean rationale. To this end, substitutes for essential administrators AND, OR, NOT must be accessible. There are a few different ways to this a common replacement is called the *Zadeh operators*:

Table 1: Fuzzy logic operators

Boolean	Fuzzy
AND(x,y)	MIN(x,y)
OR(x,y)	MAX(x,y)
NOT(x)	1 – x

Example:
IF height IS 5 feet THEN person is average
IF height IS 6 feet THEN person is tall
IF height IS 4 feet THEN person is short

Training the data and producing an accurate output define the set of rules.

V. CONVOLUTIONAL NEURAL NETWORK

CNN is a type of artificial neural network (ANN) which has been widely used in automatic Image classification, video recognition and NLP. ANNs are computational system that works on the basic principles of biological neural network that constitute human brains. It consists of collection of interconnected units called neurons, which take weighted sum of multiple inputs and applies activation function to obtain an output which is passed on to the following neuron. The neurons are placed across multiple layers named as input layer, hidden layers and output layer. Neurons in each of these layers are connected to neurons of the next one.

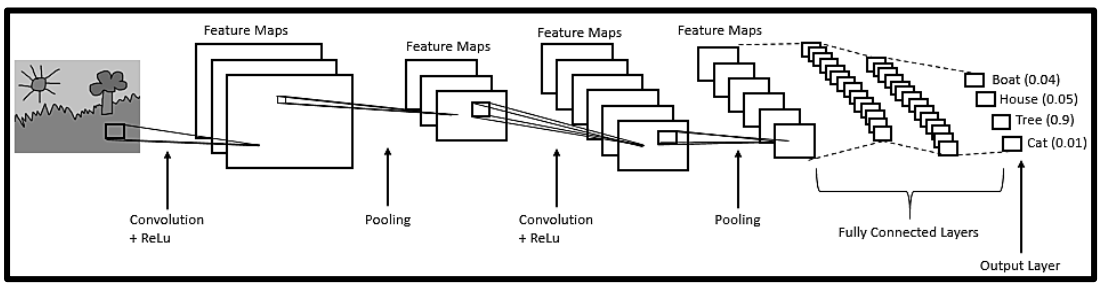

Figure 2: Convolutional Neural Network

CNNs are based on multilayer perceptron model (MLPs) which are inspired from human eye. CNNs are designed in a way that they require negligible amount of preprocessing. Each layer of CNN makes use of multiple filters which are responsible for extracting different features of an image.

A. Features & concepts

In CNN each filter is convolved throughout the image covering the entire visual field which results in formation of feature map in which all neurons have shared parameters. This is called the concept of Shared weights, which is used in order to identify features irrespective of their position in the image and to decrease the number of parameters. Another concept used by CNN for down sampling is max-pooling i.e. non-linear down sampling, which not only results in reduction of the number of parameters but also the computational complexity[10]. As we go deeper into the network number of filters tend to increase, hence to keep the complexity constant the feature map size reduces with depth. Also the neurons are spatially arranged i.e. the neurons of a given layer are only connect to a small region of neurons in the next layer instead of the entire set of neurons present in the next layer.

B. Working

CNN differs from regular neural network in terms of architecture as it consists of larger number of layers each of which are organized in three dimensions namely height, width and depth.

a. Convolutional Layer

The CNN network begins with the Convolution Layer which takes image as an input and performs convolution between the image and convolution mask or filter (a matrix with adjustable weights). In this layer each plane has connections with single or multiple feature maps of the previous layer[11]. Each Filter is traversed across the entire image while performing convolution over the chunks of input image and the output of this convolution is added with a bias followed by application of an activation function in order to obtain the corresponding feature map. Similarly it produces multiple feature maps corresponding to every filter, each of which is connected to a particular plane in the next sub-sampling layer.

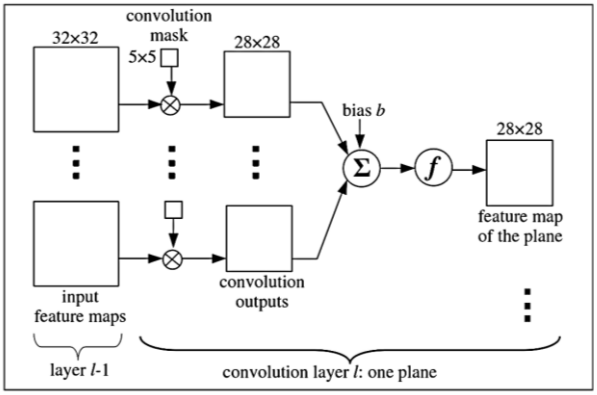

Figure 3: Convolutional Layer [10]

b. Sub sampling layer

Pooling layer (or Sub-sampling Layer) is the next layer in the network after convolution layer; it performs a down-sampling operation along the width and height of image in order to reduce the image volume. The main idea behind pooling layer is to compress the image to a less detailed version since some of the features have already been detected in previous convolution layer and are no longer required for further processing. It does not preserve the exact relation between the features, only the relative details of a feature are maintained. Pooling reduces the size of feature map which leads to reduction in memory and computation requirements of the network as well as helps in controlling overfitting. In this layer each feature maps has

connections with multiple planes in the following convolutional layer.

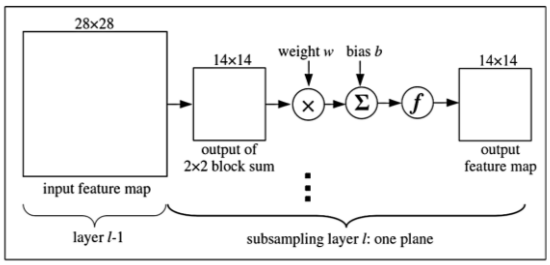

Figure 4: Sub-sampling Layer [10]

c. Fully Connected Layer

The fully connected layer comes after completion of multiple convolutional and sub sampling layers towards the end of network, which is used for high-level reasoning in the network.This layer acts similar to a layer in normal ANN as the neurons of this layer are connected to all activations in the past layer.

VI. COMPARATIVE STUDY

CNN has a lot of advantages when compared to other methods of image classification due to some of its features such as shared weights and max-pooling. It has an edge over other learnable classifiers as it requires minimal preprocessing because it can work well even with least accuracies and noisy data[13]. We can directly feed in image as an input to the network instead of extracting features first and then applying CNN to make the final decision.

Most of the techniques used for image classification only utilize the top layer features to train the network but these features may not provide enough information to completely detect patterns out of a given input image because some of the lower layer features carry more differentiation power than those from the top layer[12]. This problem can be overcome by using multi-stage feature provided by CNN which take both local details and global shape into account. Due to these unique features provided by CNN it improves the performance of image classification to a great level and also provides highest accuracy amongst all algorithms.

VII. CONCLUSION

In this review paper we studied and compared various methods used by different authors for developing an image classifier. We studied about the various image processing steps that are required to be performed before the classification of the image. Different authors used different techniques for image enhancement, image segmentation and feature extraction. The selection of these image processing techniques totally depends on the type and quality of the images present in dataset. Using appropriate feature extraction technique is important because the classification of the images is completely based on the output of feature extraction technique. Further after the feature extraction is completed we need to compares these features with each other for classification of the image. The classification techniques reviewed in this paper are Support Vector Machine(SVM), Fuzzy Logic and Convolution Neural Network. SVM is easy to implement for systems here we have few classes, but is the classification is required to be done over many classes the implementation of SVM gets very complex. Fuzzy logic is easy to construct and implement because it can accept noisy data and gives output which resembles human reasoning but accuracy is compromised because it uses precise as well as imprecise data. CNN overcomes the problem of noisy data with minimal pre-processing requirements and also improves the classification performance by providing features like max pooling and shared weights.

VIII. REFERENCES

[1]. Phadikar S., Sil J., Das A. K. "Classification of Rice Leaf Diseases Based on Morphological changes". International Journal of Information and Electronics Engineering, Vol. 2, No. 3, May 2012.

[2]. Nisale S. S., Bharambe C. J., More V. N. "Detection and Analysis of Deficiencies in Groundnut Plant using Geometric Moments". World Academy of Science, Engineering and Technology 58 2011

[3]. Mahlein, Anne-Katrin, Erich-Christian Oerke, Ulrike Steiner, and Heinz-Wilhelm Dehne. "Recent advances in sensing plant diseases for precision crop protection." European Journal of Plant Pathology 133, no. 1 (2012): 197-209.

[4]. Naik, M. Ravindra, and Chandra Mohan Reddy Sivappagari. "Plant Leaf and Disease Detection by Using HSV Features and SVM Classifier." International Journal of Engineering Science 3794 (2016).

[5]. Smita Naikwadi, Niket Amoda," Advances In Image Processing For Detection Of Plant Diseases," International Journal of Application or Innovation in Engineering & Management (IJAIEM), Vol2, Issue 11, November 2013.

[6]. Vishal .T .V, Srinidhi .S, Srividhya .S, Sri Vishnu Kumar .K, Swathika R, "A Survey and Comparison of Artificial Intelligence Techniques for Image Classification and Their Applications", International Journal of Science and Research (IJSR) ,2015.

[7]. N.Valliammal ,S.N.Geethalakshmi , "A Novel Approach for Plant Leaf Image Segmentation using Fuzzy Clustering", International Journal of Computer Applications (0975 – 8887) Volume 44– No13, April 2012

[8]. H. Al-Hiary, S. Bani-Ahmad, M. Reyalat, M. Braik and Z. ALRahamneh, Fast and Accurate Detection and Classification of Plant Diseases, International Journal of Computer Applications Vol. 17, No.1, pp.(0975-8887), 2011.

[9]. Y. Yong, Z. Chongxun, L. Pan, A Novel Fuzzy C-Means Clustering Algorithm for Image Thresholding Measurement Science Review, Vol. 4, No. 1, 2004.

[10]. Deepika Jaswal, Sowmya.V, K.P.Soman, Image Classification Using Convolutional Neural Networks,International Journal of Advancements in Research & Technology, Volume 3, Issue 6, June-2014

[11]. Son Lam Phung and Abdesselam Bouzerdoum," MATLAB Library for Convolutional Neural Network", Visual and Audio Signal Processing Lab University of Wollongong,2009.

[12]. Junho Yim, Jeongwoo Ju, Heechul Jung, and Junmo Kim, "Image Classification Using Convolutional Neural Networks With Multi-stage Feature", Department of Electrical Engineering KAIST 291.

[13]. Vishal .T .V1,Srinidhi .S2, Srividhya .S3,Sri Vishnu Kumar .K4,Swathika R5, "A Survey and Comparison of Artificial Intelligence Techniques for Image Classification andTheir Applications", International Journal of Science and Research (IJSR) 2015.

[14]. Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton. "Imagenet classification with deep convolutional neural networks." Advances in neural information processing systems. 2012

Cite this article as : Prashant Udawant, Atul Patidar, Abhijeet Singh, Atyant Yadav, "Comparative Study of Artificial Intelligence Techniques for Image Classification", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 5 Issue 2, pp. 904-910, March-April 2019. Available at doi :
https://doi.org/10.32628/CSEIT1952187
Journal URL : http://ijsrcseit.com/CSEIT1952187