International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org || PP—152-156

Review on Classification of Digital Images using Artificial Neural Network

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ABSTRACT: *Image Processing is an emerging area a lots of research has been carried out in this field. Image processing is a form of signal processing for the inputted image and the output of image processing may be either an image or set of characteristics or parameters related to the image. The purpose of image processing is to improve the quality of the image by removing the disturbances. It consists of various techniques such as Image segmentation, enhancement, classification, restoration, pattern recognition, extraction etc. Image classification plays an important part in the fields of Remote sensing, Image analysis, Pattern recognition and many more. Digital image classification is the process of sorting all the pixels in an image into a finite number of individual classes. The conventional approaches lead to misclassification. However artificial neural networks can resolve misclassification problem by various learning techniques. This paper reviews the use of ANN in image classification*

KEYWORDS: *Artificial Neural Network, Image Processing, Image classification, digital imaging*

I. INTRODUCTION

Digital imaging is a process to recognize objects of interest in an image by utilizing electronic devices and advanced computing techniques with the aim to improve image quality parameters. It contains basic difficulties due to the fact that image formation is basically a many-to-one-mapping. There are several problems associated with low-contrast images, blurred images, noisy images, image conversion to digital form, transmission, handling, manipulation, and storage of large-volume images, led to the development of efficient image processing and recognition algorithms. Digital imaging or computer vision involves image processing and pattern recognition techniques. Image processing techniques deal with image enhancement, segmentation, classification, restoration, reconstruction, manipulation and analysis of images etc.

Digital image consists of discrete picture elements called pixels which are associated with a digital number represented as DN that depicts the average radiance of relatively small area with a scene. The range of DN values is normally 0 to 255. Digital Imaging advantages include:

- Accurate data acquisition
- Better combination of spatial and contrast resolution
- No degradation with time or copying
- Compact storage/easy retrieval
- Data correction/manipulation/enhancement
- Fast accurate image transmission

Classification of digital images generally comprises four steps:

a) Pre-processing. e.g. atmospheric correction, noise suppression, and finding the band ratio, principal component analysis, etc,
b) Training: Selection of the particular feature which best describes the pattern,
c) Decision: Choice of suitable method for comparing the image patterns with the target patterns
d) Assessing the accuracy of the classification. The informational data are classified into supervised and unsupervised systems.

The conventional approaches leads to misclassification, hence we are using Artificial Neural Network which helps in training process and also help in improving the quality of image classification.

II. IMAGE CLASSIFICATION

Image classification refers to the task of extracting information classes from a multi brand raster image. The resulting raster from image classification can be used to create thematic maps. Depending on the interaction between the analyst and the computer during classification, there are two types of classification: supervised and

unsupervised.

➢ *Supervised classification*

Supervised classification uses the spectral signatures obtained from training samples to classify an image. With the assistance of the Image Classification toolbar, you can easily create training samples to represent the classes you want to extract. We can also easily create a signature file from the training samples, which is then used by the multivariate classification tools to classify the image. In supervised classification, we select representative samples for each land cover class. The software then uses these "training sites" and applies them to the entire image.

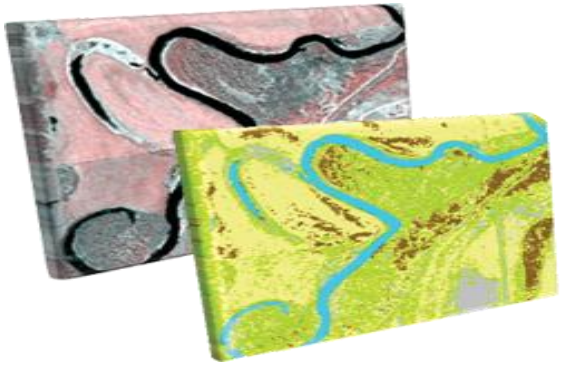


Fig. 1

Supervised classification uses the spectral signature defined in the training set. For example, it determines each class on what it resembles most in the training set. The common supervised classification algorithms are maximum likelihood and minimum-distance classification.

Supervised Classification Steps:

- Select training areas
- Generate signature file
- Classify

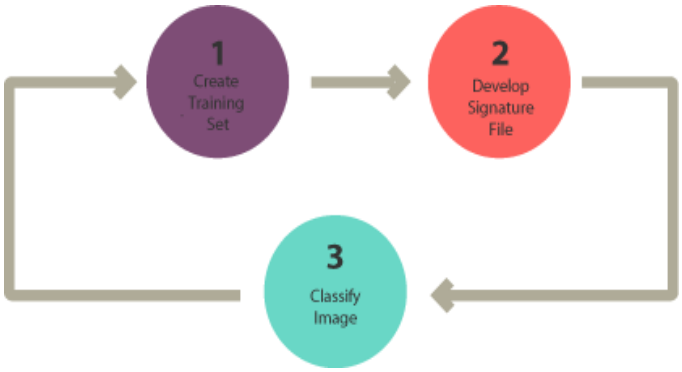


Fig. 2

➢ *Unsupervised classification*

Unsupervised classification finds spectral classes (or clusters) in a multiband image without the analyst's intervention. The Image Classification toolbar aids in unsupervised classification by providing access to the tools to create the clusters, capability to analyze the quality of the clusters, and access to classification tools. In unsupervised classification, it first groups pixels into "clusters" based on their properties.

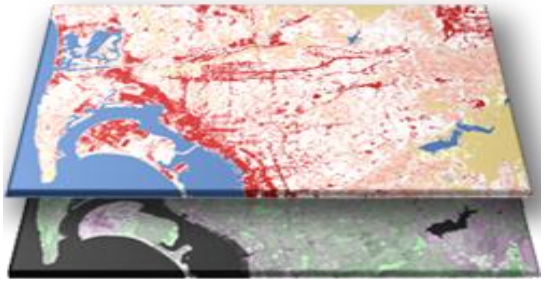


Fig. 3

Unsupervised Classification Steps:

- Generate clusters
- Assign classes

Fig. 4

Major steps involved in image classification are
1) Pre-processing.
2) Training – Selection of particular feature which describes the best pattern
3) Decisions – The choice of suitable method for comparing the image patterns with the target patterns.
4) Classified image.

III. ARTIFICIAL NEURAL NETWORK

Artificial neural networks (ANNs) are statistical learning algorithms that are inspired by properties of the biological neural networks. ANN possess large amount of highly interconnected processing elements called neurons, which usually operate in parallel and are configured in regular architectures. Each neuron is connected with other by a connection link. Each connection link is associated with weights which contain the information about the input signal. This information is used by the neuron net to solve a particular problem. ANN is characterized by their ability to learn, recall and generalize training patterns or data similar to that of a human brain. The computing world has a lot to gain from neural networks. Their ability to learn by example makes them very flexible and powerful. Furthermore there is no need to devise an algorithm in order to perform a specific task; i.e. there is no need to understand the internal mechanisms of that task. They are also very well suited for real time systems because of their fast response and computational times which are due to their parallel architecture. Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze. It is characterized by the followings:

a) Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.
b) Self-Organization: An ANN can create its own organization or representation of the information it receives during learning time.
c) Real time operation: ANN computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.
d) Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

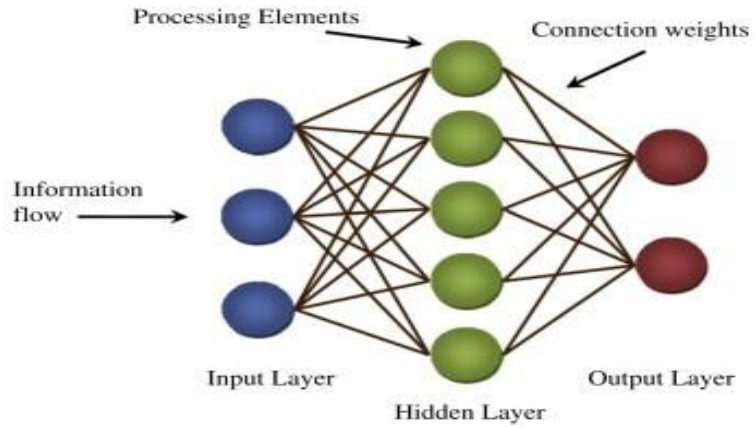


Fig. 5

Each node in the neural network takes many inputs from other nodes and calculates a single output based on the inputs and the connection weights. This output is generally fed into another neuron, repeating the process. When equipped with the information given in the last sentence, one can easily envision the internal hierarchical structure of the artificial neural network, where neurons are organized into different layers, as depicted below. The input layer receives the inputs and the output layer produces an output. The layers that lie in between these two are called hidden layers.

Properties of Neural Networks:-

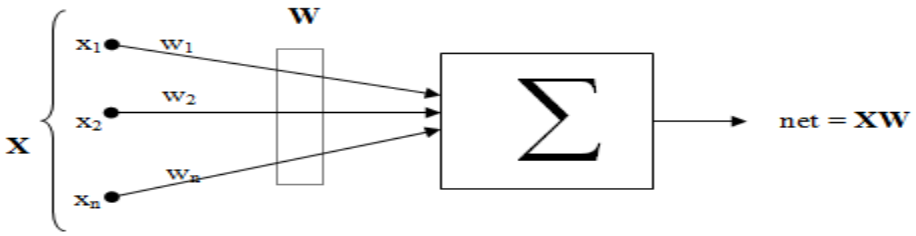
a) The NNs display mapping capabilities, i.e., they can map input patterns to their associated output patterns.
b) The NNs learn by examples. Thus, NN architectures can be trained with known examples of a problem before they are tested for their inference capability on unknown instances of the problem. They can, therefore, identify new objects previously untrained.
c) The NNs possess the ability to generalise. Thus, they can predict new outcomes from the past trends.
d) The NNs are robust systems and are fault tolerant. They can, therefore, recall full patterns from incomplete, partial or noisy patterns.
e) The NNs can process information in parallel, at high speed, and in a distributed manner.

➢ **Activation function in ANN**

Mathematically, it can be formalized as follows:

$f(x) = 1$ if $\Sigma i\ w_i\ x_i \geq$ threshold
0 if $\Sigma i\ w_i\ x_i <$ threshold

Where w and x are the weight and input vectors, respectively.



$$net = x_1w_1 + x_2w_2 + \ldots\ldots + x_nw_n$$

Fig. 6

IV. IMAGE PROCESSING WITH ARTIFICIAL NEURAL NETWORK

Processing of images with ANN involves different processes, such as:

a) Image pre-processing, an operation which shows a picture (contrast enhancement, noise reduction) with the same dimensions as the original image. The objective of images pre-processing with ANN consists in improving, restoring or rebuilding images. The resolved issues are the cartographic types, to optimize a function, an approximation function for the reconstruction of an image.

b) Data reduction or feature extraction involves extracting a number of features smaller than the number of pixels in the input window. The operation consists in compressing the image followed by extracting geometric characteristics (edges, corners, joints), facial features, etc.
c) Segmentation is a division of an image into regions.
d) Recognition involves the determination of objects in an image and their classification.

V. IMAGE CLASSIFICATION USING ARTIFICIAL NEURAL NETWORK

In digital image classification the conventional statistical approaches for image classification use only the gray values. Different advanced techniques in image classification like Artificial Neural Networks (ANN), Support Vector Machines (SVM), Fuzzy measures, Genetic Algorithms (GA), Fuzzy support Vector Machines (FSVM) and Genetic Algorithms with Neural Networks are being developed for image classification. Artificial neural networks can handle non-convex decisions. The use of textural features in ANN helps to resolve misclassification.

Artificial Neural Network is a parallel distributed processor that has a natural tendency for storing experiential knowledge. They can provide suitable solutions for problems, which are generally characterized by non-linear ties, high dimensionality noisy, complex, imprecise, and imperfect or error prone sensor data, and lack of a clearly stated mathematical solution or algorithm. A key benefit of neural networks is that a model of the system can be built from the available data. Image classification using neural networks is done by texture feature extraction and then applying the back propagation algorithm.

VI. CONCLUSION

Artificial neural network is considered to be an efficient learning process which helps in improving the quality of the image processing but a number of unresolved problems exists in the field of artificial neural network. The problem is how to choose the best ANN architecture. No general guidelines exists that guarantee the best trade-off between bias and variance of the classifier for a particular size of the training set. ANNs suffer from the black-box problem: given any input a corresponding output is produced, but it cannot be elucidated why this decision was reached, how reliable it is, etc. So in the future we will propose a ANN model that solves the problem related to it and improve the quality of image processing..

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