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A Review of Feature Extraction Techniques for Image Analysis

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Abstract: Feature extraction is the most important step in image classification. It helps in extracting the feature of an image as ideal as possible. Feature extraction techniques are applied to get the feature that will be useful in classifying and recognizing the images. In this paper, we reviewed various feature extraction techniques. These methods are classified as low-level feature extraction and High-level feature extraction. Low-level feature extractions are based on finding the points, lines, edge, etc while high level feature extraction methods use the low level feature to provide more significant information for further processing of Image analysis. Mostly high-level feature extraction method uses the Artificial Neural Network (ANN) to extract the feature in multiple layers.

Keywords: Feature extraction, Image classification, ANN.

1. INTRODUCTION

In image classification, the local features of the image are utilized to distinguish the different images. These features are catogoriesed on the various key component of image data like color intensity, edges of the objects present in image, texture, etc. [1]. The efficiency of feature extraction method enhances the further processing of an image to a great extent. These features can be used in image matching, pattern recognition and retrieval. These applications require the compact and relevant information to achieve high degree of accuracy. An input image posses large complex and redundant information. The process of transferring this information to reduce set of feature (or feature vector) is called the feature selection. Image Analysis is a process in which feature of the images are extracted and analyze for further processing. It is different from other image processing operations like restoration, coding and enhancement. Image analysis involves the detection, segmentation, extraction and classification techniques [2]. Feature extraction technique is used to extract the features by keeping as much information as possible from large set of data of image. Efficiency and effectiveness of feature selection and extraction are severe challenge nowadays. Numerous methods are used to extract features like color, texture and shape as feature vector. The techniques for feature extractions are classified are shown in Fig. 1.

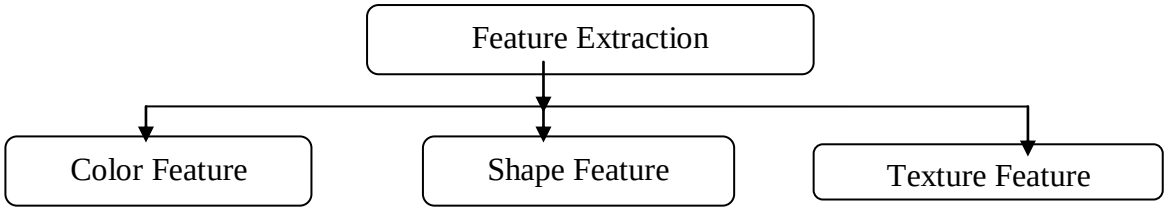

Fig.1: Classification of Feature Extraction Method

This paper reviewed various feature extraction technique to analyze the image. Feature extraction methods are classified as the low level feature and high level feature extraction. Low level feature are small details of the image like point, line edge corner etc. Low level feature can be extracted automatically from the image without having knowledge of shape. High Level feature are built on top of low level features to detect objects and larger shapes in the image. Convolution Neural network (CNN) uses both type of feature: first layer of CNN detect lines point curve edges etc then later layers recognize the common objects and shapes.

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2. LITERATURE REVIEW

There are various methods in literature that have been proposed for the feature extraction. It is a type of data reduction technique. The aim is to reduce the data set of features which is valuable information present in an image. [3]. Data present in an image are very complex and very high dimensional, it is a necessary step to extract the informative feature from an image for object recognition and segmentation [4]. Besides lowering the computational cost, feature extraction is also a means for controlling the so-called curse of dimensionality. In image analysis, all features of the images are seprated in such a manner that preserve the class separability well [5, 6].

Thresholding is one of the operations performed as point operation to extract the low level feature. Color, edges and corners are other low level feature for classification of image.

In begininng of image analysis various color spaces are used to distinguish the images. There are different color spaces such as RGV, LUV, HSV and HMMD [7]. Color histograms, Color Coherence vector, color moments based and color correlogram are used for the extraction of features in images. These techniques are based on extracting the mean, skewness and standard deviation of intensity of the image pixel [7]. Color histogram was successful and faster in detecting color distribution features in any given images meeting basic requirements. But it was unsuccessful in matching large set of images and no satisfies the following criteria (Consistency, Accuracy) [8]. Out of these method Color Moment is simplest, compact and robust technique to extract the feature [9].

As result shown in color space extraction were not met at the expectation. Image analysis limited with identification of edges and corners. Edge detection which produces the line drawing used for low level feature which define the shape of objects [10]. The quality of edge extraction feature is highly dependent on lightening conditions, the same intensity and the presence of noise. A corner detector algorithm called FAST (Features from Accelerated Segment Test) based on the SUSAN (Smallest Unvalued Segment Assimilating Nucleus) [11]. With FAST, the detection of corners was prioritized over edges as they claimed that corners are one of the most intuitive types of features that show a strong two dimensional intensity change, and are therefore well distinguished from the neighboring points [12].

Texture based feature extraction can be classified as spatial and spectral texture based on their various advantages to use in the image processing. Spatial texture is easy to use and can be extract information from any shape. These feature are very sensitive to noise and distortions. Spectral texture is robust and requires less computation. For efficient feature spectral texture require square region with sufficient size [13].

Gabor filter is widely used to extract the texture feature for image classification. Gabor filter or wavelets characterize an image by obtaining the centre frequency and orientation parameter. A feature vector is created by capturing the energy at a specific frequency and direction [14].

Shape feature extraction methods can be classified into two groups as Contour based and region-based methods. Contour based technique calculate shape feature only from the boundary and region-based method extracts feature from the entire region. These methods involve two type of approach. First is continuous approach which does not divide shape into subpart. It uses the the integral boundary to derived the feature vector. Second is Discrete (Global) Approach divides the shape boundary into sub part and compute the multi-dimensional feature vector. The Shape descriptor involves calculating area, circularity, eccentricity, major axis orientation, and bending energy [8]. Common methods of boundary decomposition are based on polygonal approximation, curvature decomposition and curve fitting.

In region based techniques, all the pixels within a shape region are taken into account to obtain the shape representation, rather than only use boundary information as in contour base methods. Common region based methods use moment descriptors to describe shapes. Other region based methods include grid method, shape matrix, convex hull and media axis. Similar to contour based methods, region based method are more effective as whole shape region is considered for descriptor where every pixel of shape is considered [10]. Zhang and Lu proposed the Generic Fourier descriptor (GFD) to overcome of multidimensional analysis of a shape. The GFD is acquired by applying a 2-D Fourier transform on a polar-raster sampled shape image.

Neural networks are very promising technique for feature extraction due to powerful parallel mechanism of computation. There exists wide range of ANNs that are trained enough to perform dimensionality reduction of the input data to create new set of compact and relevant feature vector. ANN takes the input data as pixel and extracts the feature through the layers of network based on learning. Oja [17] presented a well-known feature extraction neural network model of a one dimensional principal component analysis (PCA) which was extended to multiple dimensions [18, 31]. Baldi and Hornik [19] proved that three-layer auto-associator networks performed better corresponding to PCA. Linear PCA cannot deal efficiently with non-linear data subspace. In subsequent [20, 21], auto-associator networks with multi-layers were shown good performance in non-linear dimensionality reduction including principal surfaces [22]. It is also possible to use a mixture of linear subspaces to approximate a non-linear subspace [23]. There exists an approach by grouping the similar feature into small set of feature-cluster to reduce high-dimensional data. Clustering preserve the redundant feature of the data while network

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size is reduced which leads to good performance [24]. Most application like stereo matching [25], rotation invariant [26], character recognition [27], and hand printed Chinese [28, 30], volume segmentation of medical image [29] and many other computer vision problems used the ANNs that have been trained to perform feature extraction. Feed-forward network, self organizing map (SOM) and Hopfield ANNs are the network models which are used mostly in feature extraction technique.

It is important to make a distinction between application of supervised and unsupervised ANNs for feature extraction. A supervised ANN concerns with learning a model from labeled data which has predicted output. Classification, regression, anomaly detection are some of supervised learning technique which are helpful to reduce the data (feature), make predicted data and recognize the pattern. Unsupervised learning does not focus on predetermined feature, nor does it predict a target value. It is a technique which tries to find hidden structure in unlabeled data. Clustering is one of the unsupervised learning. Both supervised and unsupervised ANN learning methods have advantages over statistical methods [31, 32]. The SOM [33] is a dimensionality reduction technique which has properties to preserve topological relationship even in lower dimensional space.

3. CONCLUSION

Study shows that when feature extraction technique are applied for the image analysis region based shape feature are more robust as these methods extract all the shape information. Moments method and GFD provides more prominent information of shape. Zernike moments and GFD satisfy the six principle of MPEG-7. Study also shows that that supervised classification methods SOM Hopfield ANNs outperformed unsupervised algorithms.

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