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A Study on Feature Extraction Techniques in Image Processing

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***Abstract*— This paper presents a study on feature extraction techniques for image processing which is an important research subject in the field of computer vision. Representation and Feature extraction is an important step for multimedia processing. It manages how to concentrate perfect features that can mirror the intrinsic content of the picture. Feature extraction strategy extracts the distinct components from the picture like edges, corners and so on which can be used to match the similarity for estimation of relative transformation between the images. So in this paper we focus our study on the different methods used for image feature extraction, texture feature extraction and shape feature extraction.**

Keywords—Color feature, Color Histogram, Feature extraction, ,Haralik texture feature, Hu-Moment Shape Features, Tamura texture feature.

I. INTRODUCTION

According to a Chinese proverb "A picture is worth a thousand and one words", as human beings, we are able to tell a story from a picture based on what we see and get a complex idea about it. But can a computer program discover semantic concepts from images? We can say a YES. [1]The first step in programming in a computer is semantic understanding however, to extract efficient and effective visual features and build models from them rather than human background knowledge. So we can see that how to extract image low-level visual features and what kind of features will be extracted play a crucial role in various tasks of image processing. As we know that the most common visual features include color, texture and shape etc. and they are the most widely used features.

A. Importance of feature extraction

Some feature extraction technique is used in the segments after the pre-processing and the desired level of segmentation such as line, word, character or symbol has been achieved, to obtain features, which is followed by application of classification and post processing techniques.

[3]Feature extraction has been given as "extracting from the raw data information that is most suitable for classification purposes, while minimizing within the class pattern variability and enhancing the between class pattern variability".

II. Feature Extraction

Feature extraction is done after the preprocessing phase in character recognition system.[3]Feature extraction is an important step in the construction of any pattern classification and aims at the extraction of the relevant information that characterizes each class. In this process relevant features are extracted from objects/ alphabets to form feature vectors. These feature vectors are then used by classifiers to recognize the input unit with target output unit. It becomes easier for the classifier to classify between different classes by looking at these features as it allows fairly easy to distinguish. Feature extraction is the process to retrieve the most important data from the raw data. Feature extraction is finding the set of parameter that define the shape of a character precisely and uniquely. In feature extraction phase, each character is represented by a feature vector, which becomes its identity.
The major goal of feature extraction is to extract a set of features, which maximizes the recognition rate with the least amount of elements and to generate similar feature set for variety of instance with the same symbol.

III. IMAGE FEATURE EXTRACTION

A. Color Feature

The color feature is the first and the most widely used visual features in image retrieval and indexing. The important advantages of color feature are power of representing visual content of images, simple extracting color information of images and high efficiency, relatively power in separating images from each other, relatively robust to background complication and independent of image size and orientation. A number of important color features have been proposed in the literatures, including color histogram [5], Color Moments (CM) [6], Color Coherence Vector (CCV) [7] and color Correlogram [8], *etc.* Among them, CM is one of the simplest yet very effective features. The common moments are mean, standard deviation and skewness; the corresponding calculation can be defined as follows:

$$\mu_{i,j} = \frac{1}{N}\sum_{j-1}^{N} f_{ij}$$

$$\sigma_i = \left(\frac{1}{N}\sum_{j-1}^{N}\left(f_{ij} - \mu_i\right)^2\right)^{\frac{1}{2}}$$

$$\gamma_i = \left(\frac{1}{N}\sum \left(f_{ij} - \mu_i\right)^3\right)^{\frac{1}{3}}$$

Where f_{ij} is the color value of the i^{-th} color component of the j^{-th} image pixel and N is the total number of pixels in the image. μ_i, σ_i, γ_i (i=1, 2, 3) denote the mean, standard deviation and skewness of each channel of an image respectively.

Table I.[1] provides a summary of different color methods excerpted from the literature [9], including their strengths and weaknesses. Note that DCD, CSD and SCD denote the Dominant Color Descriptor, Color Structure Descriptor and Scalable Color Descriptor respectively.

TABLE I[1]Contrast of different color descriptors

Color method	**Pros.**	**Cons.**
Histogram	Simple to compute, intuitive	High dimension, no spatial info, sensitive to noise
CM	Compact, robust	Not enough to describe all colors, no spatial info
CCV	Spatial info	High dimension, high computation cost
Correlogram	Spatial info	Very high computation cost, sensitive to noise, rotation and scale
DCD	Compact, robust, perceptual meaning	Need post-processing for spatial info
CSD	Spatial info	Sensitive to noise, rotation and scale
SCD	Compact on need, scalability	No spatial info, less accurate if compact

B. Color Histogram

A Histogram counts the number of pixels of each kind and can be rapidly created by reading each image pixel just once and incrementing the appropriate bin of the histogram. Color histogram is relatively invariant to translation, rotation about the imaging axis, small off-axis rotation, scale changes and partial occlusion. There are two types of color histogram viz. global color histogram and local color histogram. Color histogram is proposed as a global color descriptor which analyzes every statistical color frequency in an image. It is used to solve the problems like change in translation, rotation and angle of view. Local color histogram focuses on the individual parts of an image. Local color histogram considers the spatial distribution of pixel which is lost in global color histograms. Color histogram is easy to compute and insensitive to small variations in the image so is very important in indexing and retrieval of image database. Apart from these advantages, it faces two major drawbacks [4]. First, overall spatial information is not taken into account. Second is that the histogram is not robust and unique as two different images with similar color distribution lead to similar histograms, the same view images with different exposure to light create different histograms.

IV. TEXTURE FEATURE EXTRACTION

Texture is a very important characteristics for the analysis of many types of images that appears everywhere in nature like natural images, remote sensing images and medical images. Texture can be defined as superficial phenomenon of human visual systems of natural objects. Texture can be attributed to almost everything in nature and also its texture structure of any image is incorporating repeated pattern of all most all of the parts. Texture is commonly known as ‘Texel’. Texture can be recognized by everyone but it is not easy to define. Texture does not occur over a point but it rather occurs over a region. Texture can be analyzed by quantitative and qualitative analysis. Based on the domain from which the texture feature is extracted, they can be broadly classified into spatial texture feature extraction methods and spectral texture feature extraction methods. For the former approach, texture features are extracted by computing the pixel statistics or finding the local pixel structures in original image domain, whereas the latter transforms an image into frequency domain and then calculates feature from the transformed image. Both spatial and spectral features have advantage and disadvantages.

TABLE II[1]
Contrast of texture features

Texture method	**Pros.**	**Cons.**
Spatial texture	Meaningful, easy to understand, can be extracted from any shape without losing info.	Sensitive to noise and distortions
Spectral texture	Robust, needless computation	No semantic meaning, need square image

A. Tamura Texture Feature

According to quantitative analysis one of the first descriptions given by the Tamura [11] proposed six textural properties and gave descriptions common over all texture patterns in Broadtz’s photographic images. These are six different texture features given by tamura Coarseness, Contrast, Directionality, Line-Likeness, Regularity and Roughness.

- *Coarseness*- Coarseness basically relates to the distance in gray levels of spatial variations, which is implicitly related to the size of primitive elements forming the texture. It has the direct relationship to scale and repetition rates and most fundamental texture feature.

- *Contrast* - Contrast measures distribution of gray levels that varies in an image and to what extent its distribution is biased to black or white.
- *Directionality*- Directionality of an image is measures by the frequency distribution of oriented local edges against their directional angles. It is a global property over a region. This texture feature given by tamura does not differentiate between orientations or patterns but measures the total degree of directionality in an image is given by Directionality. It is the most important feature given by tamura about matrix to distinguish from another image that how much uniform the region is.
- *Line-Likeness*- Line-Likeness in an image is average coincidence of direction of edges that co-occurred in the pairs of pixels separated by a distance along the edge direction in every pixel.
- *Regularity* - Regularity measures a regular pattern or similar that occurred in an image.
- *Roughness* **-** Roughness is the summation of contrast and coarseness measures.
  Roughness= Contrast + Coarseness

B. Haralick Texture Feature

Gray Level Co-occurrence Matrix (GLCM) a statistical method for examining texture features that consider the spatial relationship of pixels, also known as Gray Level Spatial Dependence. In this a GLCM matrix is created by calculating how often a pixel with the intensity value i occurs in a specific spatial relationship to a pixel with the value j. GLCM consists of frequencies at which two pixels are separated by a certain vector occur in the image. GLCM properties by which the distribution in the matrix will depends on the distance and angular or directions like horizontal, vertical, diagonal, anti-diagonal relationship between the pixels. Many statistical features of texture in an image are based on the co-occurrence matrix representing the second order of gray levels pixels relationship in an image. Various statistical and information theoretic properties of the co-occurrence matrices can serve as textural features and the limitation with these features are expensive to compute , and they were not very efficient for image classification and retrieval. Haralick [4] proposed 28 kinds of textural features each extracted from the Gray Level Co-occurrence Matrix. There are five features of Haralick Texture-

- *Contrast*- Contrast measures intensity between a pixel and its neighbor over the whole image and it is considered zero for constant image and it is also known as variance and moment of inertia.
- *Correlation* - Correlation measures how pixel is correlated to its neighbor over the whole image.
- *Entropy*- Entropy gives measures of complexity of the image and this complex texture tends to higher entropy.
- *Energy*- Energy is the sum of squared elements in the GLCM and it is by default one for constant image.

V. SHAPE FEATURE EXTRACTION

Shape is known as an important cue for human beings to identify and recognize the real-world objects, whose purpose is to encode simple geometrical forms such as straight lines in different directions. Shape feature extraction techniques can be broadly classified into two groups [10], viz., contour based and region based methods. The former calculates shape features only from the boundary of the shape, while the latter method extracts features from the entire region. For more details of image shape feature extraction and representation, please refer to the literature [10].

In addition, spatial relationship is also considered in image processing, which can tell object location within an image or the relationships between objects. It mainly includes two cases: absolute spatial location of regions and relative locations of regions. Figure 3 shows an example of a 2D string representation. The image in Figure 3(a) is decomposed into regions (blocks). For simplicity, the block identifiers are used as object symbols. Two relationship symbols ‘<’ and ‘=’ are used in this case. In horizontal and vertical directions, the symbol ‘<’ denotes ‘left-right’ and ‘below-above’ relationships respectively. The symbol ‘=’ means the spatial relationship ‘at the same spatial location as’. A 2D string takes the form (*u*, *v*), where *u* and *v* are the relationships of objects in horizontal and vertical directions respectively. Figure 3(d) shows the 2D string for the image of Figure 3(a).

d		
	b	c
a	a	

a

Object Symbols	a, b, c, d

b

Relationship symbols	Meaning
<	left-right or below-above
=	at the same spatial location as

c

$(a = d < a = b < c\ ,\ a = a < b = c < d)$ d

Figure 1[1]: Illustration of a 2D string:(a) an image decomposed into blocks,(b) object symbols as block names,(c) definitions of relationship symbols, and (d) a 2D string for (a)

A. Hu-Moment Shape Features

Hu-Moment [4] in 1962 proposed seven properties related to connected region that are invariant to rotation, scaling, and translation (RTS) and are also known as Algebraic Moment

Invariants. Moment invariants that are computed from each of the window are used to form feature vectors. They define simply calculated set properties of region that can be used for class identification and also identification of shape, and this classic technique for generating invariants in terms of algebraic was originally proposed by Hu.

Suppose R is an image, p+q, central moments or R forms as

$$\mu_{p,q}=\Sigma_{x,y}(x-xc)^p(y-yc)^q \quad (11)$$

(x_c, y_c) is the center of object .For scale –independent nature, central moments can be standardized as

$$\eta_{p,q}=\mu_{p,q}/\mu_0{}^2,0$$

$$\gamma=\frac{p+q+2}{2}$$

Based on these moments, Hu bring forward seven moments independence of translation, rotation and scaling.

$$\emptyset_1=\mu_{2,0}+\mu_{0,2} \quad (12)$$

$$\emptyset_2=(\ _{2,0}-\mu_{0,2})^2+4\mu_{1,1}{}^1 \quad (13)$$

$$\emptyset_3=(\mu_{3,0}-3\mu_{1,2})^2+(\mu_{3,0}-3\mu_{2,1})^2 \quad (14)$$

$$\emptyset_4=(\mu_{3,0}+3\mu_{2,1})^2+(\mu_{0,3}+3\mu_{2,1})^2 \quad (15)$$

$$\emptyset_5=(\mu_{3,0}-3\mu_{1,2})(\mu_{3,0}+3\mu_{1,2})[(\mu_{3,0}+3\mu_{1,2})^2-3(\mu_{2,1}+\mu_{0,3})^2]+(3\mu_{2,1}-\mu_{0,3})(\mu_{2,1}+\mu_{0,3}).[3(\mu_{3,0}+\mu_{1,2})^2-(\mu_{2,1}+\mu_{0,3})^2 \quad (16)$$

$$\emptyset_6=(\mu 2,0-\mu 0,2)[(\mu_{3,0}+\mu_{1,2})^2-(\mu_{2,1}+\mu_{0,3})^2]+4\mu_{1,1}(\mu)(\mu_{2,1}+\mu_{0,3}) \quad (17)$$

$$\emptyset_7=(3\mu_{2,1}-\mu_{0,3})(\mu_{3,0}+\mu_{1,2})[(\mu_{3,0}+\mu_{1,2})^2-3(\mu 2,1+\mu 0,3)^2]-(\mu_{3,0}-\mu_{1,2})(\mu_{2,1}+\mu_{0,3})[3(\mu_{3,0}+\mu_{1,2})^2-(\mu_{2,1}+\mu_{0,3})^2] \quad (18)$$

$\emptyset_7$, is the skew moment, and this skew invariant is valuable in recognizing mirror pictures. These moment utilized as a part of highlight extractions can be summed up to achieve design distinguishing proof, free of position, size and introduction as well as autonomously of parallel projection[4].

VI. CONCLUSION

Feature extraction is important for the pre-processing and the desired level of segmentation. In this paper, we have done a thorough study on different color, texture and shape feature extraction techniques. The color feature shows the color histograms and color moments (are mean, standard deviation and skewnes). The combination of tamura textural and shape Hu-moment feature vectors perform better than combination of GLCM Textural and shape moment invariant given by Hu. Using this paper, a quick study of feature extraction techniques maybe taken and it can be decided that which feature extraction technique will be better for the work to be done based on complexity, type of image (e.g. gray, color image).

VII. REFERENCES

[1] Dong ping Tian," A Review on Image Feature Extraction and Representation Techniques", International Journal of Multimedia and Ubiquitous Engineering Vol. 8, No. 4, July, 2013

[2] R.Venkata Ramana Chary1, Dr.D.Rajya Lakshmi2 and Dr. K.V.N Sunitha"Feature Extraction Methods For Color Image Similarity", Advanced Computing: An International Journal (ACIJ), Vol.3, No.2, March 2012

[3] N.Krishnaraj, "Feature Extraction Techniques in Keystroke Dynamics for Securing Personal Devices", International Journal of Computer Sciences and Engineering, Volume-03, Issue-03, Page No (98-101), Mar -2015

[4] Neelima Bagri1 and Punit Kumar Johari2, "A Comparative Study on Feature Extraction using Texture and Shape for Content Based Image Retrieval", International Journal of Advanced Science and Technology Vol.80 (2015), pp.41-52.

[5] A. K. Jain and A. Vailaya, "Image retrieval using colour and shape", Pattern Recognition, vol. 29, no. 8, (1996), pp. 1233-1244.

[6] M. Flickner, H. Sawhney, W. Niblack, et al., "Query by image and video content: the QBIC system", IEEE Computer, vol. 28, no. 9, (1995), pp. 23-32.

[7] G. Pass and R. Zabith, "Histogram refinement for content-based image retrieval", In Proc. Workshop on Applications of Computer Vision, (1996), pp. 96-102.

[8] J. Huang, S. Kuamr, M. Mitra, et al., "Image indexing using colour correlogram", In Proc. CVPR, (1997), pp. 762-765.

[9] D. S. Zhang, Md. M. Islam and G. J. Lu, "A review on automatic image annotation techniques", Pattern Recognition, vol. 45, no. 1, (2012), pp. 346-362.

[10] Priyarani S. Jagatap and Rupali R. Jagtap, "Electrocardiogram (ECG) Signal Analysis and Feature Extraction: A Survey", International Journal of Computer Sciences and Engineering, Volume-02, Issue-05, Page No (1-3), May -2014

[11] S. Mori Tamura and T. Yamawaki, "Textural Features Corresponding to Visual Perception", IEEE Transactions on Systems, Man and Cybernetics, vol. smc-8, no. 6, (1978) June, pp. 460-473.

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