CHAPTER 1

INTRODUCTION

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CHAPTER 1

INTRODUCTION

1.1 BRIEF OUTLINE OF THE CHAPTER

Texture Classification is most popular approach which is used in applications related to image processing and pattern recognition. This gives us the information about the distribution and arrangement of spatial data in an image.

A texture is a measure of intensity at the edges of the object, its density, roughness, regularity and uniformity. The main feature of texture image is to extract the surface properties of an object. We can say that it gives first look of the given surface or material. Because of this property many scholars do research on this particular topic.

From past four decades a rapid growth occurred in texture classification and its application in computer vision algorithms for better recognition and detection process.

Texture gives significant data related to image which is used to analyze its content. Image-analysis can be defined as a quality of the content present in an image and it’s a process of monitoring or analyzing this content in medical and remote sensing applications. Many researchers have focused their interest in the field of texture classification and still many are in progress; however this topic is a challenging task to many of researchers and scientists due to the lack of accurate results.

This chapter presents a brief overview of image processing and its applications. It explains the need and applications of image classification and different properties of the digital image on which it can be classified. It also presents the aims and objectives of the research work.

1.2 INTRODUCTION TO IMAGE CLASSIFICATION

In this 21’st century to understand the world or to communicate the people most of the companies and government organizations are using images and graphics which give more information regarding their thoughts and views. Internet and digital image
techniques are giving more pictures. But still there is a huge demand and requirement for the efficient image indexing and classification method. Image classification is the most widely used concept in the stream of pattern recognition and image mining.

Image texture is defined as a function of variations that are present in the spatial data / pixel intensities. Many scholars are doing their research work on image texture because it plays a vital role in image classification. Image texture is used in various applications. It is applicable in many practical vision systems like projectors, LCD’s etc. This also includes the applications related to object recognition and classification like bio-medical-imaging, segmentation and classification of satellite imagery, and pattern recognition.

Pattern recognition is the main process involved in computer vision applications in Artificial Intelligence (AI). The aim is to acknowledge pattern counting and their data, information or its options.

Generally, pattern recognition applications comprise of 3 stages:

- Preprocessing.
- Feature extraction and
- Recognition/Classification.

In pre-processing, the image is corrected before entering the actual algorithm for computations it involves removal of noise content, correcting the skew angle, normalizing and block segmentation.

In feature extraction stage, the characteristic features of the image content are extracted through some feature descriptor algorithms or transforms.

In classification stage, with the use of extracted features the given object in a image is recognized to its corresponding object in a unknown image or sometimes it may be classified to its corresponding class or category [1].

The main objective of image classification is finding the objects which are presented in that particular image while using computer [2]. All image processing operations typically aim at a stronger recognition of objects of interest, i.e., at finding appropriate
native options that may be distinguished from different objects and from the background.

The application mentioned in this work is recognition of image regions using texture properties. One will determine total different textures and their identities with different texture options or primitives. Textures are the most vital visual cue in distinguishing these kinds of homogenized regions in an image. A texture arrangement may be an automatic data processing system for browsing, searching, recognizing, examination and classifying images from an oversized volume of digital pictures.

The main intention of the texture classification is to retain a map of the input image in which the texture content is categorized as class to which it belongs. In image processing and pattern recognition the technique being used is texture classification, mainly motivated by the fact that information about the arrangement and spatial properties of image fundamental components.

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**Fig. 1.1** Block diagram of image classification system

A model of texture classification system is presented in the Fig. 1.1, it can be seen that all the data, to be processed by the classification systems.

In this unknown images will be passed at three various levels.

- First passes through a preprocessing stage.
- Second feature extraction stage.
- Third classification stage
In the pre-processing stage it should serve for two purposes.

- Initially at this stage the spatial has to be normalized in order to eliminate the undesirable changes like illumination variation, variation in resolution, digitization etc.
- The second step is texture feature extraction.

Texture feature extraction is the process of generating metaphors of the textured surface with some computable parameters. These extracted features with its distinctive feature elements are classified with the use of a classifier. For instance, the spatial features like local luminance which describe the illumination variation, and entropy, co occurrence properties are used to describe the texture feature. The edges and contours of the object are defined by using some edge operators like canny and Sobel [3].

Feature extraction is the process where the distinctive quantitative parameters /elements used for describing a group of spatial elements referred as a feature vector. The choice of appropriate expressive parameters will drastically influence the consistency and efficiency of subsequent feature qualification through classification.

These extracted features significantly represent the properties of surface and may be used for classification with a classifier. In many of the applications these features are fed to application independent and numerical dependent classifiers like support vector machines [4-7], Artificial Neural Networks [8-12] etc. Depending on the values of training feature vector the classifier will decide an unknown vector to the class to which it belongs. In most of all the classification applications texture features play a vital role in classifying the feature vector.

1.3 PROPERTIES OF NATURAL IMAGES

In this section, the properties of natural images are explained briefly. These properties are defined based on the image modeling enabling the description of spatial content.
1.3.1 Self Similarity

Several objects across the globe are similar and components corresponding to them show equivalent statistical properties at different instants. Such objects are said to be self similar. The self similarity will be relation to the shape of the object like mountains or coastlines.

1.3.2 Adaptive-ness of spatial content

Real world images strongly exhibits this adaptive-ness, though they are composed of several textures, edges and many. The importance of this spatial adaptivity is very much observed in problems like denoising and de-blurring. However considering this varying feature may be a tough task in parameterization.

A minimum of one per pixel could in-evitable cause over fitting problems, since the non-stationary parameters will adapt additional to the noise other than the underlying signal, if they are not subject to any constraint.

1.3.3 Inter-scale persistence

Multi resolution transforms like wavelets are used to analyze the scale invariant spatial data. This helps to consider the spatial invariance and scale invariance as two individual property of the image. Each digital image do consists of different scales and time durations which are high and low value of the coefficient leading to the high and low value in next level of scale decomposition. This sought of process is a demerit for any transformation technique to de-correlate an image.

1.3.4 Intra-scale dependencies

Let us consider two sub bands of the same scale but with different orientations. One can find that similar spatial content can found at different decomposition sub bands. There are certain regions which are isotropic in nature and contain the details like smooth areas and round features, which are naturally found at all orientations. This shows again that multi scale transforms do not perfectly de-correlate the information contained in natural images.
1.4 IMPORTANCE OF TEXTURE IN IMAGE CLASSIFICATION

Different elements or objects in the universe do consist of texture which are considered as the appearance of that surface or object. Look at the cloud in the sky and ridges on your finger both represents different and are differ in various aspects. The variations in the line patterns that appear on the finger print represent a unique biological marker for human being. While in the sky the cloud represents different shapes these two observations implies the variation of textures of the objects. The appearance of the texture greatly differed from the angle from where it is observed, for instance the fingerprint look almost flat when looked from a distance. Apart from this aspect the texture is greatly depends on the environment and illumination conditions. Based on these factors it becomes very critical in defining the texture.

Over decades the properties of texture are studied in various applications this includes medical image processing, remote sensing, pattern recognition, Industrial defect/object detection, Image retrieval systems and many. In all these applications the perception and the properties of texture are used for interpretation and recognition. From some of the literature the texture content in an image is described by the number of primitives and its types present in it. This may be a pair wise dependence or neighboring dependence or it may have ‘n’ primitives at a time.

In image-processing for the applications like pattern recognition texture, is the key feature by which it can be discriminated. The use of these concepts is applied in analyzing multispectral image that are captured using high dynamic ranging cameras in satellites and also in analyzing the minute details of micro scope images containing cells and tissue samples. Texture feature plays a key role in quality control. In many of the inspection the defectiveness of an object can be found from its texture analysis. This is one of the main reasons why this texture analysis is of great demand in research area.

In literature many researchers have presented their definitions on texture and there is no such definition is presented which is universally agreed [15].
In Early 1970, Haralick et al [16] were very much conscious about defining the term texture. In 1990’s Bovik et al [17] has presented a definition for texture. It says that texture cannot formulate exactly either a surface or image content. Some of the researchers in later stages have also shared these opinions [18].

Image is captured by a digital imaging device (camera) and is stored image as pixels. These pixels are non-homogenous at some areas, where there is a significant change in intensity or pixel levels. These areas correspond to the texture content; this may be occurred due to the roughness of the surface and low resolution. However, one can understand that every object in the environment is not flat or uniform and there are various imaging applications that utilize these properties in recognizing. The roughness or fine details or textures can categorized based on their physical appearance this may be fine, coarse, smooth, regular, irregular [19]. Tamura et al [20] studied how differently human differentiates the subjects based on their textures. He presented that humans find this in their psycho-logical experiments with such properties like coarseness, contrast and directionality. However mathematical analyses of these properties are very poor. Rao & Lohse [21] has presented 3 important points of human perception. He mentioned the properties or variations like receptiveness versus irregularity, directional versus non-directional and structurally complex versus simple.

1.5 IMPORTANCE OF TEXTURE CLASSIFICATION

Texture analysis is the one of the important aspect of interpreting the digital images. Though there is a repetition of the spatial data there is a large variation in representing object in it. There are many applications like segmentation, texture synthesis, extraction of shape information and classification. The present research is focused on the classification and the issues related to it.

The main problem related texture classification is how one can find out the distinctive set of features that comprises the exact texture content. This problem was attempted earlier by many researchers and a large set of texture features were proposed to serve the purpose of classification.
To analyze this sought of large set of features is a typical problem in classification which may lead to inaccuracy and high complexity. One of the solutions for this is to use a small set of features which hold most of the significant feature that are primarily sued to distinguish in very best manner. This process reduces overall complexity, dimensionality, computational complexity involved in deriving unnecessary feature.

There are multiple variations of texture in the image which affects the classification process and feature extraction [22]. One of the major constraints is scale of capture, which determines the quality. Low resolution and illumination are few more constraints that affect the quality of the image. For all these above constraints the overall quality of the image is degraded which makes it difficult to extract the features there by decreasing in classification rate [23].

The present research concentrates on finding a best matching category for a given texture among the existing textures using texture features and weighted finite automata.

1.6 OBJECTIVES OF PRESENT RESEARCH

The main contribution of this research is to provide an efficient image texture classification algorithm which is suitable for different types of textures. The objectives of present research includes

1. To enhance the quality of the images by quadratic programming and analyze the concept of regular bands for texture segmentation that can be used in defect detection.

2. To extract the texture content using different binary and ternary patterns. Also it includes the concept of steerable filter decomposition and Zernike moments for scale and translation invariant texture content.

3. To analyze the efficiency of binary and ternary patterns for feature extraction using Support Vector Machines (SVM), K-Nearest Neighborhood (KNN).
4. To formulate the concept of finite automata to images and incorporate it for texture classification.

5. To apply weighted finite automata for classification and evaluate its performance under different constraints.

6. To evaluate the performance of the proposed approaches for texture content extraction and classification on standard image database and also on real time fabric images.

1.7 ORGANIZATION OF THE THESIS

Texture analysis and detection is the key process discussed in this thesis.

The remaining part of the thesis is organized as follows

Chapter 2 explains about the types of textures for classification and brief discussion of various methods implemented earlier; their merits and limitations.

Chapter 3 presents the parameters used for the texture representation and extraction using binary and ternary patterns. The results that are obtained with experimental data sets for binary and ternary patterns with different parameters and classifiers are presented.

Chapter 4 gives a clear explanation of Finite State Machine (FSM) and its role in the texture content extraction and classification.

Chapter 5 explains about the emergence of weighted finite automata and its advantage over conventional FSM for texture content extraction and classification.

Chapter 6 presents the conclusions and future scope.