Chapter-1

Introduction

1. Introduction

Computer vision is based on high-level image processing and the cognition process is tightly bound to prior knowledge about image content. The image is mapped to formalized model of the world [1], but this model does not remain unchanged. The computer switches to low-level image processing to find the information needed to update the model. The process is then repeated iteratively and the ‘understanding’ becomes a co-operation between top down and bottom up processes.

Low-level computer vision techniques almost overlap with digital image processing, which has been practiced for decades. Image’s capture, its digitization, pre-processing such as noise suppression and enhancement techniques and some preliminary image analysis etc. comprise this layer of image understanding followed sometimes by edge extraction. Image segmentation is the next step, in which the computer tries to separate objects from the image background or from each other. Object recognition and classification in a totally segmented image is considered to be an important task in the process of image understanding.

The present investigation is concerned with problem areas in high-level image understanding in which the property "texture" plays an important role. Being an intrinsic feature of realistic objects, texture [2] gives important information about depth and orientation of objects. Texture [3] refers to the properties that represent the surface or structure on an object (in reflective and transmissive images respectively). It is intuitively obvious and something, which consists of mutually, related elements called texture primitives. The texture described is highly dependent on number of pixels in texture primitive (texture scale). People describe texture as fine, coarse, smooth, rough, regular, directional, grainy, line-like, macro, micro etc. implying that some more features must be defined to make machine recognition possible. Such features can be found in the tone and structure of texture. Tone is based mostly on pixel intensity properties in the primitives while structure is spatial relationship between primitives. Texture can be classified as artificial or natural. Artificial texture [4] consists of arrangements of symbols
such as line segments, dots, stars etc. placed against a neutral background. Natural textures are images of natural scenes, containing semi repetitive arrangements of pixels.

There is no universally accepted definition for texture. Part of the difficulty in giving a definition of texture is the extremely large number of attributes of texture [5] that we would like to subsume under definition. Despite the lack of a universally agreed definition, all researchers agree on two points.

- There is significant variation in intensity levels between nearby pixels, at the limit of resolution, there is non-homogeneity.
- Texture has a homogeneous property at some spatial scale larger than the resolution of the image.

1.1 Some Definitions of Texture

Texture is an important surface characteristic, which is used to identify and recognize objects. The texture of an image may be thought as something, which describes the characteristics of the intensity surface of the image. Intensity can be measured at resolution of a single pixel, whereas texture can only be perceived from an image region, which is large enough. Compared with intensity, texture is more of a global property [4, 6, 7, 8, 9, 10].

- The Longman Dictionary:
  Something composed of closely interwoven elements or an organisation of constituent particles of a body or substance; and the visual or tactile surface characteristics and appearance of something (e.g. fabric).
- Haralick et al:
  The image texture we consider is non-figurative and cellular. An image texture is described by the number and types of its (tonal) primitives and the spatial organisation or layout of its (tonal) primitives.
- Bovik, Clark and Gelsler:
  An image texture may be defined as a local arrangement of image irradiances, projected from a surface patch of perceptually homogeneous irradiances.
- Jain and Karu:
  Texture is characterized not only by the gray value at a given pixel, but also by the gray value ‘pattern’ in a neighborhood surrounding the pixel.
1.2 Application Areas

The exact applications of texture in image understanding are:

- Segmentation of an input image into regions of homogeneous textures
- Classifying images based on their textures and use the classification process for retrieving images of similar textures from database
- Synthesizing textures that resemble natural images for various computer graphics applications
- Extracting surface shape information from texture gradient.
- Realism in computer graphics and image encoding

The broad application areas and possibilities are almost unlimited. To mention a few, automated industrial surface inspection, automatic diagnosis of diseases from x-ray images, recognition of clouds from meteorological satellite data, localization of forests from remotely sensed data, biometric person authentication etc. Even though there are many potential areas of texture applications, only a limited number of successful exploitations exist so far, because the real world textures are often non-uniform and susceptible to changes in orientation, scale and other visual appearances [15, 16].

1.3 Some Texture Pictures
Fig 1.1 (a) Reptile skin (b) Woven aluminum wire (c) Brick wall (d) Lizard skin.

1.4 Problem statement

There are three major issues in texture analysis:
1) Feature extraction: To compute a characteristic of a digital image able to numerically describe its texture properties.
2) Texture discrimination: To partition a textured image into regions, each corresponding to a perceptually homogeneous texture.
3) Texture classification: To determine to which of a finite number of physically defined classes (such as normal and abnormal tissue) a homogeneous texture region belongs.

Feature extraction is the first stage of image texture analysis. Results obtained from this stage are used for texture discrimination, texture classification or object shape determination. This review is confined mainly to feature extraction and texture classification techniques. Texture has been one of the most important characteristics which have been used to classify and recognize objects and scenes.

1.5 Texture Classification
Most natural surfaces and naturally occurring patterns exhibit texture. A texture classification system is, therefore, a natural constituent of many computer vision systems. The problem is that, given a texture region, to decide which of a finite number of classes that it belongs to? If the classes have not been defined a priori, the task is referred to as unsupervised texture classification. On the other hand, if the classes have already been defined through the use of training textures, then the process is referred to as supervised texture classification and classification accuracy can refer to the percentage of correctly classified texture samples [7, 11].