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DSP in image processing

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Abstract: Vision extracts useful information from images. Reconstructing the three-dimensional structure of our environment and recognizing the objects that populate it are among the most important functions of our visual system. Computer vision researchers study the computational principles of vision and aim at designing algorithms that reproduce these functions. Vision is difficult: the same scene may give rise to very different images depending on illumination and viewpoint. Typically, an astronomical number of hypotheses exist that in principle have to be analyzed to infer a correct scene description. Moreover, image information might be extracted at different levels of spatial and logical resolution dependent on the image processing task. Knowledge of the world allows the visual system to limit the amount of ambiguity and to greatly simplify visual computations. We discuss how simple properties of the world are captured by the Gestalt rules of grouping, how the visual system may learn and organize models of objects for recognition, and how one may control the complexity of the description that the visual system computes.

Keyword: Image Processing, Spatial and Logical Resolution, Visual system.

I. INTRODUCTION

In imaging science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Image processing usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images (producing the input image in the first place) is referred to as imaging. Closely related to image processing are computer graphics and computer vision [1]. In computer graphics, images are manually made from physical models of objects, environments, and lighting, instead of being acquired (via imaging devices such as cameras) from natural scenes, as in most animated movies. Computer vision, on the other hand, is often considered high-level image processing out of which a machine/computer/software intends to decipher the physical contents of an image or a sequence of images (e.g., videos or 3D full-body magnetic resonance scans)[1,2].In modern sciences and technologies, images also gain much broader scopes due to the ever growing importance of scientific visualization (of often large-scale complex scientific/experimental data). Examples include microarray data in genetic research, or real-time multi-asset portfolio trading in finance. Image Processing is a technique to enhance raw images received from cameras/sensors placed on satellites, space probes and aircrafts or pictures taken in normal day-to-day life for various applications. Various techniques have been developed in Image Processing during the last four to five decades. Most of the techniques are developed for enhancing images obtained from unmanned spacecrafts, space probes and military reconnaissance flights. Image Processing systems are becoming popular due to easy availability of powerful personnel computers, large size memory devices, graphics software etc.

Image Processing is used in various applications such as:

- Remote Sensing
- Medical Imaging
- Non-destructive Evaluation
- Forensic Studies
- Textiles
- Material Science
- Military
- Film industry
- Document processing
- Graphic arts
- Printing Industry

II.INTRODUCTION TO IMAGE PROCESSING

A) What is an image: An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows. In a (8-bit) grayscale image each picture element has an assigned intensity that ranges from 0 to 255[3,4]. A grey scale image is what people normally call a black and white image, but the name emphasizes that such an image will also include many shades of grey. A normal grayscale image has 8 bit colour depth = 256 grayscales. A "true colour" image has 24 bit colour depth = 8 x 8 x 8 bits = 256 x 256 xcolour= ~16 million colours.

B) Colours: For science communication, the two main colour spaces are RGB and CMYK. RGB the RGB colour model relates very closely to the way we perceive colour with the r, g and b receptors in our retinas. RGB uses additive colour mixing and is the basic colour model used in television or any other medium that projects colour with light. It is the basic colour model used in computers and for web graphics, but it cannot be used for print production. The secondary colours of RGB - cyan, magenta, and yellow - are formed by mixing two of the primary colours (red, green or blue) and excluding the third colour. Red and green combine to make yellow, green and blue to make cyan, and blue and red form magenta. The combination of red, green, and blue in full intensity makes white.

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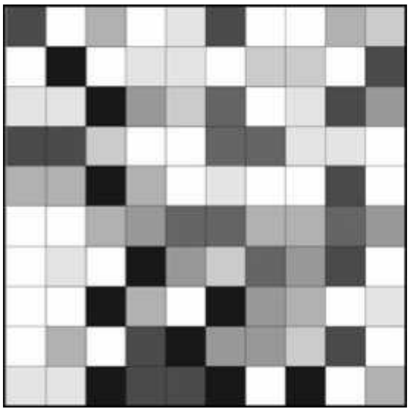

Fig1: Each pixel has a value from 0 (black) to 255 (white). The possible range of the pixel values depend on the depth of the image, here 8 bit = 256 tones or grayscales.

In Photoshop using the "screen" mode for the different layers in an image will make the intensities mix together according to the additive colour mixing mode[4]l. This is analogous to stacking slide images on top of each other and shining light through them.

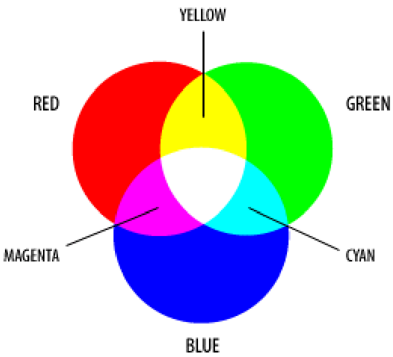

Fig 2: The additive model of RGB. Red, green, and blue are the primary stimuli for human colour perception and are the primary additive colours. Courtesy of adobe.com.

Image processing is the study of any algorithm that takes an image as input and returns an image as output.

C) Includes: Image display and printing**,** Image editing and manipulation**,** Image enhancement**,** Feature detection**,** Image compression

D) Relationship to Other Fields: Image Analysis involves extracting meaningful information from an image. Image segmentation**,** Image matching and comparison**,** Medical diagnosis from an image Computer Vision strives to emulate the human visual system and interpret our 3D world from 2Dimages or video. Object recognition**,** Motion tracking**,** 3D shape from multiple 2D images[5,6].

E) Computer Vision: **O**bject detection, recognition, shape analysis, tracking Use of Artificial Intelligence and Machine

F) Image Processing: Image enhancement, noise removal, restoration, feature detection, compression

G) Relationship to Graphics and Visualization: Computer Graphics and Visualization deal with the synthesis of images. Image processing techniques are often used to improve the visual quality of synthesized images

Examples: Image enhancement, Compression, Image warping, blending and morphing

H) Mathematics in Image Processing
Calculus
Linear Algebra
Probability and Statistics
Differential Equations (ODEs and PDEs)
Differential Geometry
Harmonic Analysis (Fourier, wavelets, etc)

III. DIGITAL IMAGE PROCESSING

In this case, digital computers are used to process the image. The image will be converted to digital form using a scanner digitizer (as shown in Figure 1) and then process it. It is defined as the subjecting numerical representations of objects to a series of operations in order to obtain a desired result. It starts with one image and produces a modified version of the same. It is therefore a process that takes an image into another. The term digital image processing generally refers to processing of a two-dimensional picture by a digital computer[6]. In a broader context, it implies digital processing of any two-dimensional data. A digital image is an array of real numbers represented by a finite number of bits. The principle advantage of Digital Image Processing methods is its versatility, repeatability and the preservation of original data precision.

The various Image Processing techniques are:

- Image representation
- Image preprocessing
- Image enhancement
- Image restoration
- Image analysis
- Image reconstruction
- Image data compression

IV. IMAGE REPRESENTATION

An image defined in the "real world" is considered to be a function of two real variables, for example, f(x,y) with f as the amplitude (e.g. brightness) of the image at the real coordinate position (x,y). The effect of digitization is shown in Figure 3. The enhancement process itself does not increase the inherent information content in the data. It simply emphasizes certain specified image characteristics. Enhancement algorithms are generally interactive and application-dependent. As shown in figure a kind of array matrix is used in matlab. [7] By using matlab tool we can convert the image. Here we are converting a kind of array matrix using matlab tool. As shown in figure divisons of rows and columns occur using array matrix and image is converted into pixel as shown in figure and in this way image is converted into desired form.

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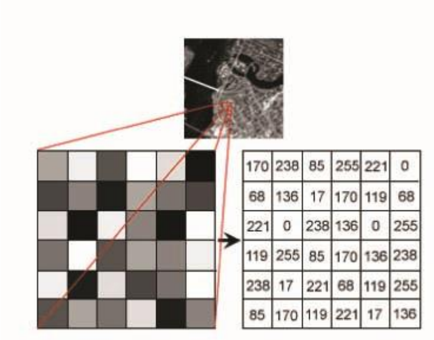

Figure 3: Divison of rows and columns

The 2D continuous image f(x,y) is divided into N rows and M columns. The intersection of a row and a column is called as pixel. The value assigned to the integer coordinates [m,n] with {m=0,1, 2,...,M-1} and {n=0,1,2,...,N-1} is f[m,n]. In fact, in most cases f(x,y)--which we might consider to be the physical signal that impinges on the face of a sensor. Typically an image file such as BMP, JPEG, TIFF etc., has some header and picture information. A header usually includes details like format identifier (typically first information), resolution, number of bits/pixel, compression type, etc[8,9].

V. IMAGE PREPROCESSING

A) Scaling: The theme of the technique of magnification is to have a closer view by magnifying or zooming the interested part in the imagery. By reduction, we can bring the unmanageable size of data to a manageable limit. For resampling an image Nearest Neighborhood, Linear, or cubic convolution techniques are used.

B) Reduction: To reduce a digital image to the original data, every mth row and mth column of the original imagery is selected and displayed. Another way of accomplishing the same is by taking the average in 'm x m' block and displaying this average after proper rounding of the resultant value.

Advantages

- No scaling no associated resampling degradations.
- Shear can be implemented very efficiently

VI. IMAGE ENHANCEMENT TECHNIQUES

Sometimes images obtained from satellites and conventional and digital cameras lack in contrast and brightness because of the limitations of imaging sub systems and illumination conditions while capturing image. Images may have different types of noise. In image enhancement, the goal is to accentuate certain image features for subsequent analysis or for image display[10]. Examples include contrast and edge enhancement, pseudo-coloring, noise filtering, sharpening, and magnifying. Image enhancement is useful in feature extraction, image analysis and an image display. The enhancement process itself does not increase the inherent information content in the data. It simply emphasizes certain specified image characteristics. Enhancement algorithms are generally interactive and application-dependent.

Some of the enhancement techniques are:

- Contrast Stretching
- Noise Filtering
- Histogram modification

A) Contrast Stretching

Some images (eg. over water bodies, deserts, dense forests, snow, clouds and under hazy conditions over heterogeneous regions) are homogeneous i.e., they do not have much change in their levels. In terms of histogram representation, they are characterized as the occurrence of very narrow peaks. The homogeneity can also be due to the incorrect illumination of the scene.

B) Histogram Modification

Histogram has a lot of importance in image enhancement. It reflects the characteristics of image. By modifying the histogram, image characteristics can be modified. One such example is Histogram Equalization.
Histogram equalization is a nonlinear stretch that redistributes pixel values so that there is approximately the same number of pixels with each value within a range. The result approximates a flat histogram. Therefore, contrast is increased at the peaks and lessened at the tails.

C) Noise Filtering

Noise filtering is used to filter the unnecessary information from an image[11]. It is also used to remove various types of noises from the images. Mostly this feature is interactive. Various filters like low pass, high pass, mean, median etc.,

VII. IMAGE ANALYSIS

Image analysis is concerned with making quantitative measurements from an image to produce a description of it. In the simplest form, this task could be reading a label on a grocery item, sorting different parts on an assembly line, or measuring the size and orientation of blood cells in a medical image. More advanced image analysis systems measure quantitative information and use it to make a sophisticated decision, such as controlling the arm of a robot to move an object after identifying it or navigating an aircraft with the aid of images acquired along its trajectory. Image analysis techniques require extraction of certain features that aid in the identification of the object. Segmentation techniques are used to isolate the desired object from the scene so that measurements can be made on it subsequently [12]. Quantitative measurements of object features allow classification and description of the image.

VIII. IMAGE SEGMENTATION

Image segmentation is the process that subdivides an image into its constituent parts or objects. The level to which this subdivision is carried out depends on the problem being solved, i.e., the segmentation should stop when the objects of interest in an application have been isolated e.g., in autonomous air-to-ground target acquisition, suppose our interest lies in identifying vehicles on a road, the first step is to segment the road from the image and then to segment the contents of the road down to potential vehicles. Image thresholding techniques are used for image segmentation.

IX. CLASSIFICATION

Classification is the labeling of a pixel or a group of pixels based on its grey value. Classification is one of the most often used methods of information extraction. In Classification, usually multiple features are used for a set of pixels i.e., many images of a particular object are needed. In Remote Sensing area, this procedure assumes that the imagery of a specific geographic area is collected in multiple regions of the electromagnetic spectrum and that the images are in good registration. Most of the information extraction techniques rely on analysis of the spectral reflectance properties of such imagery and employ special algorithms designed to perform various types of 'spectral analysis'. The process of multispectral classification can be performed using either of the two methods: Supervised or Unsupervised [13,14].

In Supervised classification, the identity and location of some of the land cover types such as urban, wetland, forest etc., are known as priori through a combination of field works and toposheets. The analyst attempts to locate specific sites in the remotely sensed data that represents homogeneous examples of these land cover types. These areas are commonly referred as TRAINING SITES because the spectral characteristics of these known areas are used to 'train' the classification algorithm for eventual land cover mapping of reminder of the image. Multivariate statistical parameters are calculated for each training site. Every pixel both within and outside these training sites is then evaluated and assigned to a class of which it has the highest likelihood of being a member.

IX. CONCLUSION

In an Unsupervised classification, the identities of land cover types has to be specified as classes within a scene are not generally known as priori because ground truth is lacking or surface features within the scene are not well defined. The computer is required to group pixel data into different spectral classes according to some statistically determined criteria. The comparison in medical area is the labeling of cells based on their shape, size, color and texture, which act as features. This method is also useful for MRI images.

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