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Visual Cryptography for Color Images

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Abstract: *"An image is worth a thousand words."*
This aphorism is indeed true. Huge amount of data available to us is in form of images which makes image processing an indispensable operation. Digital Image Processing is a rapidly growing field with vast applications in science and engineering. Image processing developing the machine that could perform the visual functions over an image and words.
This paper addresses to following:

- *Digital Image Processing.*
- *Image Representation (acquisition, digitization and display).*
- *Image Perception.*
- *Image Enhancement.*
- *Image Restoration.*
- *Image Data Compression.*

This paper suggests various algorithms for these processes and the research work done in the respective field.
Keywords: *Visual Cryptography, halftonning, secret sharing scheme, Error diffusion.*

I. Introduction

The term *digital image processing* refers to processing of a 2D/3D picture by a digital computer. A genealogy photo can be greatly improved by photo enhancement process as shown below.

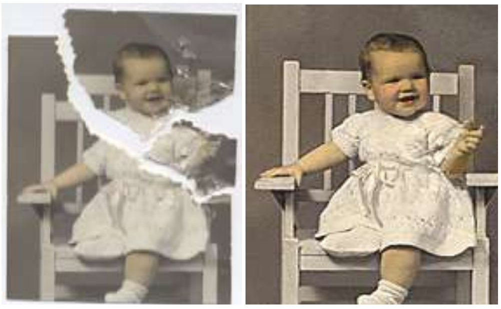


Figure 1. *Reconstructing a torn picture*

An image processing problem can have following basic classes:
I. Image representation and modeling.
II. Image perception.
III. Image enhancement.
IV. Image restoration.
V. Image analysis.
We are going to consider each of these processes, their application, the research work done on each and latest technologies.

II. Image Representation And Modeling.

In image representation one is concerned with elaborate of the quantity that each pixelrepresents. An image could represent luminance of objects in a scene (such as *picture taken by ordinary camera*), the absorption characteristics of body tissue (*X-ray imaging*), the radar cross section of a target (*Radar imaging*), temperature profile of a region (*Infrared imaging*), or the gravitational field in an area (*Geophysical imaging*). In general, any 2d values function that bears more over information can be an image.

An important image representation is the intelligibility criteria for verifying the quality of an image. Specifications of such measures require models of perception of contrast, spatial frequencies, colors etc.

Knowledge of fidelity criterion helps in designing the imaging sensor, because it tells us the variables that should be measured most accurately.

2.1 Image.

An image may be defined as a 2d function f(x, y), where x = spatial(plane), y= spatialcoordinates, and the amplitude of f at any pair of coordinates (x, y) called the *intensity* or *gray level* of the image at that point.

An image is usually represented by an array or grid of pixels stored in raster order, appropriate for loading into a frame buffer. Each pixel is represented using some color system.
Images can also be considered as *spatial waveform.* For each point on the image, a particular color is seen. So the spatial waveform is described by how the color changes as we move across the image.

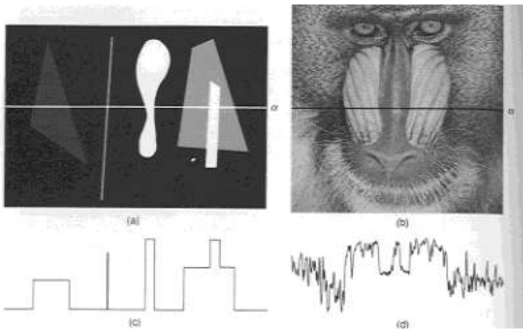


Figure 2.*Constructing spatial waveforms*

III. Image Perception.

Image Perception is Visual detection of details having a certain level of contrast to their surroundings, or recognition of patterns in an image. Image perception is intimately connected to the psychophysical properties of the visual system of the observer, i.e. the ability of the observer to respond to low-contrast and fine-detail stimuli.

Detection and recognition of objects in an image having very faint contrast to its surroundings is a task for which the eye is particularly suited. The human eye can in favorable geometrical and light conditions discern contrast objects with relative contrast difference as low as 1.2% on a grey scale (where black is 0% and white is 100%). However, the eyes ability to detect low-contrast objects is strongly dependent on how clearly the edge of an object is reproduced in the image. This is closely related to the noise level in the image. Higher the noise, the lower the detect ability of a low-contrast object. Also, smaller objects of a certain contrast level are more difficult to detect than larger objects.

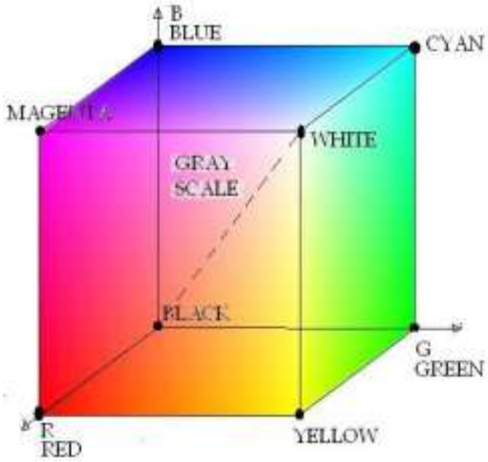
The human brain instinctively searches for geometrical patterns of objects in an image, such as border lines preferring well-known figures such as circles, rectangles and triangles and tries to form those objects. This phenomenon is especially important when digital images are examined. It is of vital importance that the viewing distance is long enough that the pixels cannot be distinguished individually and thus be seen as squares. Otherwise, the faculty of vision gives priority to identification of the square-shaped objects rather than to combining them into a larger object within the image. It is therefore extremely important that, for digital images, the viewing distance is sufficiently long that separate pixels cannot be discerned.

The resolution properties of the eye are dependent on both the contrast level and the light intensity impinging on the eye. The resolution limit for a very bright image (light box illumination) is 60 line pairs per degree at 100% contrast (full light - no light) and for a cathode ray tube CRT monitor with significantly lower luminance it is around 30 line pairs per degree.

IV. Color Model.

4.1. RGB.

All color is represented like proportions of **R**ed, **G**reen, and **B**lue light, when combined produce the color. This model represents color in Cartesian coordinate system as shown below:



V. Image Enhancement.

Image tremendoustechniques are used to extract and sharpen image features for display and analysis. Figure 12. Shows the importance of the application giving the feedback from the output image back to the start of the

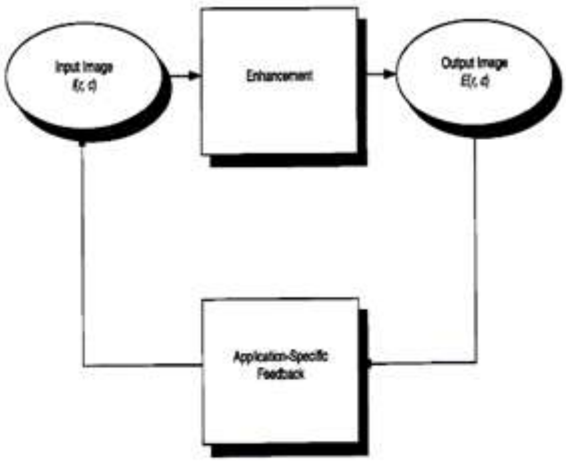


Figure 12.*The Image Enhancement Process*

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VI. Image Transformation.

- edit (paint)
- rotate, scale a set of pixels
- BLIT : Block Transfer -- move a block of pixels all at once
- compositing: combining multiple images
  - Alpha channel: defines regions of full or partial transparency
  - Logical operations: combine a source pixels (or block) with a destination pixel (or block) by computing a logical operation on the pixel values (XOR, AND, OR). Can yield unpredictable results for color images, esp. indexed color.
  - Arithmetic operations: combine source and destination pixels with operations such as add, subtract, etc. Works best with direct color representations.
- Convolution (filtering):
- Warping - Distort, Morph etc.

VII. Image Compression.

Image compression is recognized as an "enabling technology".Thus an ever expanding number of applications depend on the efficient manipulation, storage and transmission of binary, gray scale and color images.

The MSE is squared errorin between the value compressed which is original image, whereas PSNR is a measure of the peak error. A lower value for MSE means lesser error, and since MSE and PSNR are inversely related, it translates to a high value of PSNR.

The steps involved in compressing an image are

1. The Rate (bits available) and Distortion (tolerable error) parameters for the target image.
2. Each class the bit allocation information derived in step separated.
3. Each class encoded by separately using an entropy coder and write to the file.

This is how 'most' image compression techniques work. But there are exceptions. One example is the Fractal Image Compression technique, where possible self similarity within the image is identified and used to reduce the amount of data required to reproduce the image.

Reconstructing the image from the compressed data is usually a faster process than compression. The steps involved are

1. Read in the quantized data from the file, using an entropy decoder. (reverse of step 5).
2. Dequantize the data. (reverse of step 4).
3. Rebuild the image. (reverse of step 2).

VIII. Conclusion

Digital image processing finds innumerable applications in digital signal processing. A number of fields of application of DIP are in medical imaging, satellite imaging etc. In medical imaging various techniques are used to process images like magnetic resonance imaging etc. These techniques have made the work of doctors easy and efficient. Similarly in satellite communication also DIP has brought a revolution. DIP will also play a major role in the robots that will be made in 21st century. Besides artificial intelligence efficiency of robots will be judged by how well they can perceive images. This will also be a measure of their smartness.

Another application of image processing is in "Smart Homes" where home appliances will have to process a lot of digital data. This especially includes the devices that employ Biometric Security. Here the devices have to process the images of body parts like Iris, Finger print, face etc. This involves a lot amount of image processing. Some schools have even started taking attendance by Iris recognition.

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