CS 4059
Fundamentals of Computer Vision

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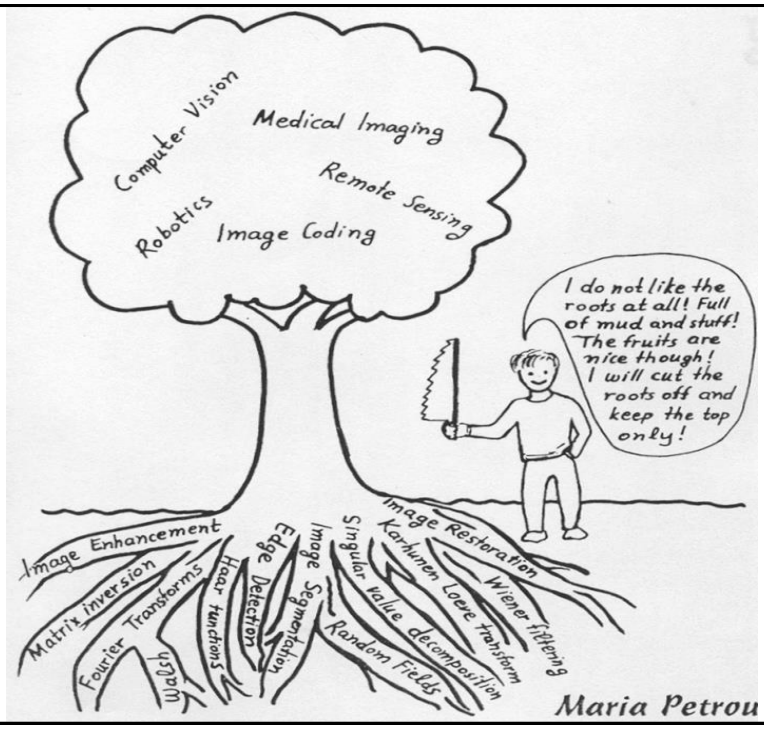
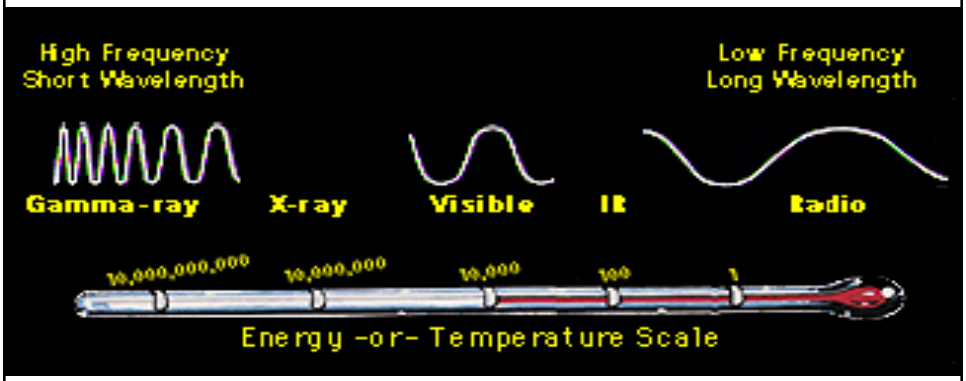


Electromagnetic Radiation

- **The EM spectrum spans many useful radiations used in imaging**:



- **We will usually demonstrate images from the visible spectrum**
- **This is a very narrow piece of radiated world-information !**

Computer Imaging

- Acquisition and processing of visual information by computer
- Divided into two primary application areas:
  1. Computer vision
  2. Image processing
     - With Image analysis being a key component in the development and deployment of both

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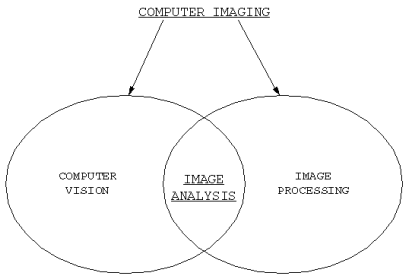
Figure 1.1-1: COMPUTER IMAGING



Computer imaging can be separated into computer vision and image processing applications, with image analysis being part of both

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Image Analysis and Computer Vision

- Image analysis involves examination of image data to facilitate solving an imaging problem
- A computer vision application can be considered to be a deployed image analysis system
- In a computer vision system the images are intended to be “seen” by a computer

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Image Analysis Tools

- Image segmentation
- Image transforms
- Feature extraction
- Pattern classification

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Computer Vision Applications

- Quality control
  - Microdisplay chips inspection
  - Lumber counting and grading
- Medical sciences
- Law enforcement and security
- US space program
- Defense department

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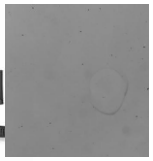
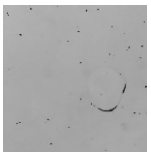
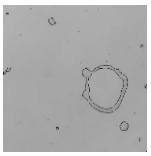
Defect Detection in Microdisplay Chips



Captured image



After defect detection



After blob analysis

- Inspection speed vastly increased
- Much lower error rates
- More complete analysis
- Cost savings

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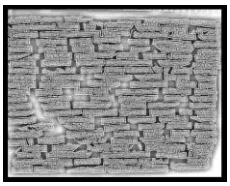
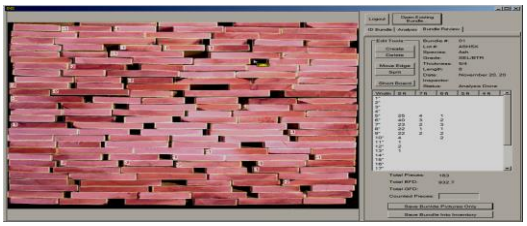
Lumber Counting and Grading

Computer Vision System

Captured image



Intermediate processed image



System output

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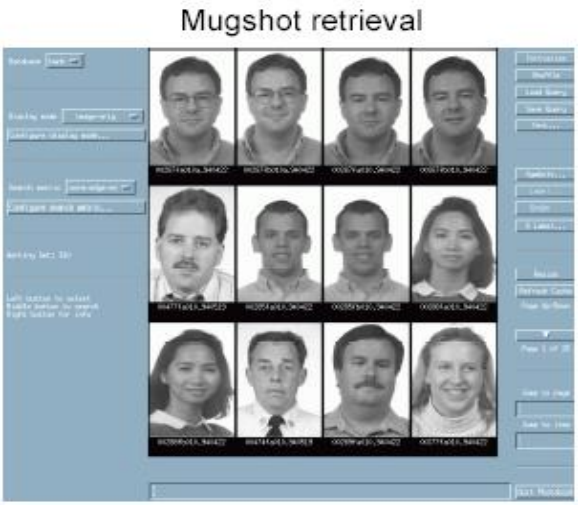
Imaging Example

Face Detection

Imaging Example

Face Tracking

Imaging Example



Source: MIT Media Lab

Image Processing

- Computer imaging application involving a human being in the visual loop
- Consists of following major fields:
- Image restoration
- Image enhancement
- Image compression

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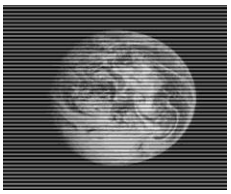
Image Restoration



Distorted image

Restored image

Geometric distorted image

Restored image

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Image Restoration

Noisy image

Restored image

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Imaging Example

Image Processing Examples

Color Photo Restoration

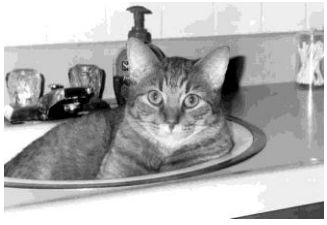
Degraded image

Restored image

Source: IVPL Northwestern University, Chicago

Image Enhancement

Poor contrast image



Enhanced image

Original image

Sharpened image

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Image Compression

Original image

Compressed image(1/10)

Compressed image(1/20)

Compressed image(1/30)

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Image Processing Applications

- Medical community
- Entertainment industry
- Design applications (Spacecraft, Building)
- Scientific research
- Virtual reality

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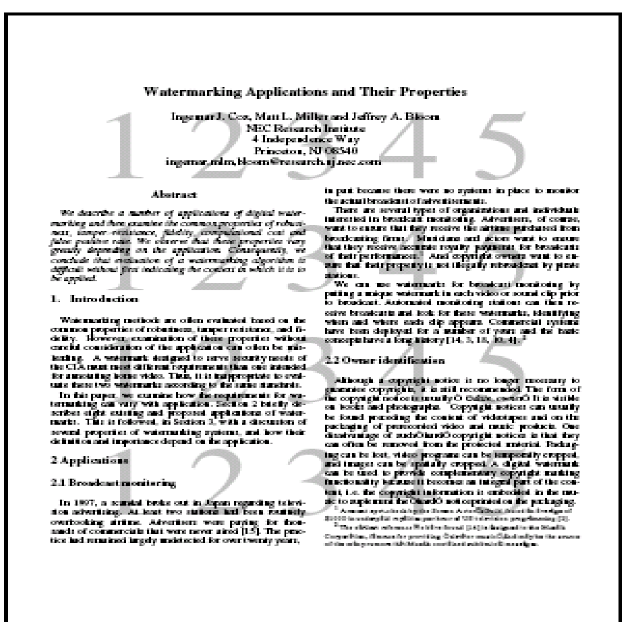
Imaging Example

Face morphing

Source: Yi-Wen Liu and Yu-Li Hsueh, EE368 class project, spring 2000.



Watermarking Applications and Their Properties

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Abstract

We describe a number of applications of digital watermarking and then examine the common properties of robustness, tamper resistance, fidelity, computational cost and false positive rate. We observe that these properties vary greatly depending on the application. Consequently, we conclude that evaluation of a watermarking algorithm is difficult without first indicating the context in which it is to be applied.

1. Introduction

Watermarking methods are often evaluated based on the common properties of robustness, tamper resistance, and fidelity. However, examination of these properties without careful consideration of the application can often be misleading. A watermark designed to serve security needs of the CIA must meet different requirements than one intended for annotating home video. Thus, it is inappropriate to evaluate these two watermarks according to the same standards.

In this paper, we examine how the requirements for watermarking can vary with application. Section 2 briefly describes eight existing and proposed applications of watermarks. This is followed, in Section 3, with a discussion of several properties of watermarking systems, and how their definition and importance depend on the application.

2 Applications

2.1 Broadcast monitoring

In 1997, a scandal broke out in Japan regarding television advertising. At least two stations had been routinely overbooking airtime. Advertisers were paying for thousands of commercials that were never aired [15]. The practice had remained largely undetected for over twenty years, in part because there were no systems in place to monitor the actual broadcast of advertisements.

There are several types of organizations and individuals interested in broadcast monitoring. Advertisers, of course, want to ensure that they receive the airtime purchased from broadcasting firms. Musicians and actors want to ensure that they receive accurate royalty payments for broadcasts of their performances.[1] And copyright owners want to ensure that their property is not illegally rebroadcast by pirate stations.

We can use watermarks for broadcast monitoring by putting a unique watermark in each video or sound clip prior to broadcast. Automated monitoring stations can then receive broadcasts and look for these watermarks, identifying when and where each clip appears. Commercial systems have been deployed for a number of years and the basic concepts have a long history [14, 3, 18, 10, 4].[2]

2.2 Owner identification

Although a copyright notice is no longer necessary to guarantee copyrights, it is still recommended. The form of the copyright notice is usually Ò© date, ownerÓ. It is visible on books and photographs. Copyright notices can usually be found preceding the content of videotapes and on the packaging of prerecorded video and music products. One disadvantage of suchÒ textÓ copyright notices is that they can often be removed from the protected material. Packaging can be lost, video programs can be temporally cropped, and images can be spatially cropped. A digital watermark can be used to provide complementary copyright marking functionality because it becomes an integral part of the content, i.e. the copyright information is embedded in the music to supplement the ÒtextÓ notice printed on the packaging.