

Digital Image Processing

Introduction

Course Description

- Digital Image Processing
- *Number of Credit Hours: 3 credits*
- *Catalog Description:*
 - This course covers the fundamental concepts related to digital images and their processing. Topics covered include image processing fundamentals, image pre-processing, image segmentation, image compression, image representation, image description and object recognition.

Definition

- Processing of images which are Digital in nature by digital Computers.

Why do we need to image processing ?

- Motivation by three major applications
 - Improvement of pictorial information for human perception
 - Image processing for autonomous machine applications
 - Efficient storage and transmission

Human Perception

- Methods for enhancing pictorial information for human interpretation and analysis
 - Common applications are
 - Noise filtering
 - Content enhancement
 - Contrast
 - De-blurring
 - Remote sensing

Noise Filtering



Noisy Image

Filtered Image



Contrast enhancement



Contrast enhancement

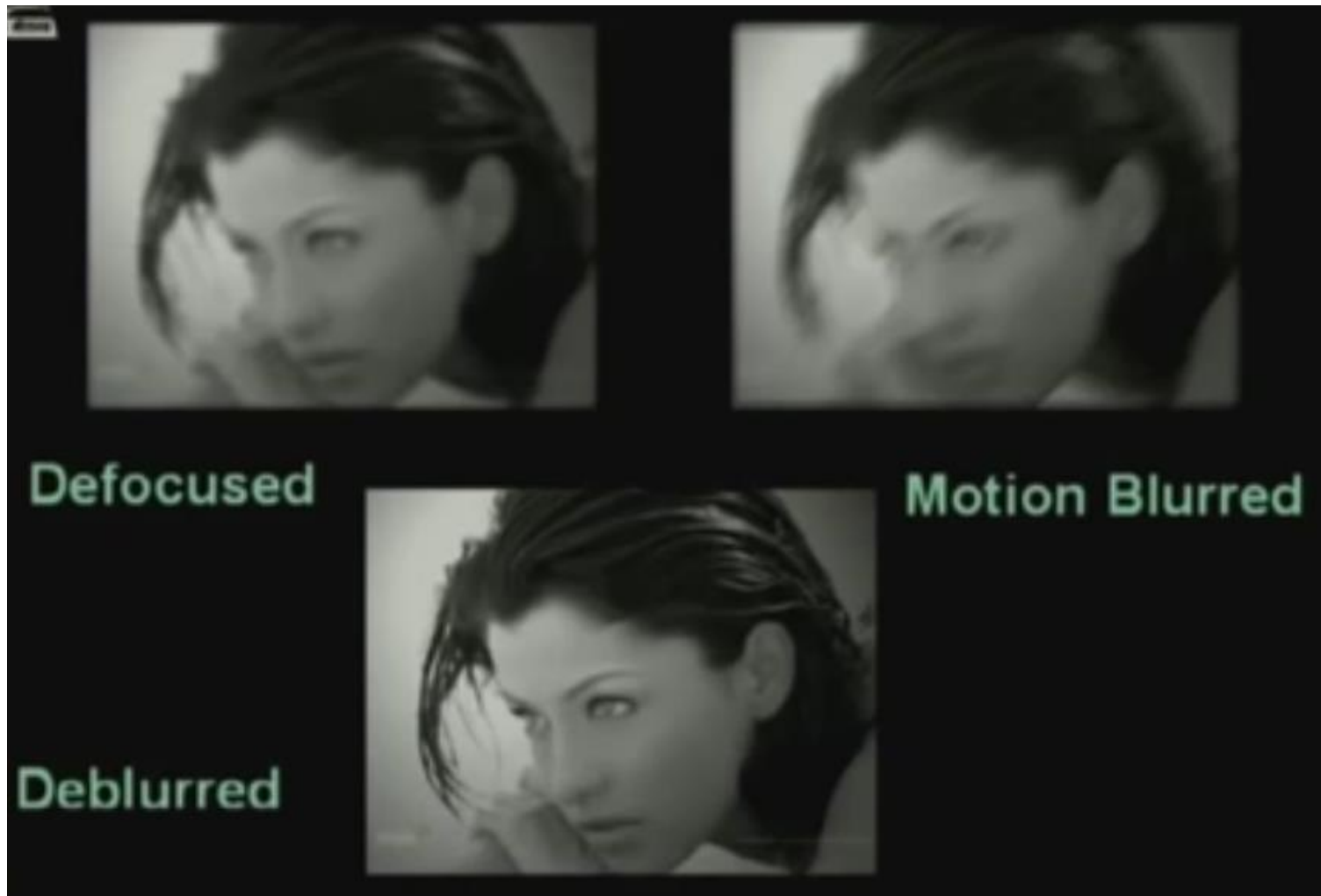


Low contrast Image

Enhanced Image



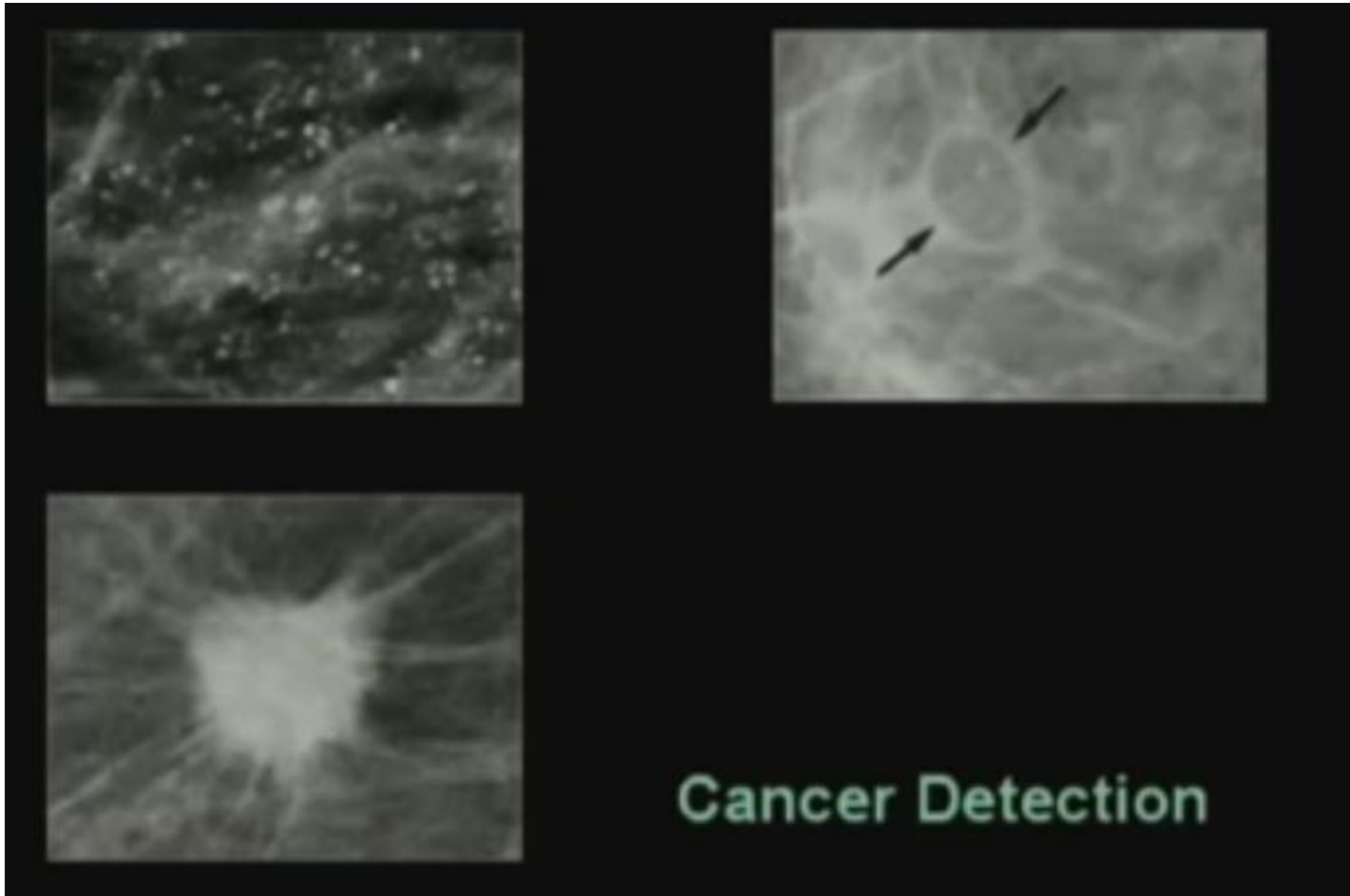
De-blurring



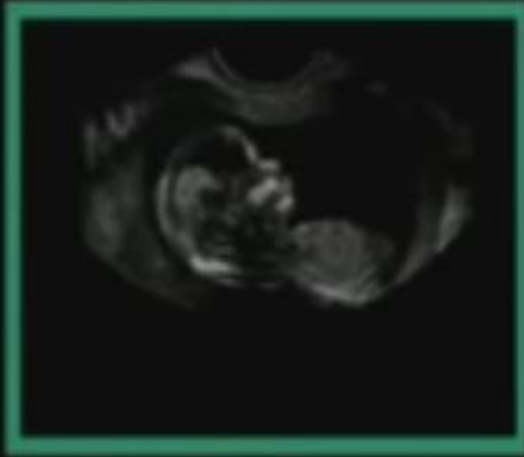
Medical Imaging



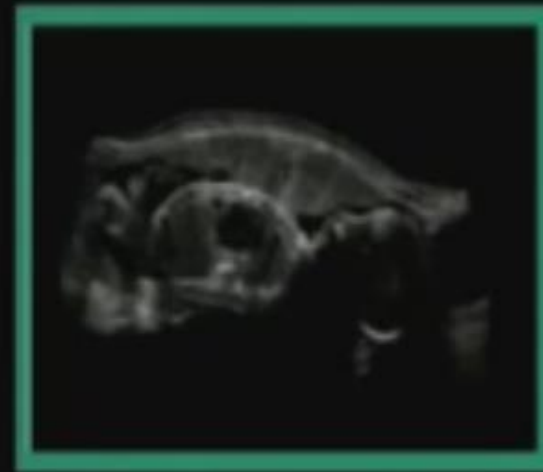
Medical Imaging



Medical Imaging



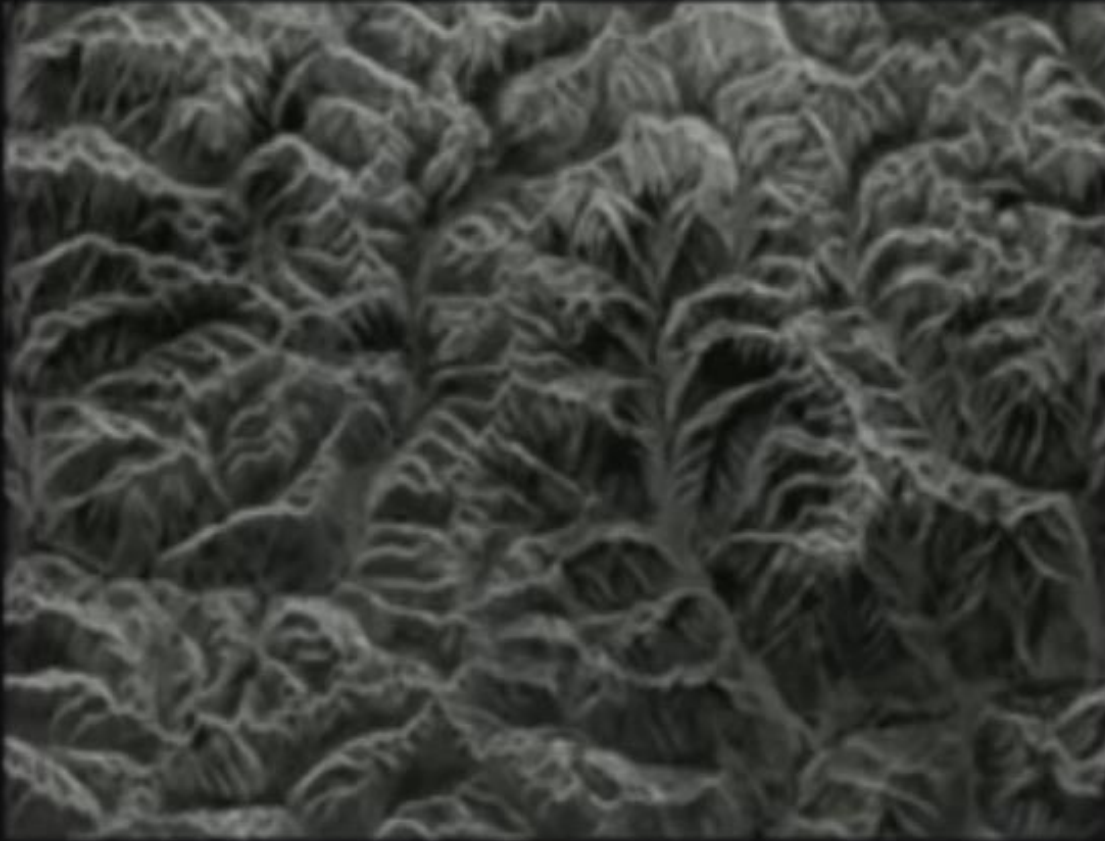
Ultra Sonogram



Remote Sensing

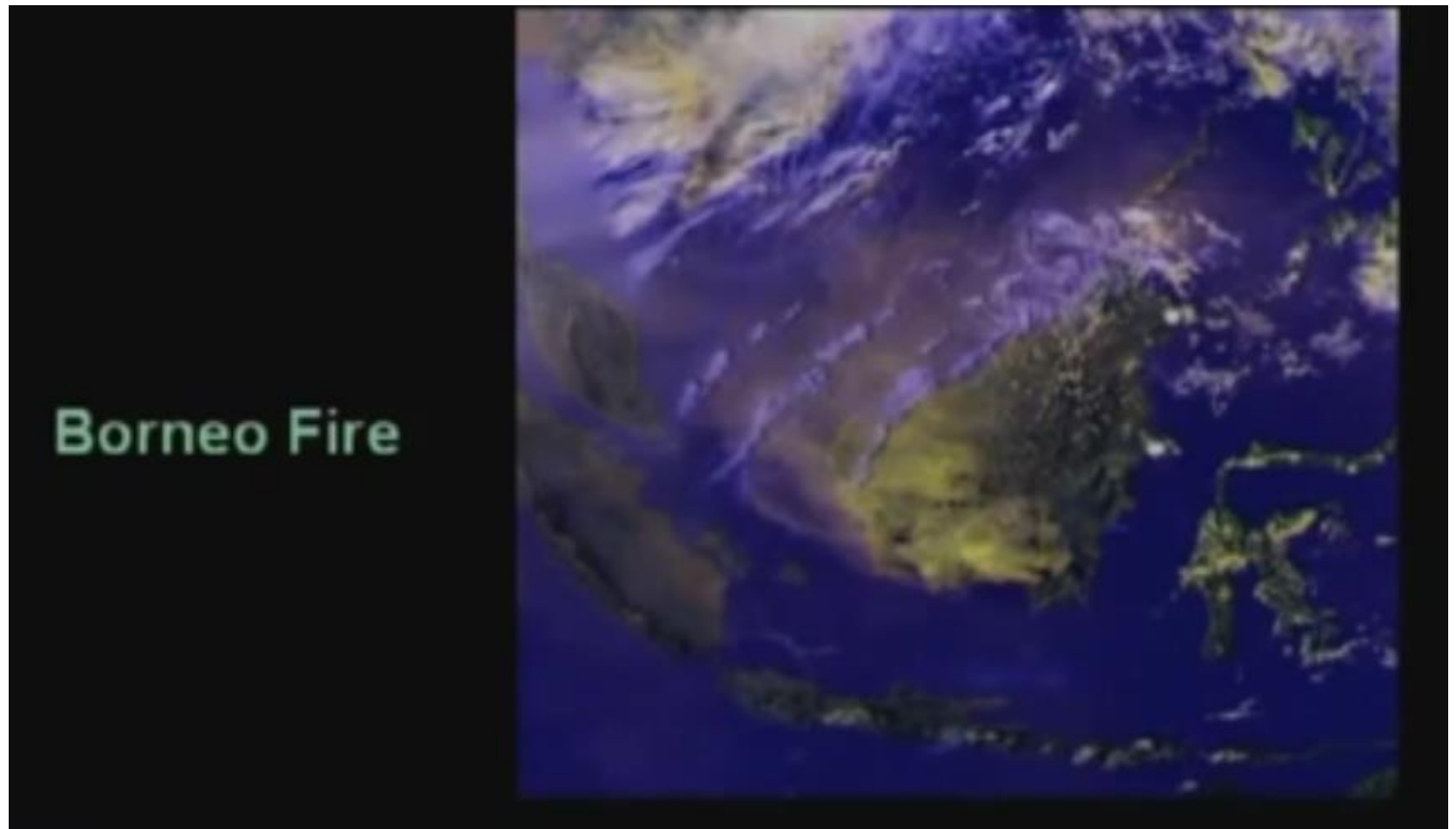


Remote Sensing



**Terrain
Mapping**

Remote Sensing

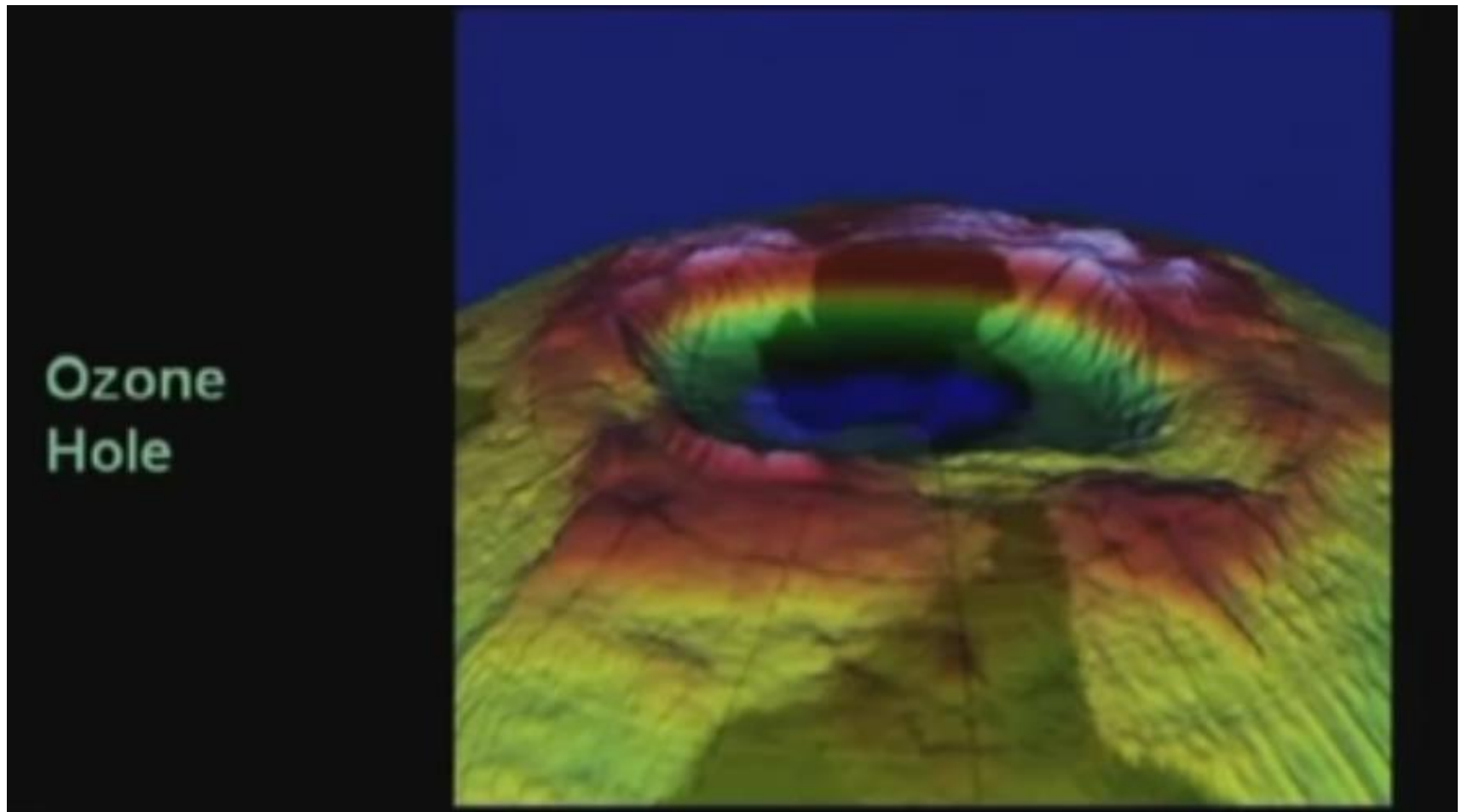


Weather Forecasting



Hurricane
over Dennis
1990

Atmospheric study



Astronomy



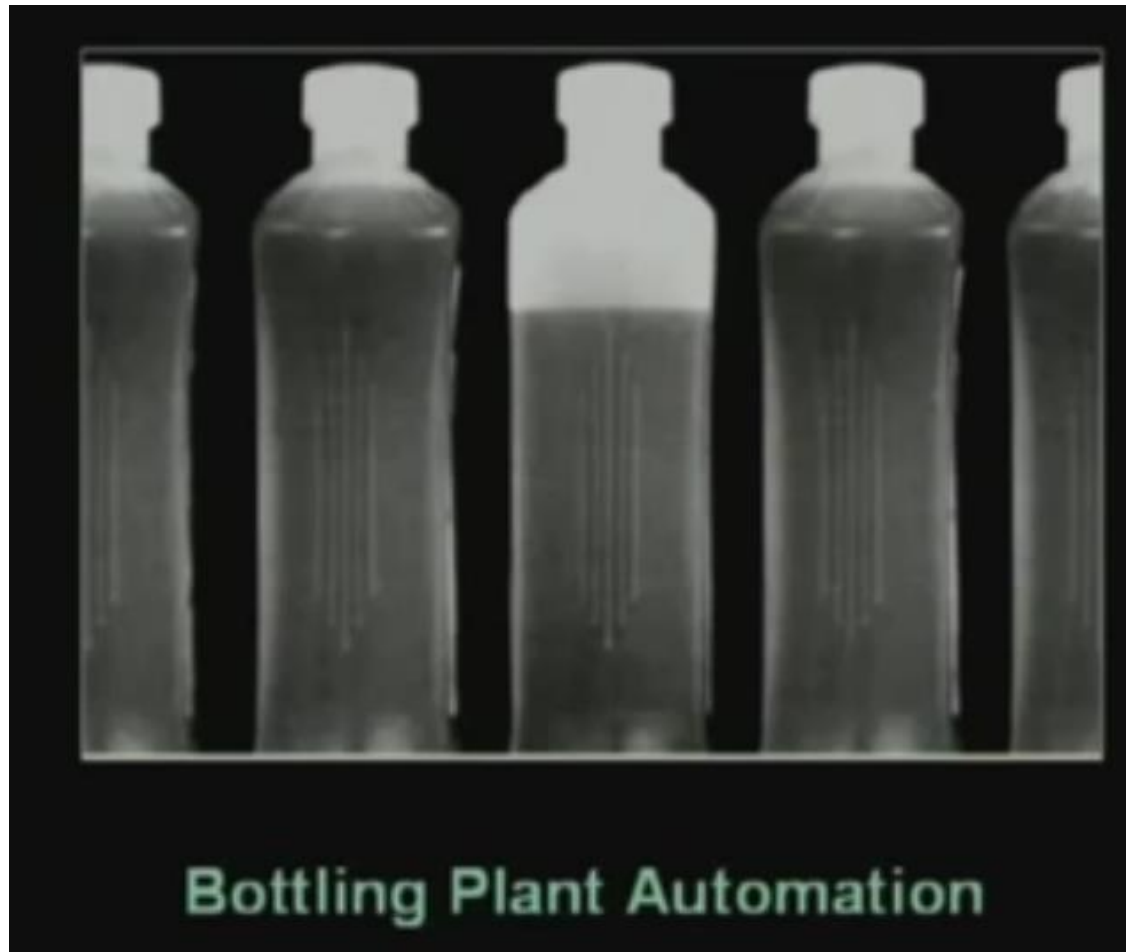
Astronomy



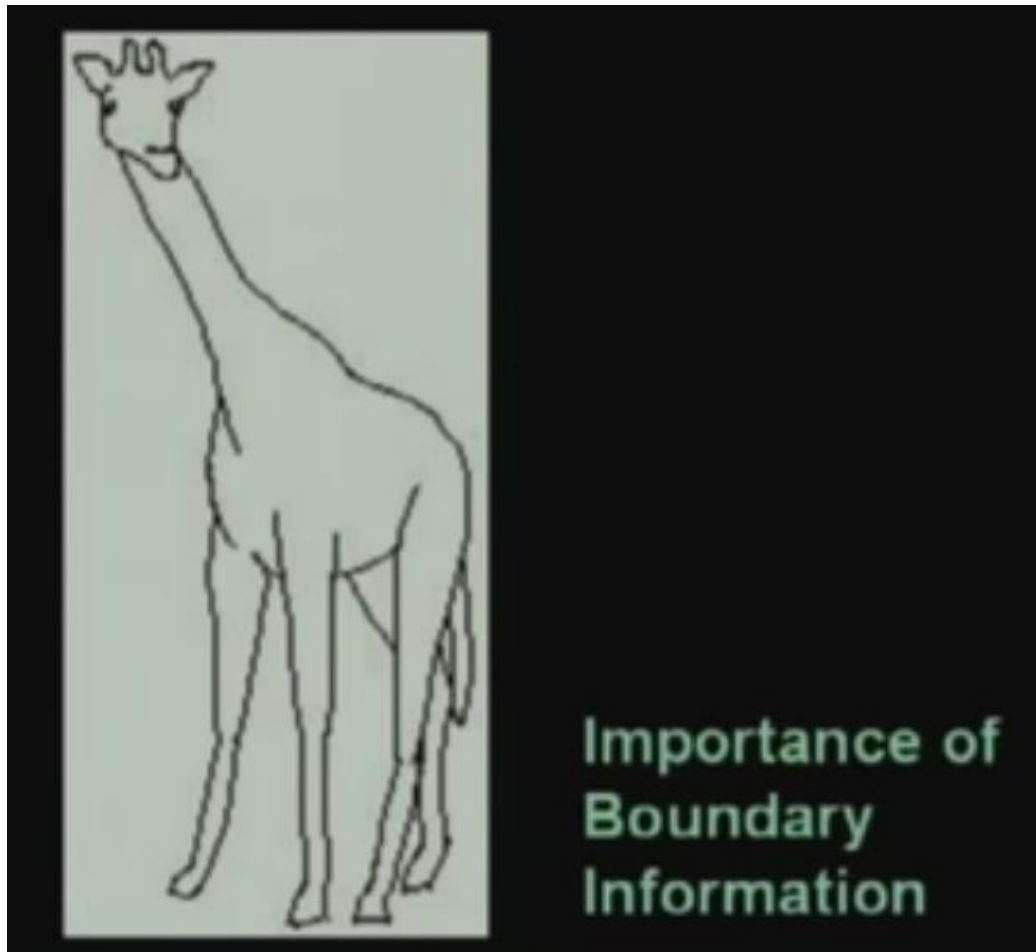
Machine vision applications

- Extract the image information for further computer processing
- Common applications are:
 - Industrial machine vision for product assembly and inspection
 - Automated target detection and tracking
 - Finger print recognition
 - Machine processing of aerial and satellite imagery for weather prediction and crop assessment

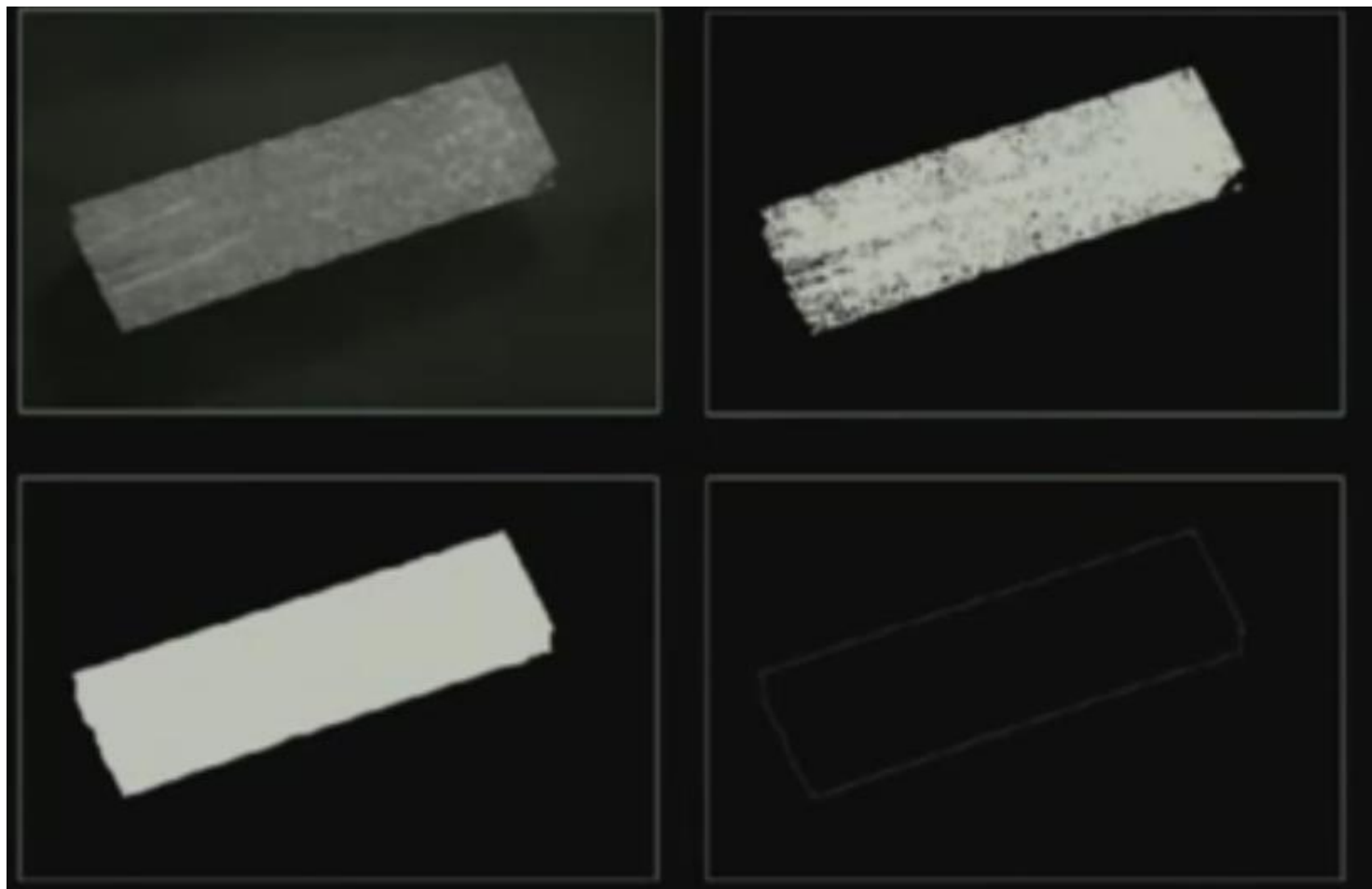
Automated inspection



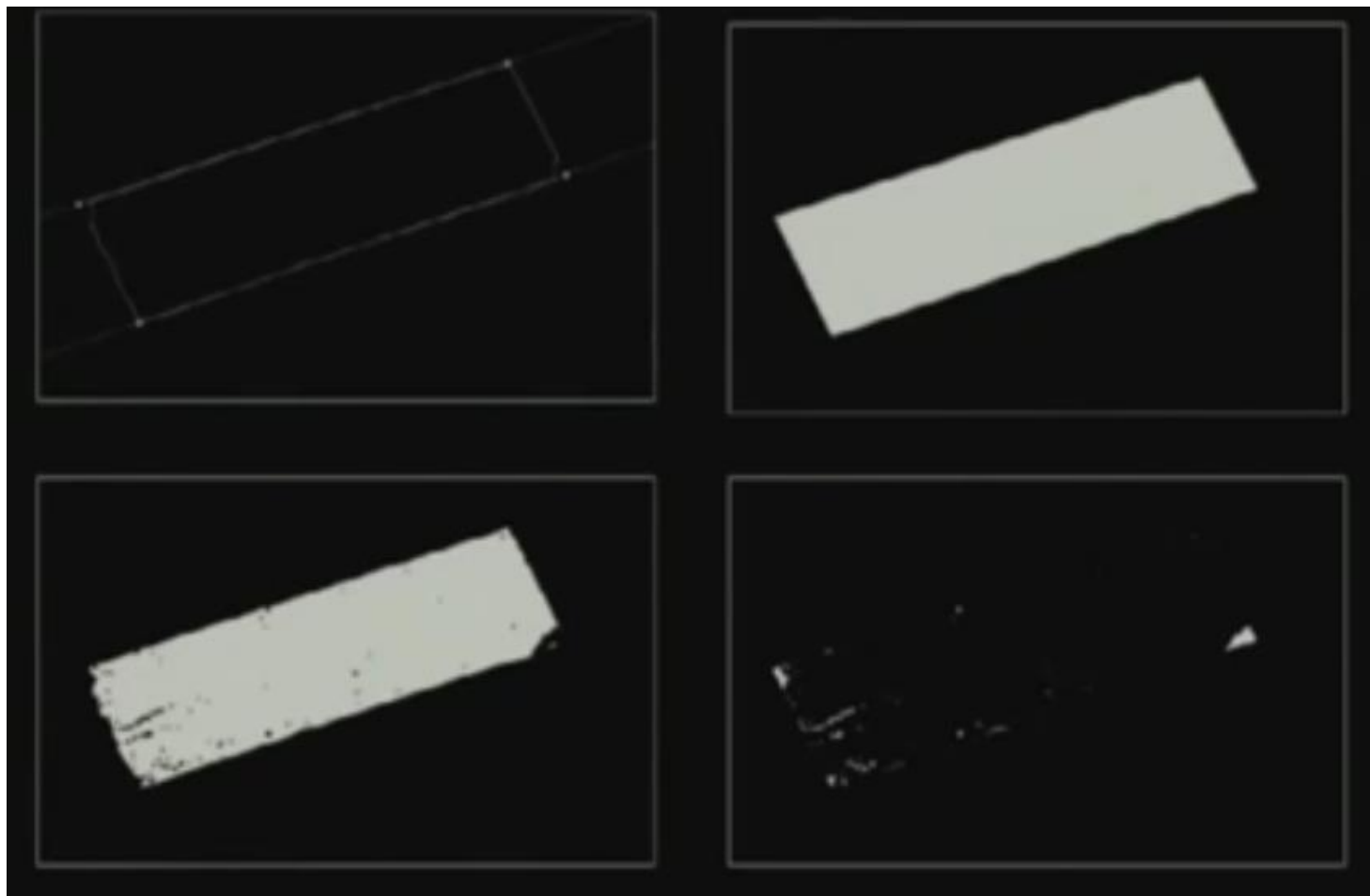
Boundary Information



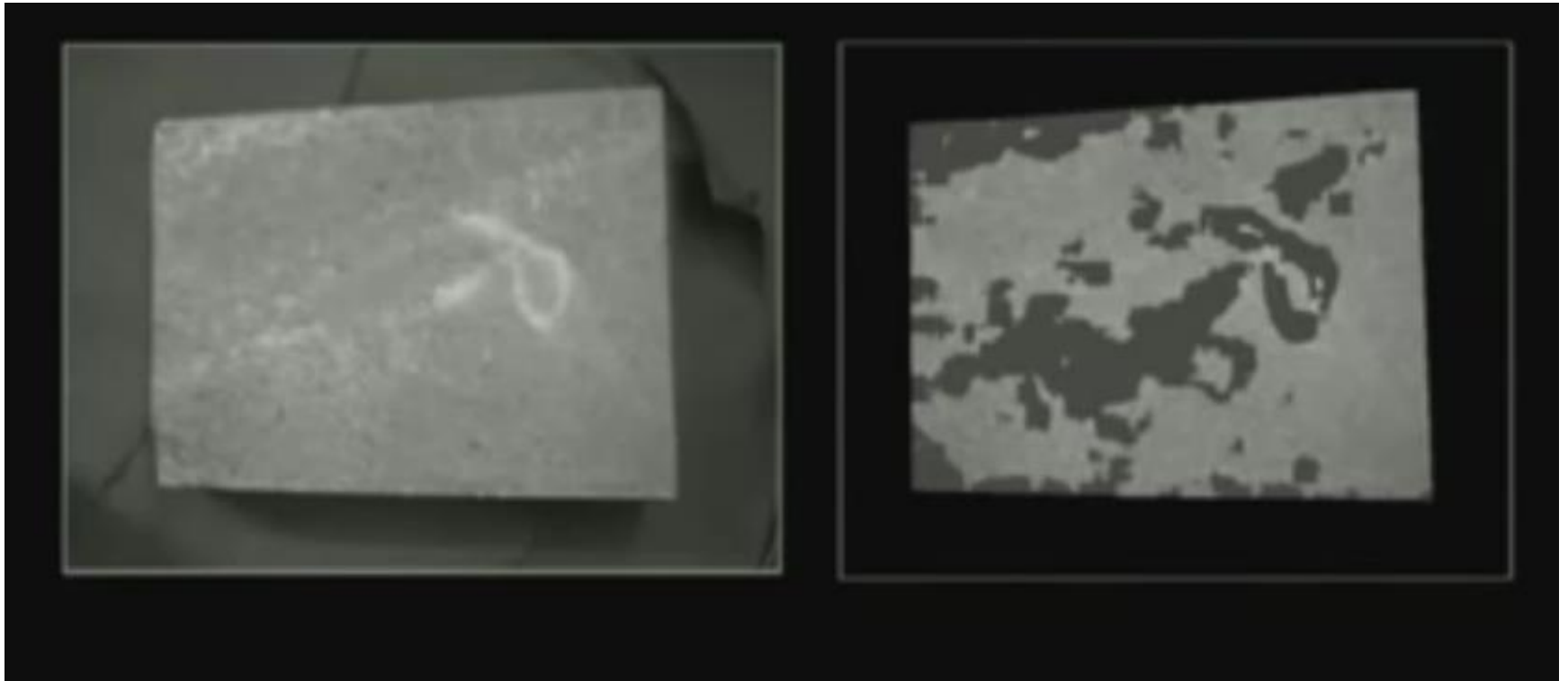
Automated inspection



Automated inspection



Surface information



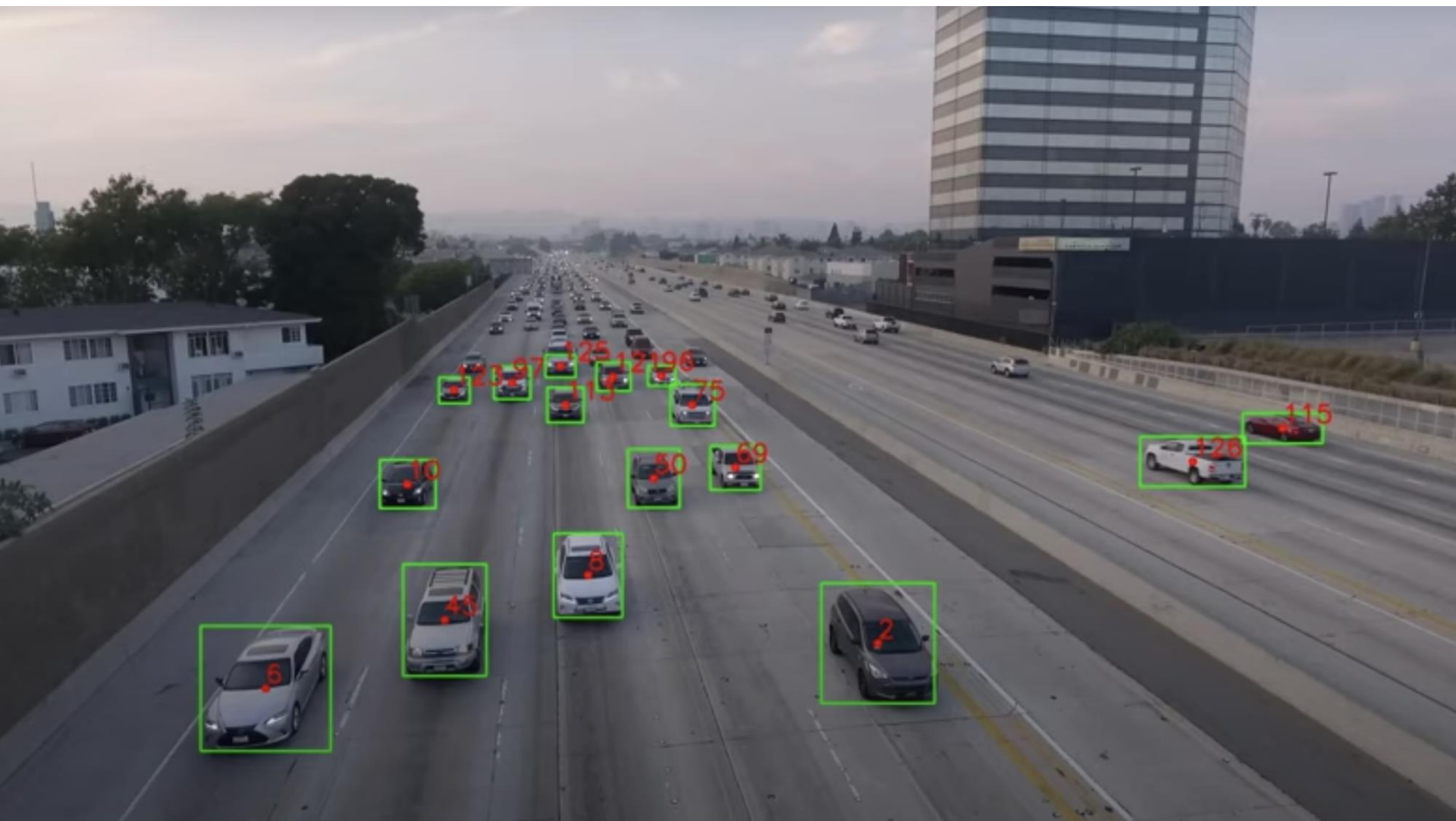
Automated inspection



Inspection of IC Manufacturing

Video sequence processing

- To detect moving objects in image sequence for further processing
 - Some applications are
 - Detection and tracking of moving targets for security surveillance
 - Finding the trajectory of moving targets
 - Monitoring the movements of organ boundaries in medical applications



Application

- By single camera tracking
 - Find out what is the Azimuth and elevation of that particular object with respect to certain difference coordinate system.
- By 2 different cameras tracking
 - Azimuth and elevation + can identify X Y Z coordinate of that object with respect to that 3 D coordinate system
 - locating those locations in different frames, we can find out that over the time which path the object is following
 - also we can determine that what is the trajectory that the moving object follows

Image Formats

- Compression
 - An image contains redundant information which can be exploited for achieving compression
 - Three types of redundancy
 - The first kind of redundancy is called a pixel redundancy
 - The second kind of redundancy is called a coding redundancy
 - Third kind of redundancy is called a psycho visual redundancy.

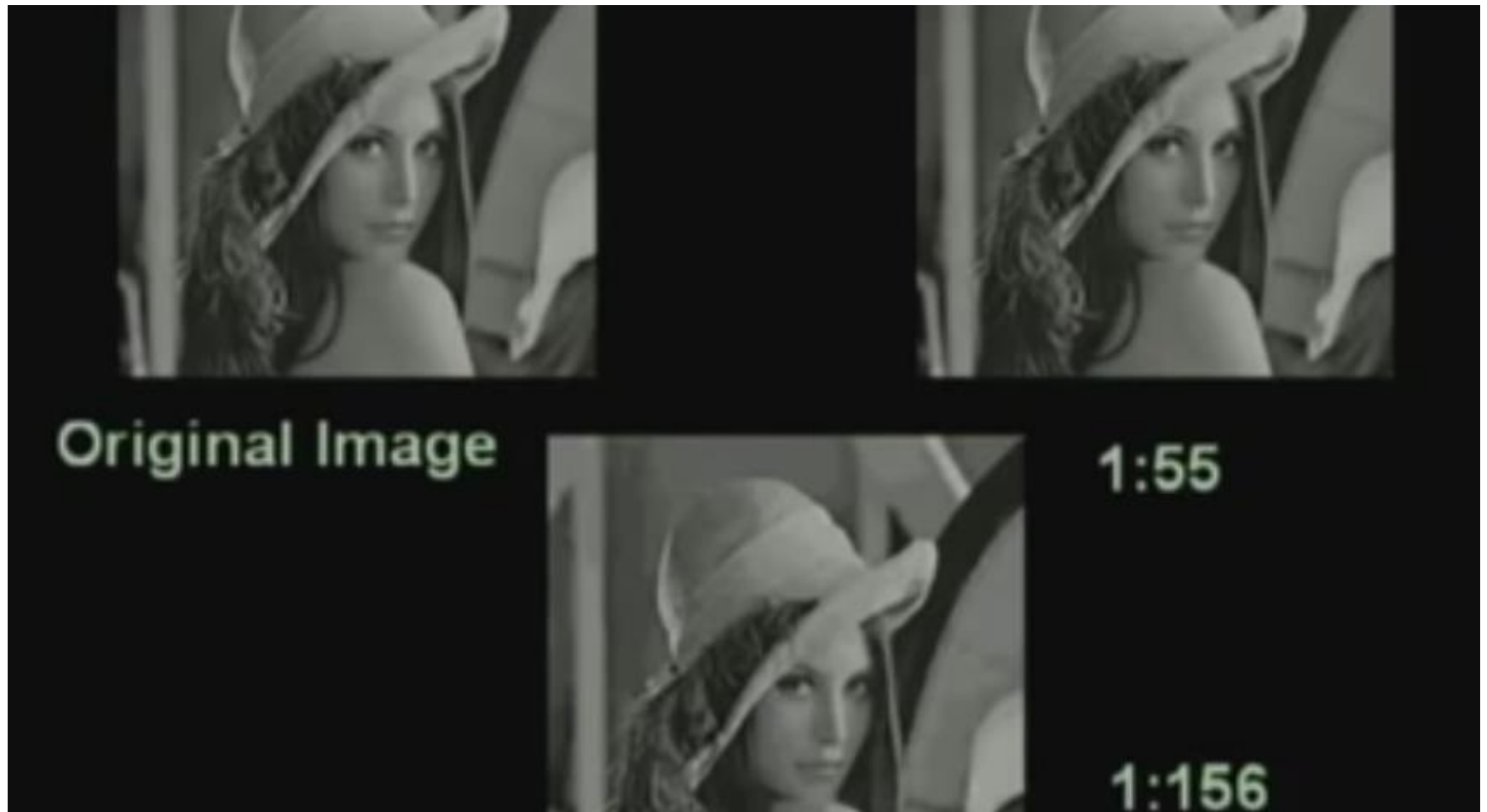
Pixel redundancy



Applications

- Storage space reduction
- Bandwidth reduction

Compression



Lossy compression

- Remove redundancy as well as also remove some of the information so that after removing those information, the quality of the reconstructed image is still acceptable
- There will be some loss or some distortion and this is taken care by what is called rate distortion theorem.

Compare the space according to compression

- Compare the space requirement of these 3 images;
- If the original image is of size say 256 by 256 bytes that is 64 kilobytes,
- The second image which is compressed 55 times, the second image will take slightly above something around say 10 kilobytes.
- The third one will take something around 500 bytes or even less than 500 bytes.