Vision inspection systems

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A.A. 2000-2001

Bibliographic references

- PPT slides prepared by the instructor and presented during the lecture
- National Instruments tutorials http://www.ni.com

Definition

- Computer vision is the extraction of information from images.
- The entire process ranges from acquisition to interpretation

Observations

- It is an interdisciplinary technology that benefits from advancements in electronics (sensors, processors, specialized boards) and computer science (algorithm development), applied to specific fields.
- Human vision remains unmatched in interpretation; however, vision systems outperform in terms of quantitative performance.

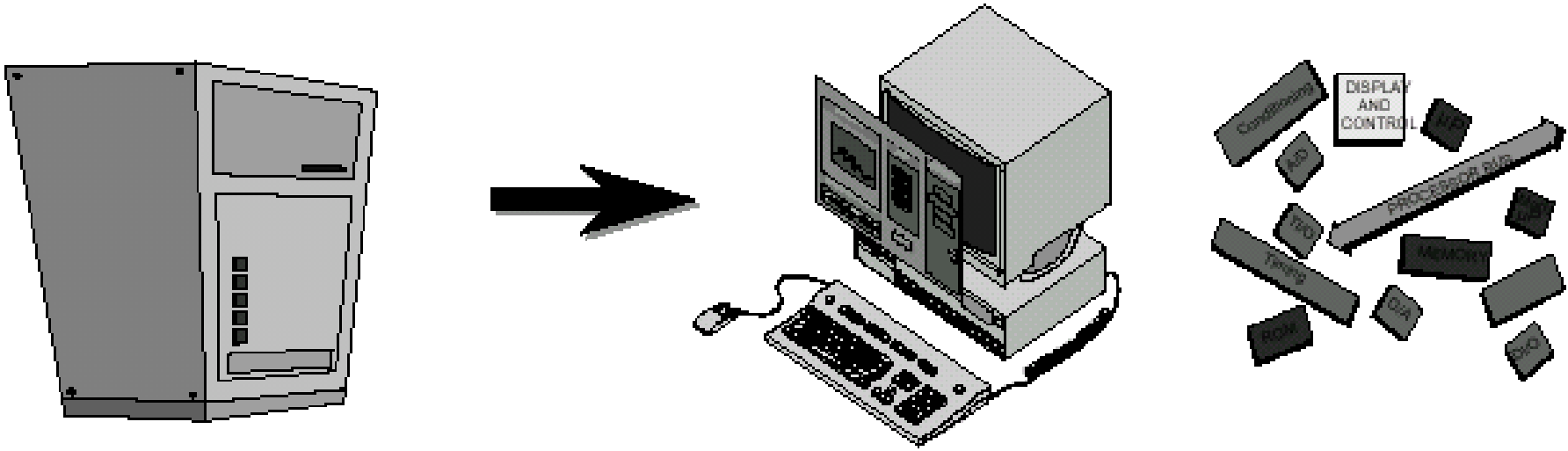
Types of applications of artificial vision systems

- Presence/absence of a part
- Recognition
- Correct assembly (Peg-in-hole)
- Quality control (mechanical parts)
- Classification (natural materials)
- Measurement

Vision and Virtual Instrumentation

Closed Turnkey Vision System

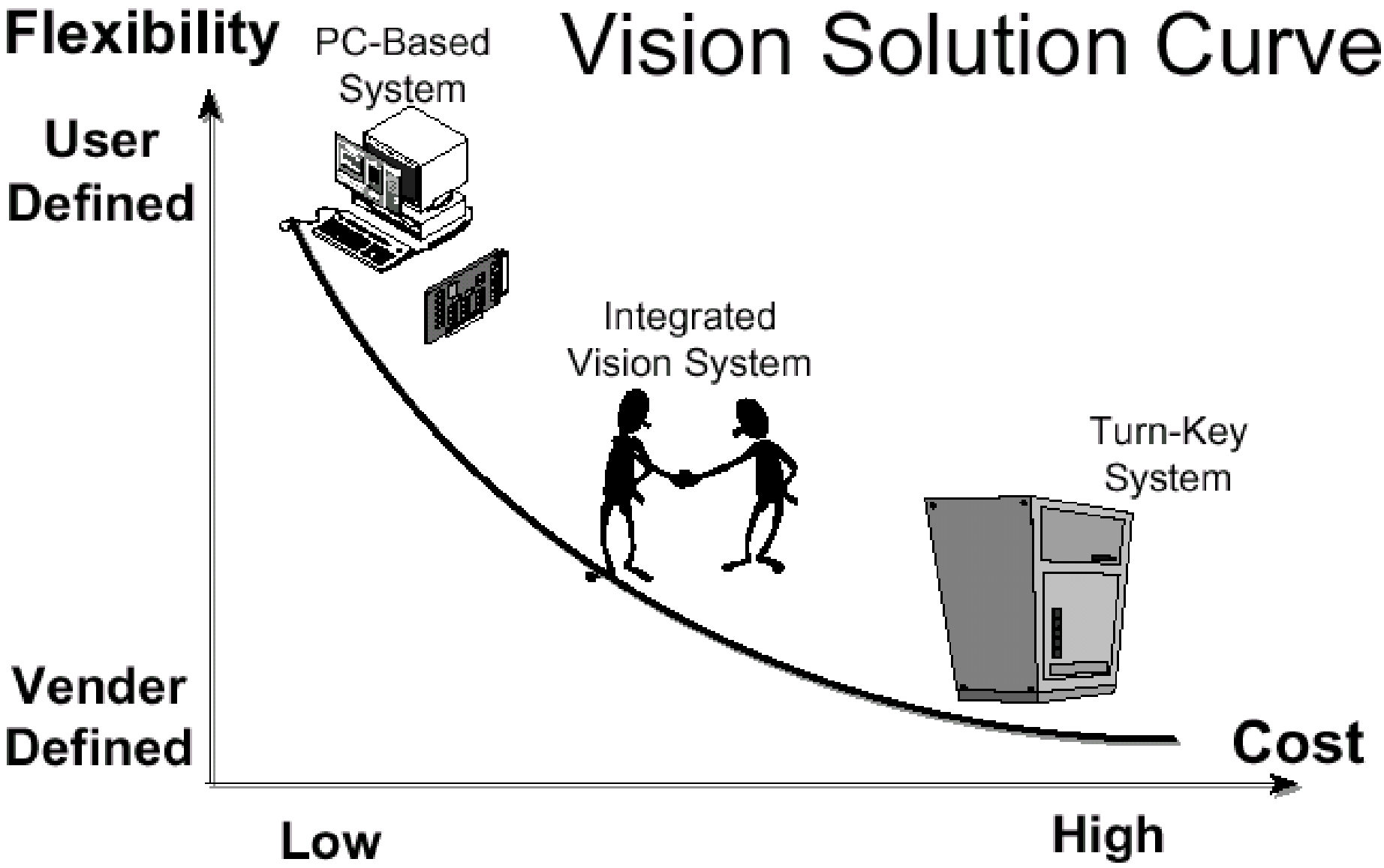
Open PC-Based Vision System



Vender Defined

User Defined

Vision Solution Curve



Fields of application

- Robotics:
  - autonomous navigation (ego or echo docking)
  - underwater inspection, pipelines
- Military:
  - exploration
  - missile guidance
- Industrial Automation

Related fields

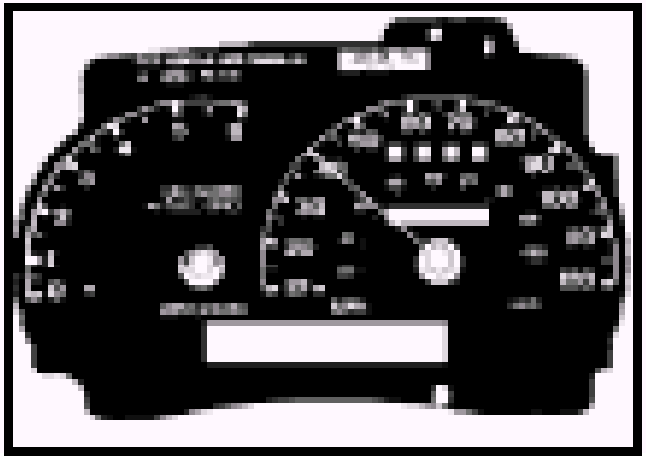
- Image processing
  - Medicine (CT, MRI)
  - Satellite
  - Photo editing
- Teleoperation
  - Microsurgery
  - Internet-based
- Virtual reality
- OCR (Optical Character Recognition)
  - Scanner
  - Barcodes
- Image transmission
  - Compression
  - Video conferencing

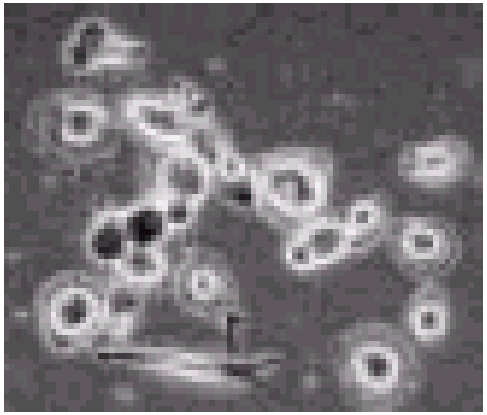
Vision Applications

- Industrial automation
- Test and measurement
- Lab automation

IA - Container Inspection

T&M - Automotive Testing



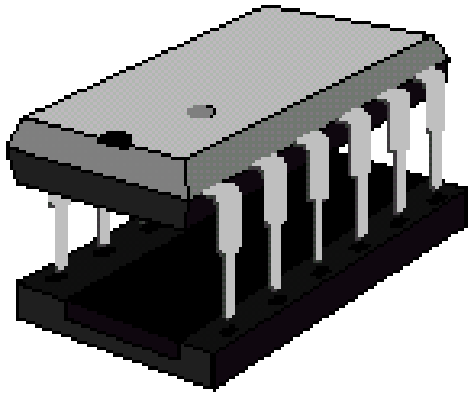


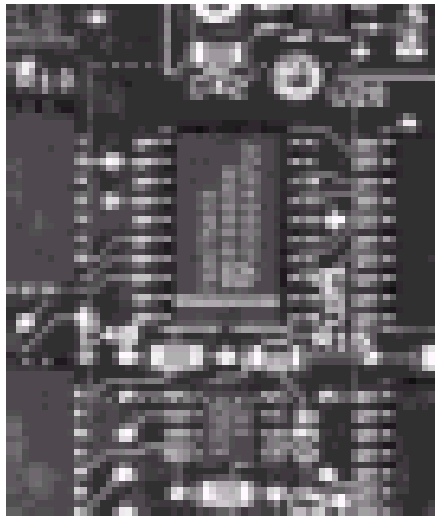
Lab automation - Cell Counting

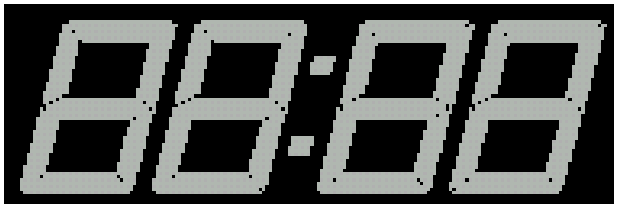
Industrial Inspection Applications

Electrical and Electronic Components

- Connectors
- Switches
- LCD/LED displays
- Relays
- Motors
- Gauges
- Thermostats
- Watch parts

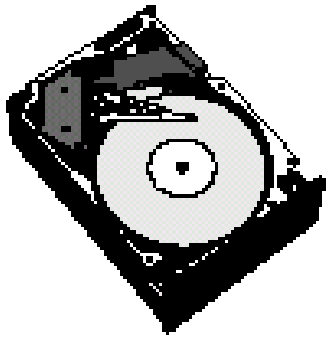


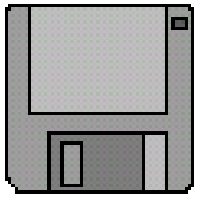


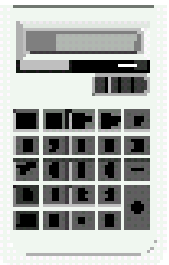


Computer and Telecommunications Peripherals

- Pagers
- Printers
- Monitors
- Cellular handsets
- Telephone handsets
- Keyboards and keypads
- Copiers/FAX machines
- Disk drives and components

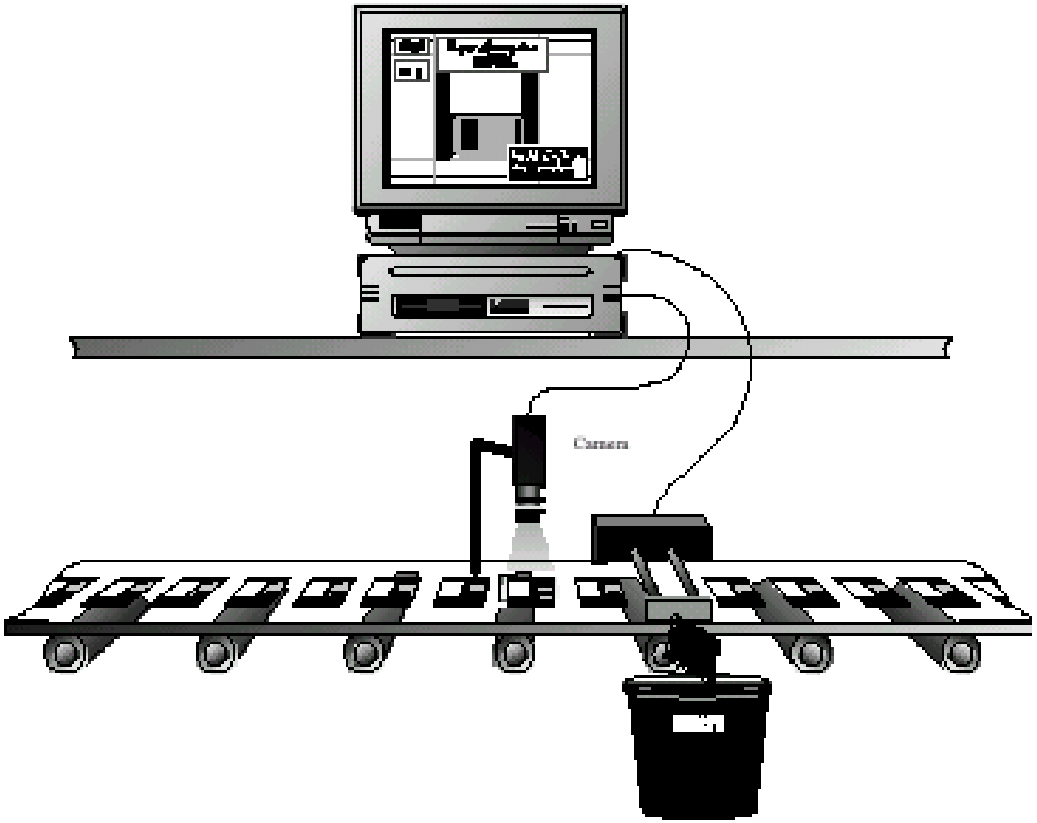






Components of a PC-Based Vision System

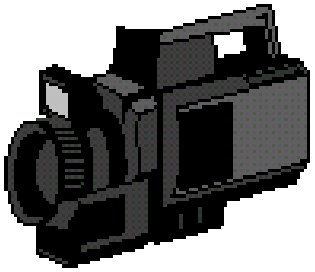
- Personal computer/PXI computer
- Plug-in IMAQ hardware
- Plug-in DAQ hardware
- Application software
- Camera
- Lighting



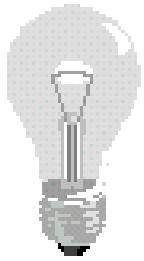
Snap and Display

Vision Basics

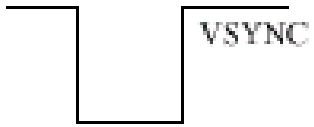
Cameras

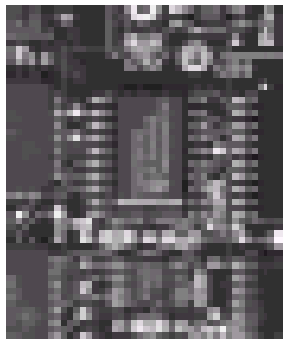


Lighting



PC-Based
Vision Systems





Video

Image
Processing

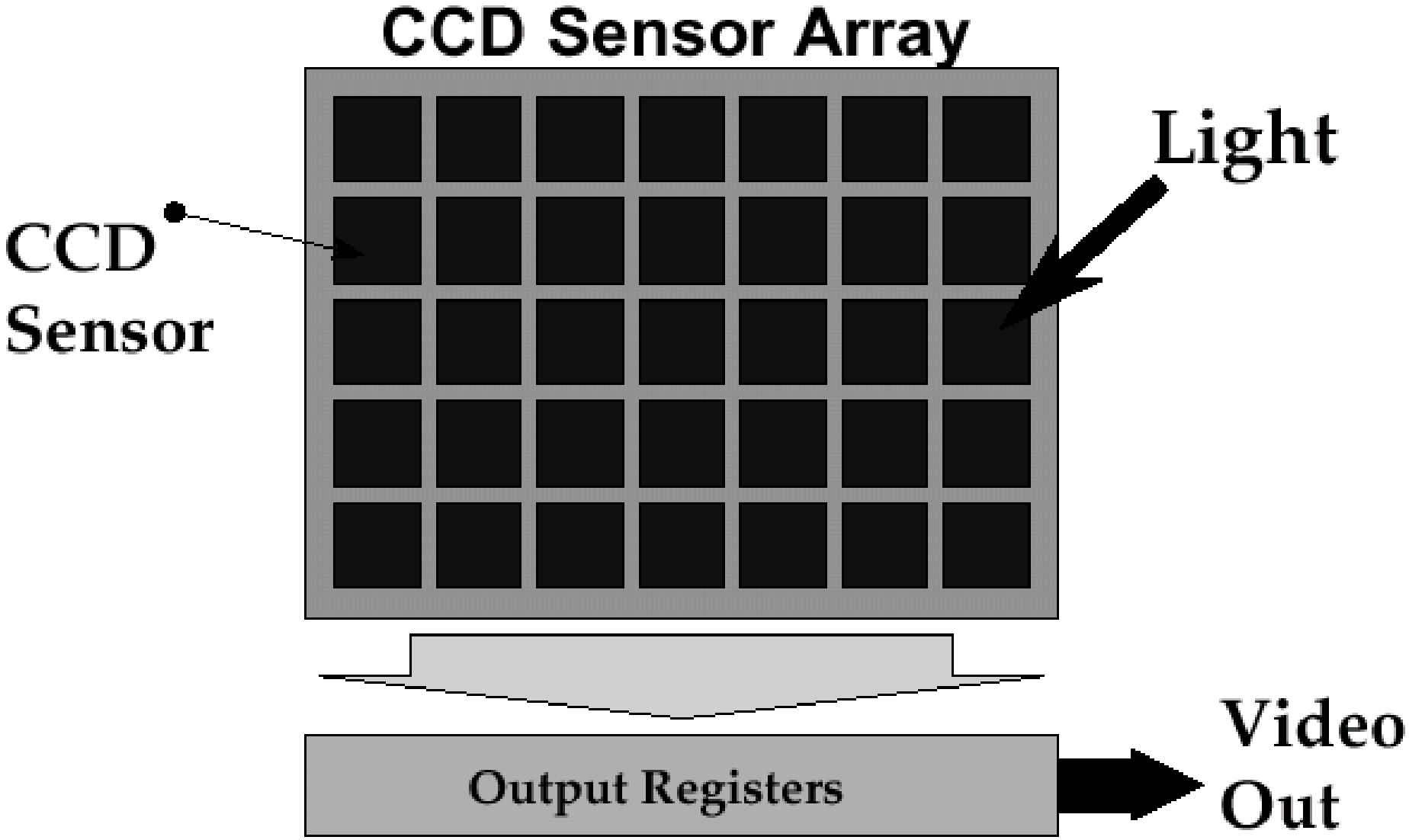
System’s elemets

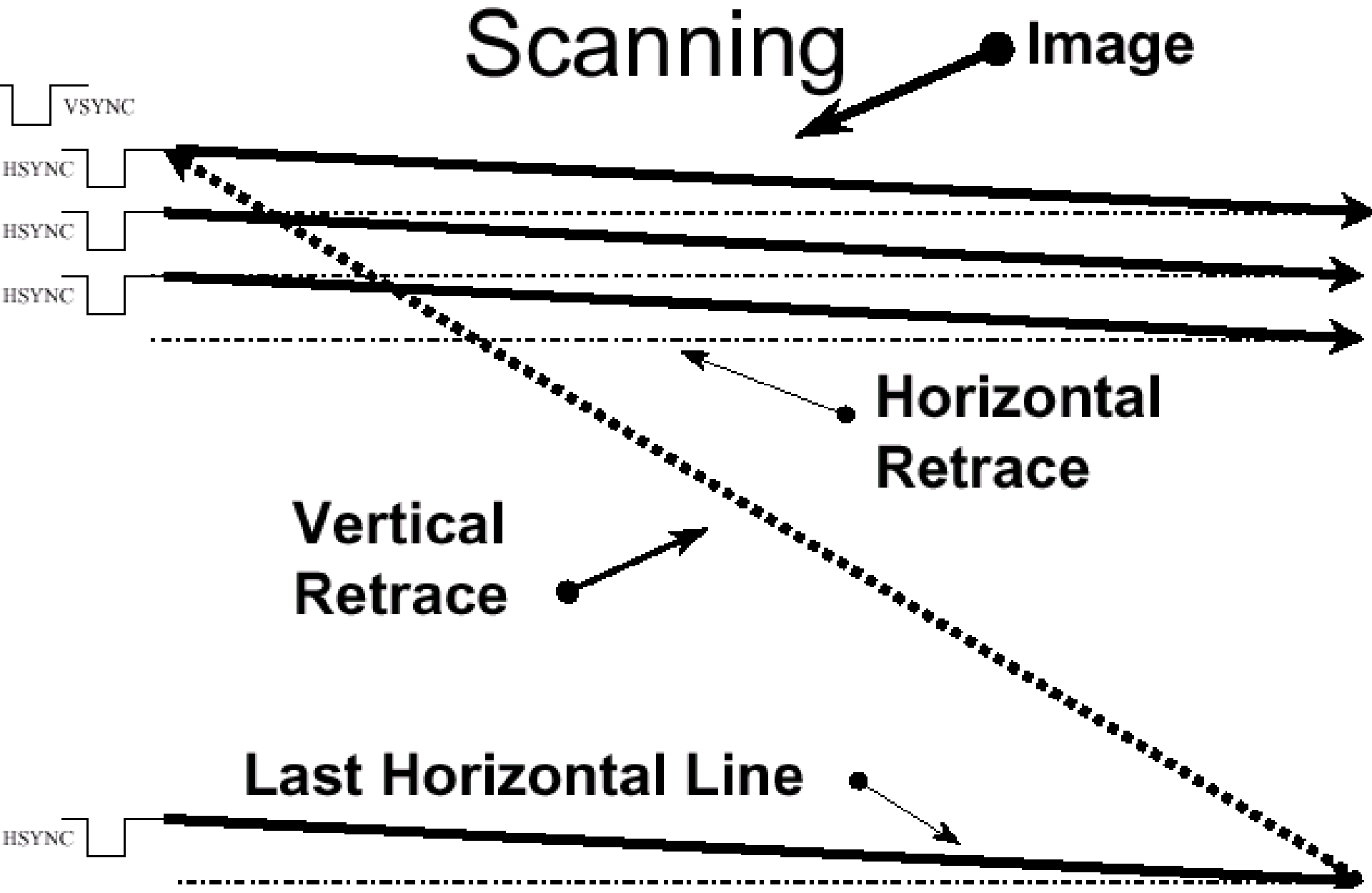
- Lighting environment;
- Observed object;
- Lighting device;
- Imaging device: sensors, cameras (linear, matrix, progressive, IR);
- Optical system: lenses (telecentric, zoom), optics, extension rings;
- A/D converter;
- Frame grabber;
- Memory: RAM or HD;
- Special or general-purpose hardware: vision card (typically includes the three previous components) or PC;
- Host computer;
- Television monitor: connected as output to the camera.

Charge Couple Device (CCD) Camera

- Easy to operate
- High resolution
- Durable
- Small
- Low power consumption
- Low cost

How a CCD Works




Scanning
Image
VSYNC
HSYNC
HSYNC
HSYNC
Horizontal
Retrace
Vertical
Retrace
Last Horizontal Line
HSYNC

Lightin Types

- Type of lighting
  - Ambient
  - Diffuse
  - Optical fibers (concentrated and directional)
- Nature of the source
  - Incandescent
  - Fluorescent (discontinuous spectrum)
- Lighting direction
  - Front
  - Diffuse
  - Raking
  - Back
- Structured lighting
  - Laser profiles
  - Video projectors

The main steps of a Computer Vision process

1. Acquisition
2. Pre-processing / Enhancement
3. Processing – Interpretation - Feature extraction
4. Post-processing

Some types of algorithms

- Processing
  - Binarization
  - Filtering
- Feature extraction
  - Geometric (dimensions, shapes)
  - Statistical parameters (gray-level histogram)
- Pattern matching (comparison with model)
- Classification
  - Artificial neural networks