

CONTENT

Chapter 9: Machine Vision Applications

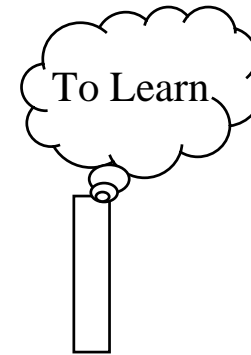
9.1 Visual Inspection

9.2 Visual Guidance of Robot Manipulator

9.3 Visual Guidance of Robotic Head

9.4 Visual Guidance of Vehicle

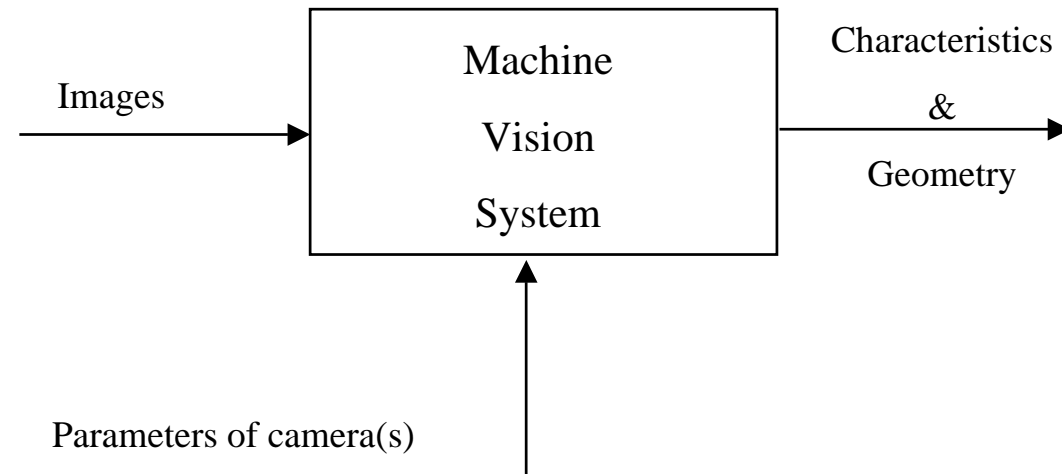
9.5 3D Model Acquisition



What is a machine vision system ? (A Review)

ANSWER (one possible definition):

It's a system that takes images as input and produce characteristics/geometry of objects as output.



What can be done with a machine vision system ? (A Review)

ANSWER:

Visual Guidance:

To obtain a geometric (full or partial) description of a scene necessary to the safe planning and control of the movement of machine (eg, robot).

Visual Inspection:

To obtain photometric and/or geometric measurement of goods or parts or machined outputs (like printing) for the sake of ensuring the highest quality if possible.

Visual Measurement:

To obtain photometric and/or geometric measurement of machined outputs for different purposes (inspection, surveillance, etc)

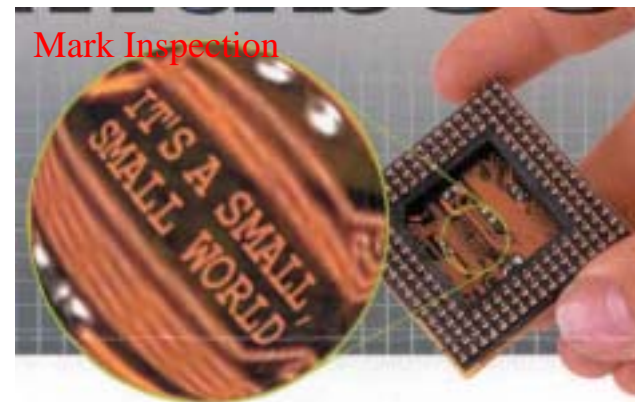
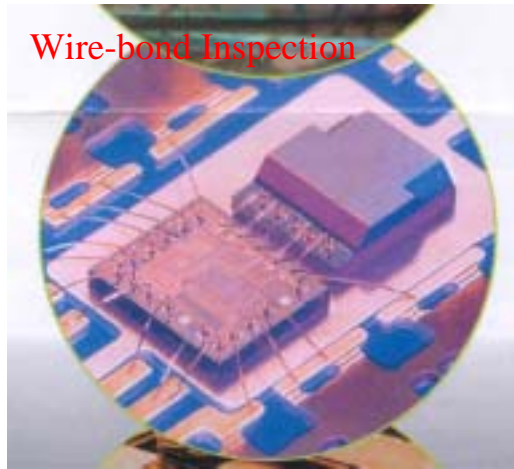
Visual Identification:

To obtain metric features from images for the sake of identifying the belonging of objects under the viewing.



VISUAL INSPECTION

1. Illustration:



VISUAL INSPECTION

2. Problem Statement:

Visual inspection is a process of using image(s) to test whether an object meets certain criteria for the purposes of:

- a) Quality Control (verification), or
- b) Sorting (classification).



VISUAL INSPECTION

4. Criteria Relevant for Visual Inspection :

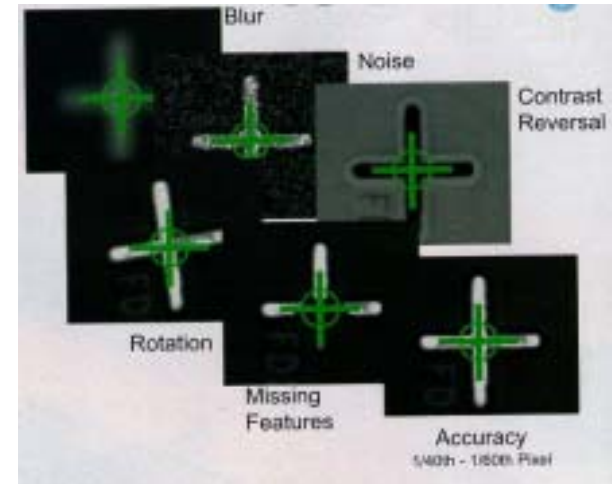
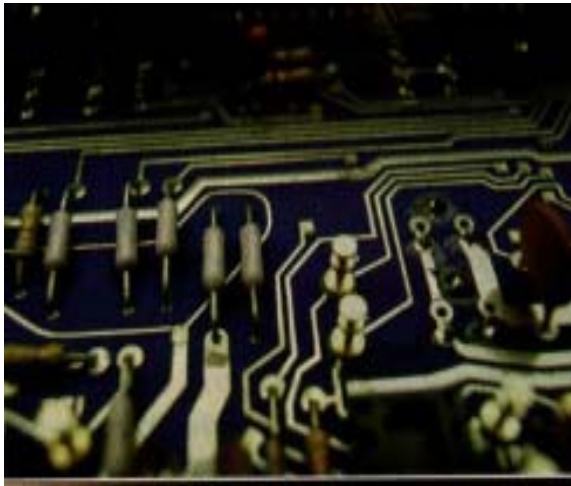
a) Photometric Criteria:

- Intensity
- Color
- Uniformity
- Texture



b) Geometric Criteria:

- Shape
- Dimension
- Distance
- Alignment
- Topology
- Location



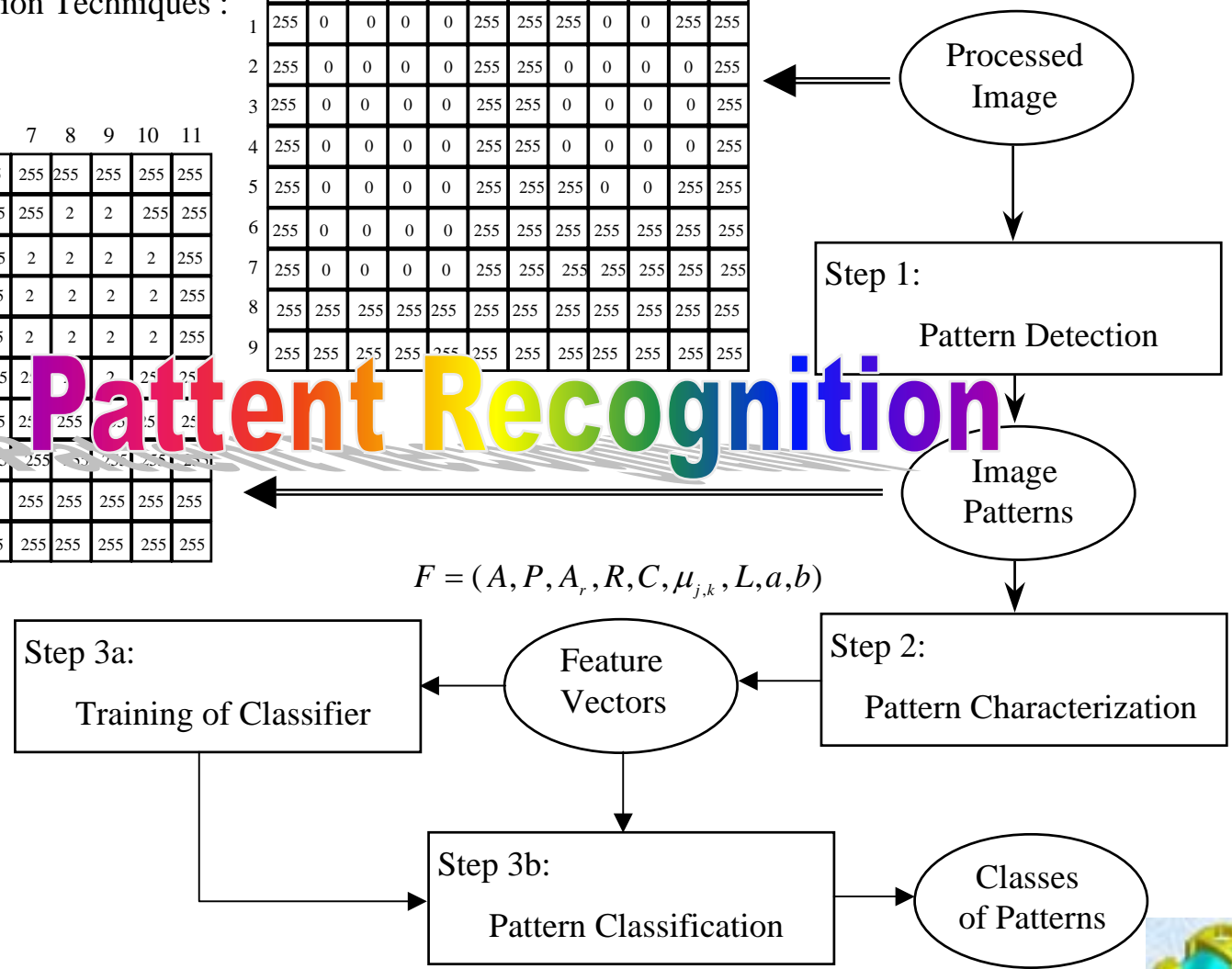
VISUAL INSPECTION

5. Vision Techniques :

	0	1	2	3	4	5	6	7	8	9	10	11
0	255	255	255	255	255	255	255	255	255	255	255	255
1	255	1	1	1	1	255	255	255	2	2	255	255
2	255	1	1	1	1	255	255	2	2	2	2	255
3	255	1	1	1	1	255	255	2	2	2	2	255
4	255	1	1	1	1	255	255	2	2	2	2	255
5	255	1	1	1	1	255	255	2	2	2	2	255
6	255	1	1	1	1	255	255	2	2	2	2	255
7	255	1	1	1	1	255	255	2	2	2	2	255
8	255	255	255	255	255	255	255	255	255	255	255	255
9	255	255	255	255	255	255	255	255	255	255	255	255

	0	1	2	3	4	5	6	7	8	9	10	11
0	255	255	255	255	255	255	255	255	255	255	255	255
1	255	0	0	0	0	255	255	255	0	0	255	255
2	255	0	0	0	0	255	255	0	0	0	0	255
3	255	0	0	0	0	255	255	0	0	0	0	255
4	255	0	0	0	0	255	255	0	0	0	0	255
5	255	0	0	0	0	255	255	255	0	0	255	255
6	255	0	0	0	0	255	255	255	255	255	255	255
7	255	0	0	0	0	255	255	255	255	255	255	255
8	255	255	255	255	255	255	255	255	255	255	255	255
9	255	255	255	255	255	255	255	255	255	255	255	255

Pattern Recognition

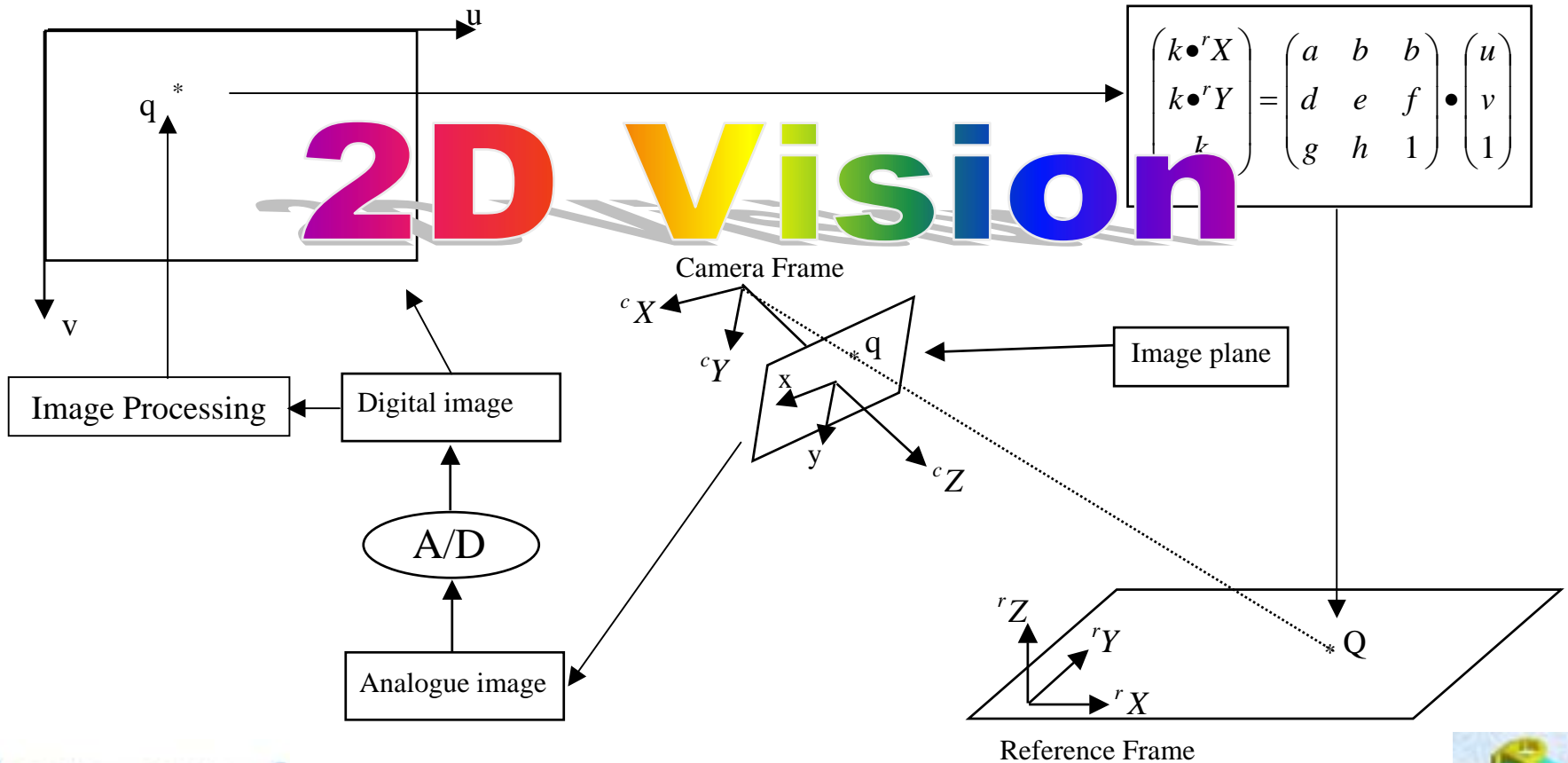


$$F = (A, P, A_r, R, C, \mu_{j,k}, L, a, b)$$



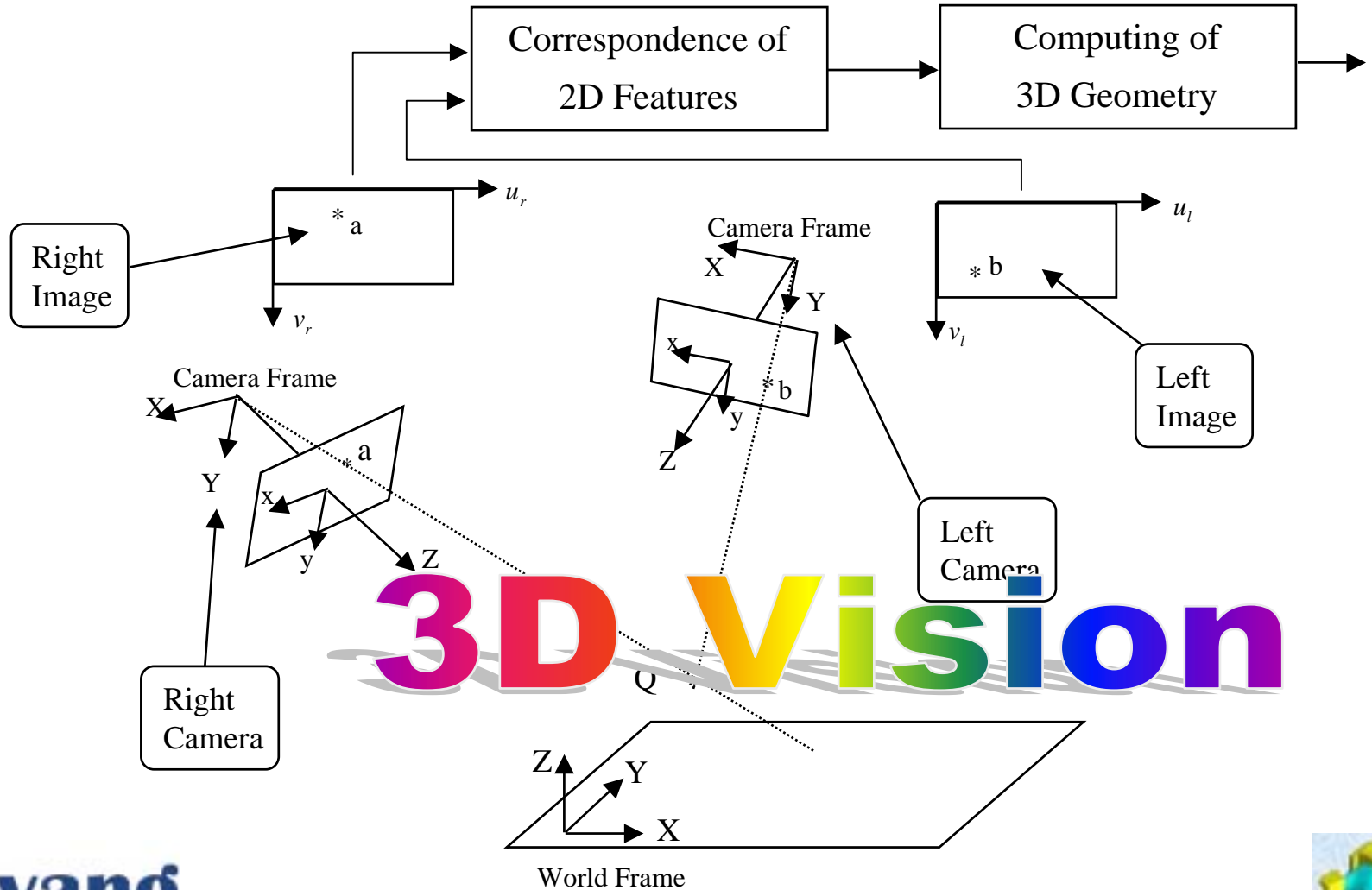
VISUAL INSPECTION

5. Vision Techniques :



VISUAL INSPECTION

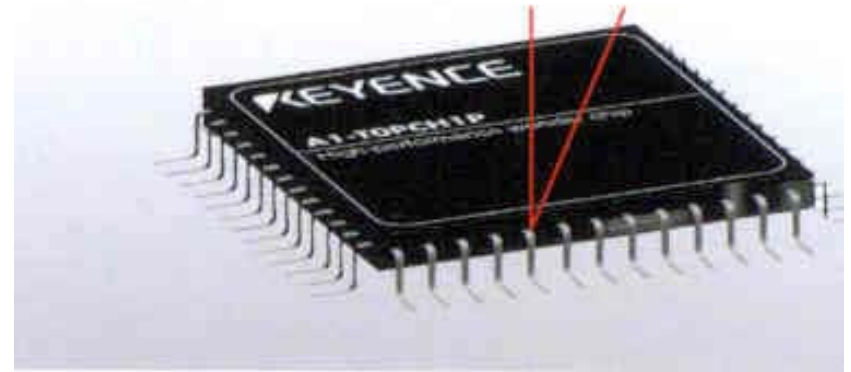
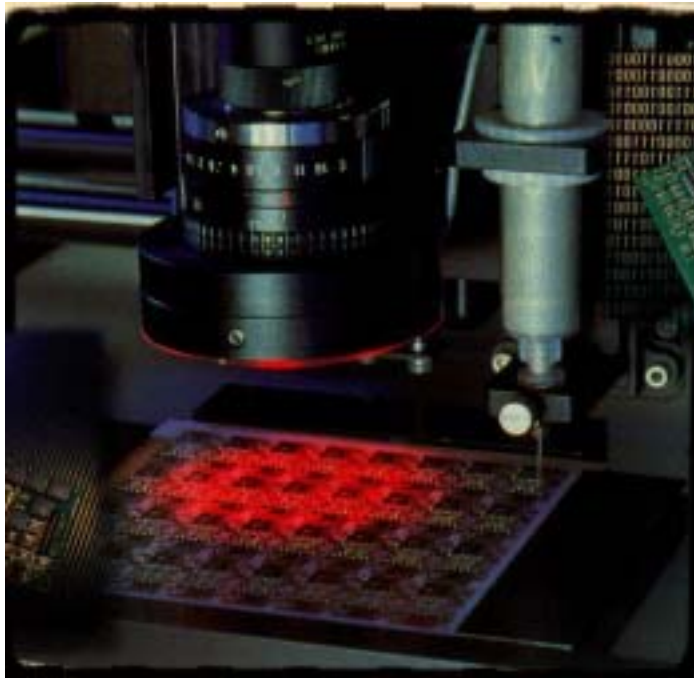
5. Vision Techniques :



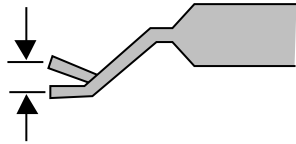
VISUAL INSPECTION

6. Case Studies : Lead Inspection of IC Chip

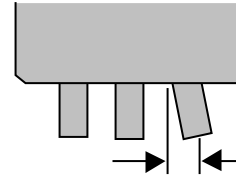
a) System Set-up



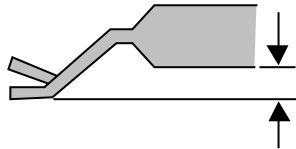
b) Possible defects:



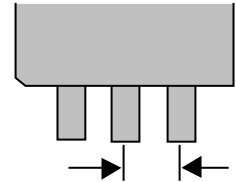
Coplanarity



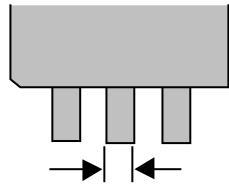
Bent Lead



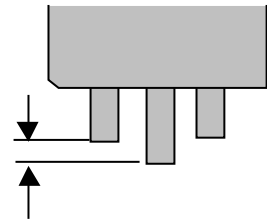
Standoff



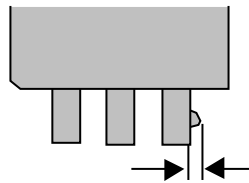
Pitch



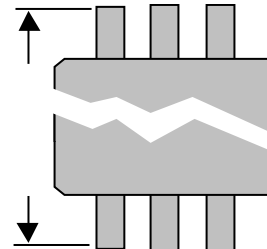
Width



Tip Offset



Burr



Terminal Dimensions



c) Specifications:

	Repeatability	Accuracy
Coplanarity	2.0/.08	6.5/.25
Standoff	4.0/.16	12.5/.50
Width	2.0/.08	6.5/.25
Bent Lead	2.0/.08	6.5/.25
Skew	2.0/.08	6.5/.25
Pitch	2.0/.08	6.5/.25
Tip Offset	2.0/.08	6.5/.25
Terminal Dimension	2.0/.08	12.5/.50

All Numbers are in Microns / Mils



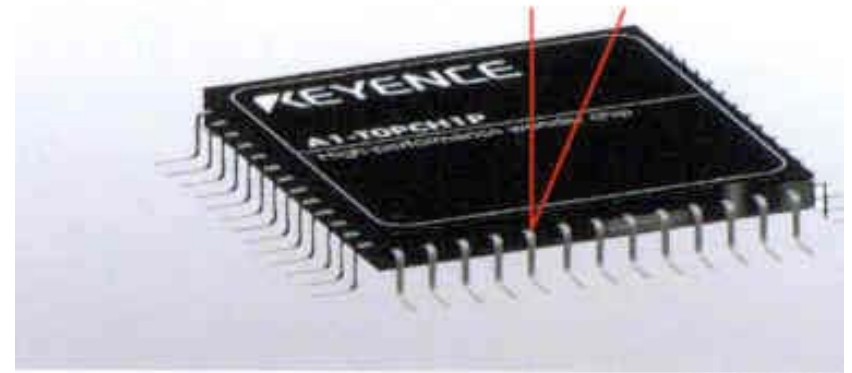
d) Possible Solutions:

2D Inspection

1. Lighting
2. Color Image Recognition
3. 2D Vision

3D Visual Inspection

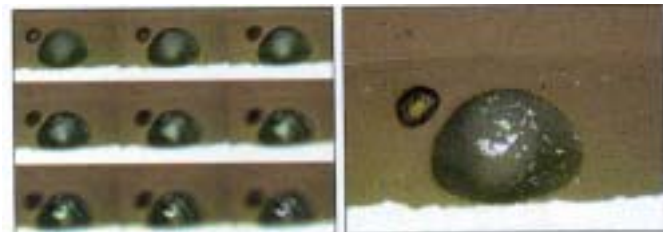
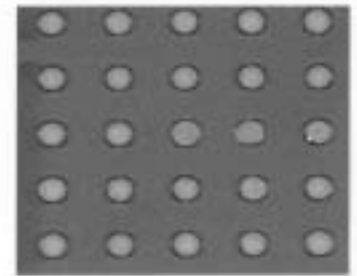
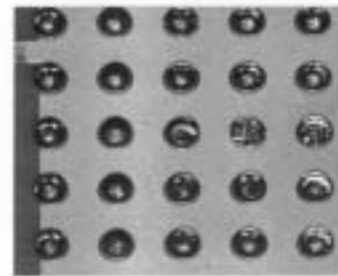
1. Point or line laser scanning
2. Structured Lighting Method



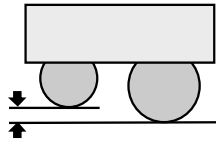
VISUAL INSPECTION

6. Case Studies : BGA Inspection of IC Chip

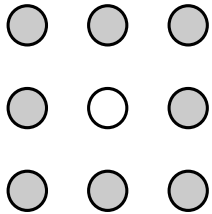
a) System Set-up



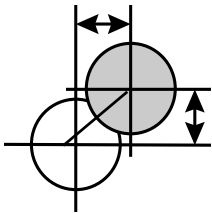
b) Possible defects:



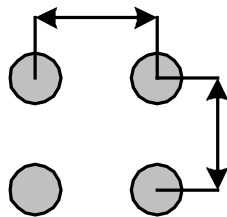
Coplanarity



Presence/Absence (Missing Balls)

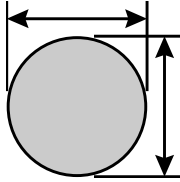


Ball Position (X, Y and Radial Error)

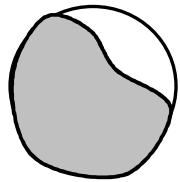


Ball Pitch (Center-to-center distance to nearest ball)

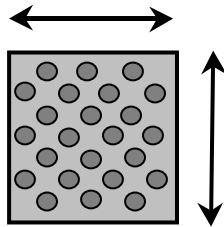




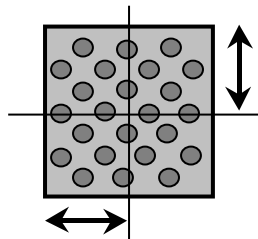
Ball Diameter



Ball Quality or Shape Factor



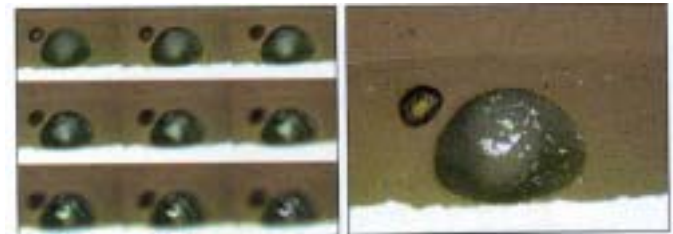
Grid Position (X and Y)



c) Possible Solutions:

2D Inspection

1. Lighting
2. Thresholding
3. Shape Analysis
4. 2D Vision



3D Visual Inspection

1. Line laser scanning
2. Structured Lighting Method



VISUAL INSPECTION

6. Case Studies :Mark A Inspection of IC Chip

a) System Set-up



b) Possible defects:

- Broken or Partial Characters
- Extra Characters or Ink
- Scratched Marks
- Correlation (Quality) of Mark
- Smearred or Blurred Marks
- Mark Correctness
- Position of Mark (X,Y and Rotation)
- Over-printing of the Mark
- Under-printing of the Mark



c) Possible Solutions:

2D Inspection

1. Template Matching
2. Pattern Recognition
3. Color Image Recognition
4. 2D Vision

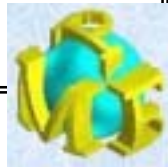
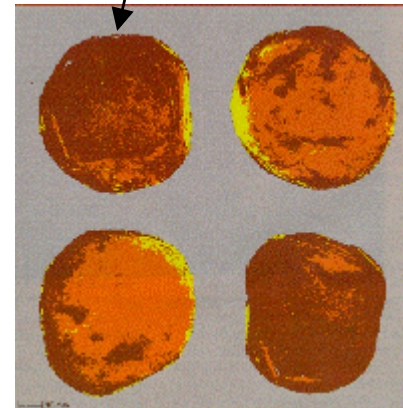
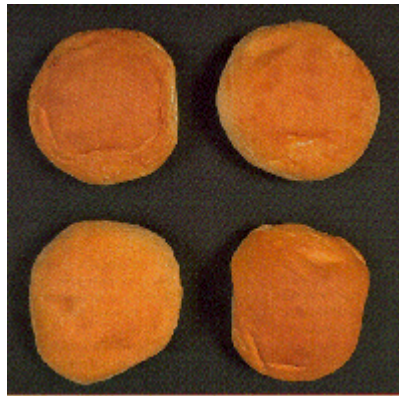


VISUAL INSPECTION

6. Case Studies :Food Inspection

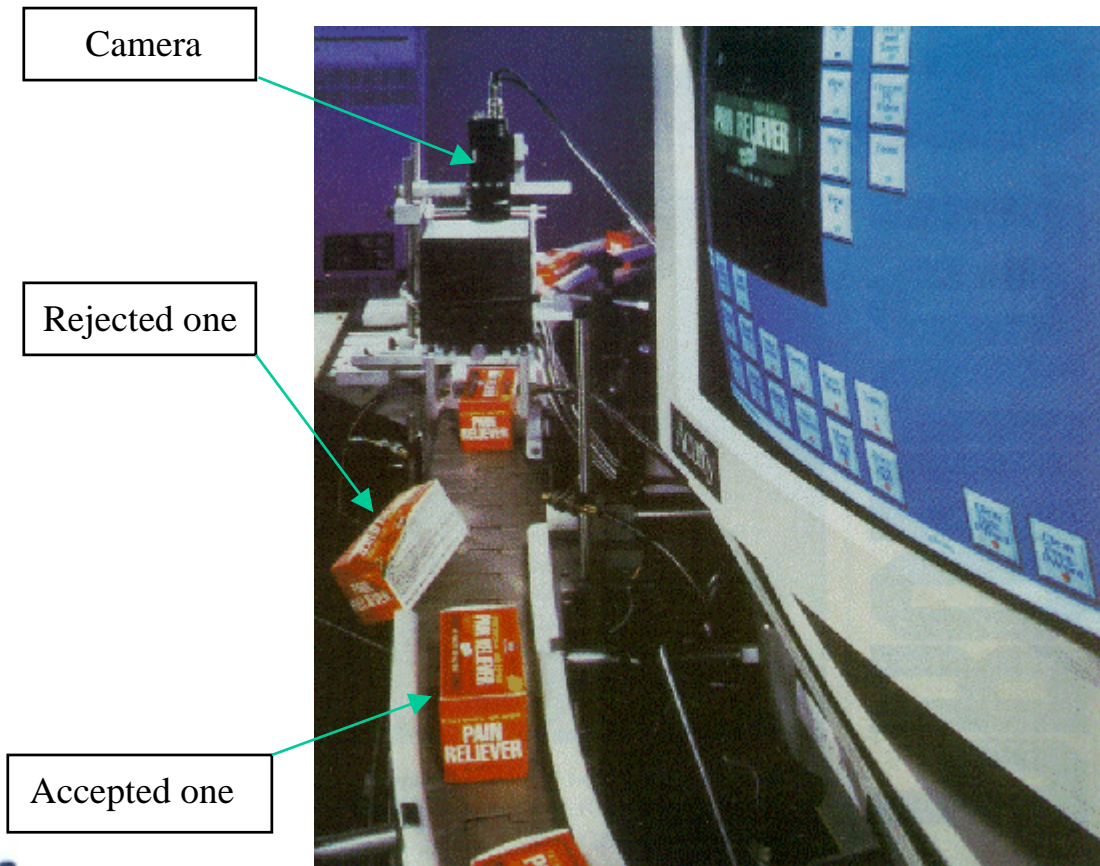


Overcooked



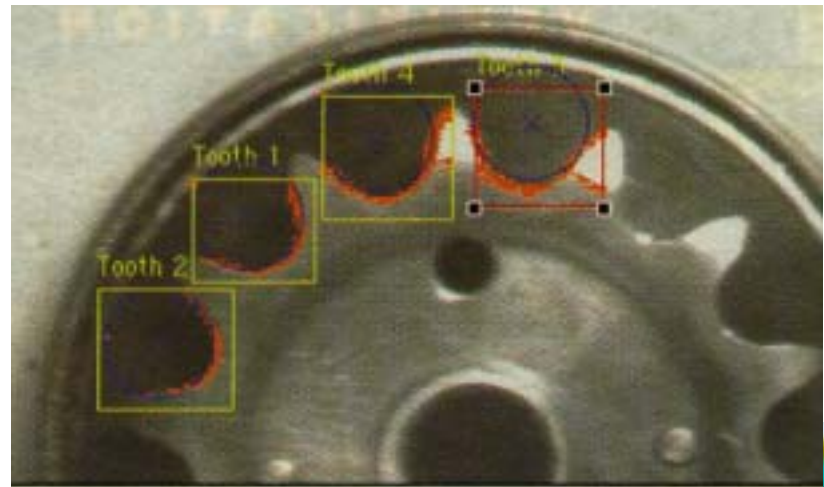
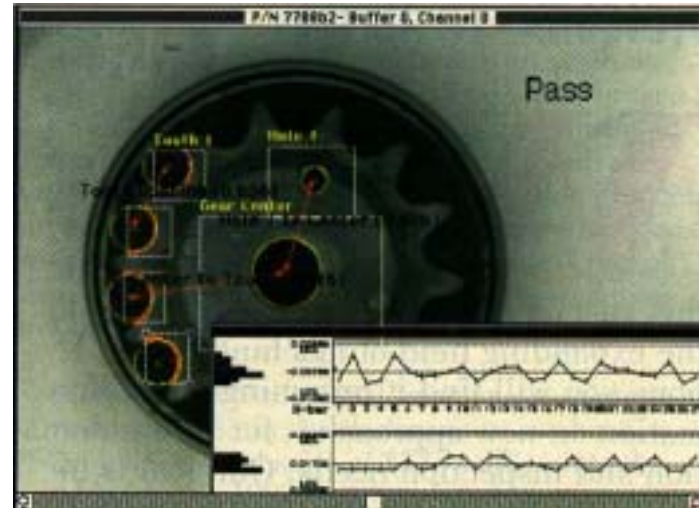
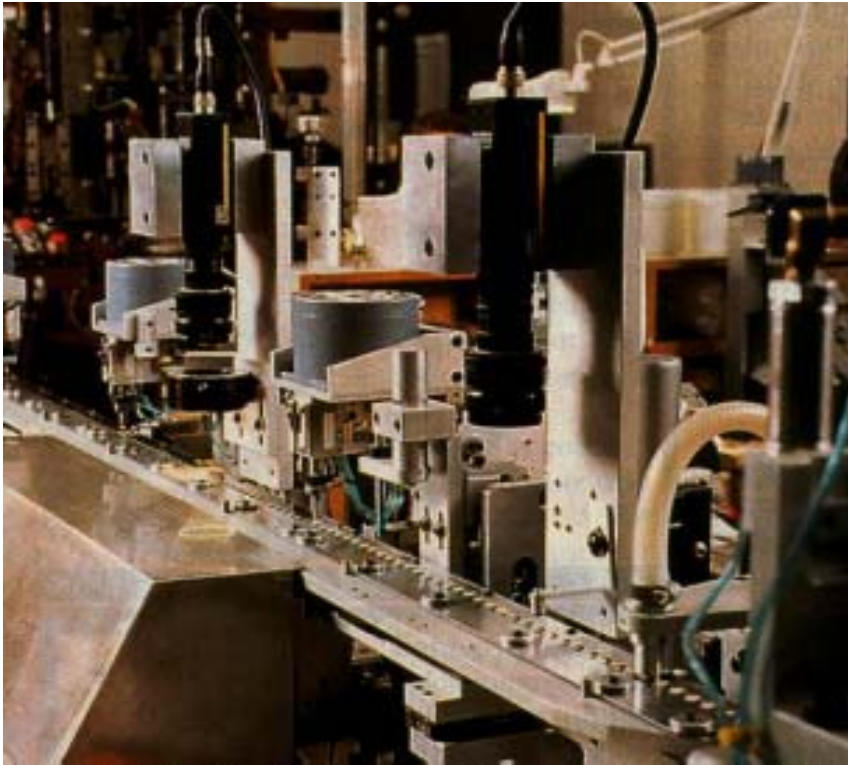
VISUAL INSPECTION

6. Case Studies :Printed Packaging Inspection



VISUAL INSPECTION

6. Case Studies :Part Inspection



SUMMARY

1. Visual inspection is a process of using images to test whether an object meets certain criteria.

2. The commonly used photometric criteria are:
 - Intensity
 - Color
 - Uniformity
 - Texture, etc

3. The commonly used geometric criteria are:
 - Shape
 - Alignment
 - Dimension - Topology
 - Distance
 - Location

4. The main purposes of doing visual inspection are:
 - Quality control (verification)
 - Sorting (classification)

