Chapitre1:

Introduction à la Vision par Ordinateur

1– Définition de la vision par ordinateur
2- Applications de la vision par ordinateur

1-Définitions:

La Vision par Ordinateur est une discipline qui a pour objectif le développement d'un système informatique capable de doter l'ordinateur du sens de vision.

En entrée, le système dispose:

- d'images de la scène prises par un ensemble de capteurs,
- d'une base de connaissances acquise et enrichie dans le temps.

En sortie, le système doit être capable de reconnaître et situer relativement les objets composant la scène, en temps réel.

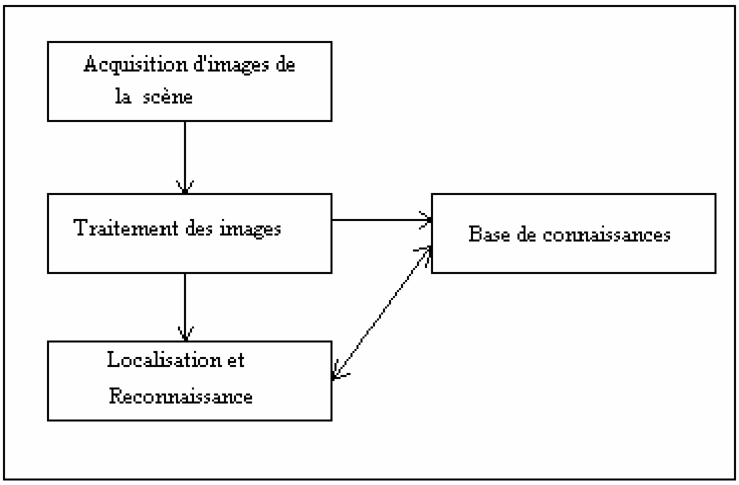


Figure1-Schéma fonctionnel d'un système Informatique de Vision

Dans la littérature on trouve les définitions suivantes :

- D'après David Marr [Marr82], la Vision par Ordinateur est le processus qui consiste à découvrir à partir des observations d'un univers ce qui y est présent et où il se situe. Ce processus produit à partir d'images du monde extérieur une description utile et non confuse par une information inadéquate.

- La Vision par Ordinateur est la construction explicite des descriptions significatives d'objets physiques à partir d'images[Ballard and Brown82].

- La Vision par Ordinateur est un système pour lequel on produit des descriptions de l'environnement perçu à partir de l'analyse d'images. Ces descriptions doivent contenir les aspects des objets observés qui sont utiles pour accomplir les tâches auxquelles est dédiée la machine de vision[Horn86].

- The goal of Computer Vision is to make useful decisions about real physical objects and scenes based on sensed images.

In order to make decisions about real objects, it is almost always necessary to construct some description or model of them from the image.

Sensing: How do sensors obtain images of the world? How do the images encode properties of the world, such as material, shape, illumination, and spatial relationships?

Encoded Information: How do images yield information for understanding the 3D world, including the geometry, texture, motion, and identity of object in it?

Representations: What representations should be used for stored descriptions of objects, their parts, properties, and relationships?

Algorithms: What methods are there to process image information and construct descriptions of the world and its objects?

2- Applications de la Vision par Ordinateur

The applications of computers in image analysis are virtually limitless. Only a small sample of applications can be included here, but these will serve us well for both motivation and orientation to the field of study.

2.1 A Preview of the digital image

A digital image might represent a cartoon, a page of text, a person's face, a map of Algiers, or a product for purchase from a catalogue.

A digital image contains a fixed number of rows and columns of pixels (short for pixel elements). Pixels are like tiles holding quantized values-small numbers, often between 0 and 255, that represent the brightness at the points of the image.

Depending on the coding scheme, 0 could be the darkest and 255 the brightest, or vice-versa.

At the left in Figure 2 is a printed digital image of inside scene that is 768 rows high by 576 columns wide. At the right is an 13x12 subimage extracted from the framed region of the left image.The numbers below 160 represent the lower reflection, while the higher numbers represent the brighter area of wall.

Figure 2. Image of inside scene, at the right a subimage 13x12 pixels from the framed region; and (bottom) intensity values from the 13x12 subimage

	0	1	2	3	4	5	6	7	8	9	10	11
0	154	163	191	204	214	225	232	237	238	238	233	222
1	152	161	189	204	213	225	231	235	236	233	211	208
2	154	162	188	202	214	225	231	236	231	225	211	194
3	154	161	186	201	213	224	230	229	225	215	197	179
4	152	161	186	201	212	223	228	229	217	202	183	166
5	153	159	186	200	210	221	225	222	207	190	172	158
6	154	160	187	201	210	221	221	211	195	178	162	150
7	154	159	185	198	209	216	215	199	184	168	155	147
8	155	162	186	199	209	211	207	189	173	160	148	143
9	156	161	183	195	205	203	196	179	165	154	147	141
10	156	161	182	194	201	195	187	171	158	149	143	140
11	157	162	182	192	195	186	177	162	152	145	143	140
12	164	184	190	189	177	167	155	149	145	142	139	255

2.2 Image Database Query

Huge digital memories, high bandwidth transmission, and multimedia personal computers have facilitated the development of image databases.

Good use of many existing images requires good retrieval methods.

Standard database techniques apply to images that have been augmented with text keys; however, content-based retrieval is needed and is a topic of much current research.

Suppose that a newly formed company wants to design and protect a new logo and that an artist has created several candidatures for the company to consider. A logo cannot be used if it is too similar to one of an existing company, so a database of existing logos must be searched.

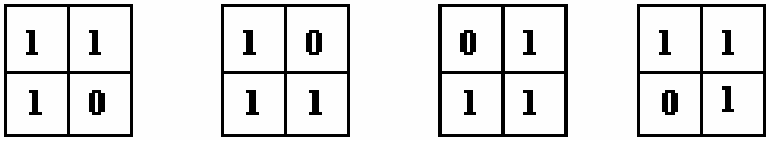
Figure 3. Image query by example: (left) query image; and two most similar images produced by an image database system. (Courtesy of Graphic-sha, Tokyo.)

2.3 Inspecting Crossbars for Holes

In the late 1970s an engineer in Milwaukee implemented a machine vision that successfully counted the number of bolt holes in crossbars made for truck companies. The truck companies demanded that every crossbar be inspected before being shipped to them, because a missing bolt hole on a partly assembled truck was a very costly defect. Either the assembly line would have to be stopped while the needed hole was drilled, or worse, a worker might ignore placing a required bolt in order to keep the production line running.

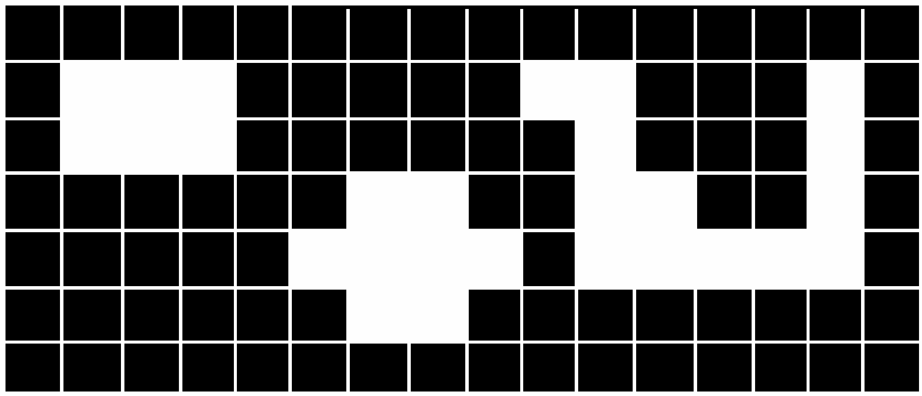
To create a digital image of the truck crossbar, lights were placed beneath the existing transfer line and a digital camera above it. When a crossbar came into the field of view, an image was taken. Dark pixels inside the shadow of the crossbar were represented as 1s indicating steel, and pixels in the bright holes were represented as 0s, indicating that the hole was drilled.

The number of holes can be computed as the number of external corners minus the number of internal corners all divided by four.



(a) 2x2 external corner patterns

(b) 2x2 internal corner patterns



(c) Three bright holes in dark background

	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	e	i
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	6	0
1	1	0	0	0	1	1	1	1	1	0	0	1	1	0	0	1	1	1
2	1	0	0	0	1	1	1	1	1	1	0	1	1	0	0	1	6	2
3	1	1	1	1	1	1	0	0	1	1	0	0	1	1	0	1	2	4
4	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	1	4	2
5	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	2	0
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0

(d) Binary input image 7 rows high and 16 columns wide, External corner patterns marked with e; internal corners marked i

Figure 4. Counting the number of holes in binary image: 21 external corner patterns minus 9 internal patterns divided by 4 yields a count of 3 holes.

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Input a binary image and output the number of holes it contains
M is a binary image of R rows of C columns.
1 represents material through which light has not passed;
0 represents absence of material indicated by light passing.
Each region of 0s must be 4-connected and all image border pixels must be 1s.
E is the count of external corners (3 ones and 1 zero)
I is the count of internal corners (3 zeros and 1 one )
 Integer procedure Count_Holes (M)
{ examine entire image, 2 rows at a time;
                count external corners E;
                count internal corners I;
                return (number_of_holes=(E-I)/4);
 }
```

Algorithm 1.1 Skeleton of algorithm for counting holes in a binary image

2.4 Examining the inside oh Human Head

Magnetic resonance imaging (MRI) devices can sense materials in the interior of 3D objects. Figure 5 shows a section through a human head: brightness is related to movement of material; this is actually a picture of blood flow. One can see important blood vessels.

MRI images are used by doctors to check for tumours or blood flow problems such as abnormal vessel constrictions or expansions.

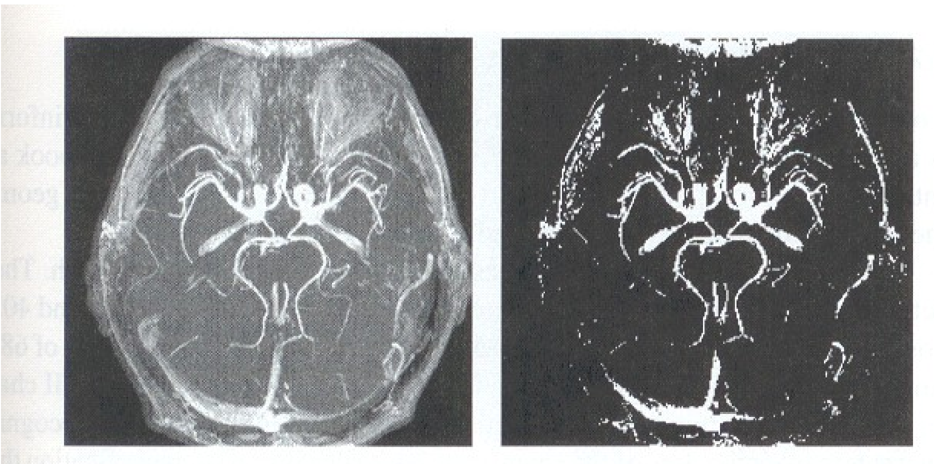

Figure 5: (left) Magnetic resonance image where brightness relates to blood flow; and (right) binary image from changing all pixels with value 208 or above to 255 and those below 208 to 0.

2.5 Processing scanned text pages

Converting information from paper documents into digital form for information systems is a common problem. For example, we might want to make an old book available on the internet, or we might need to convert a blueprint of some object into a geometry file so that the part can be made by a numerically controlled machine tool.

Recognizing individual characters from the dots of the scanner or fax files is one such application that is done fairly well today, provided that the characters conform to standard patterns. Providing a semantic interpretation of the information, possibly to be used for indexing in a large database, is a harder problem.

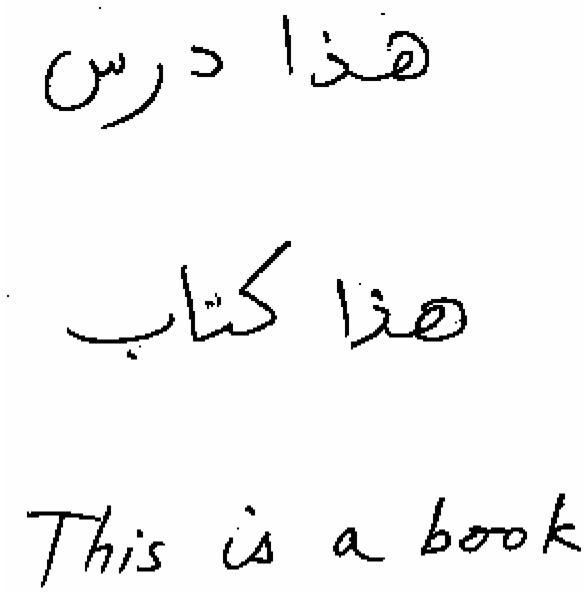

Figure 6. The text: this is a book

2.6 Accounting for Snow Cover using a satellite Image

Much of the earth's surface is scanned regularly from satellites, which transmit their images to earth in digital form. These images can be processed to extract a wealth of information.

Estimates of snow mass can be made by accounting for the number of pixels in the image that appear as snow. A pixel from a satellite image might result from sensing a 10mx10m spot of earth.

Figure 7 is a photograph taken on a space shuttle flight. It shows the town of Wenatchee, Washington, where the Wenatchee River flows into Columbia River.

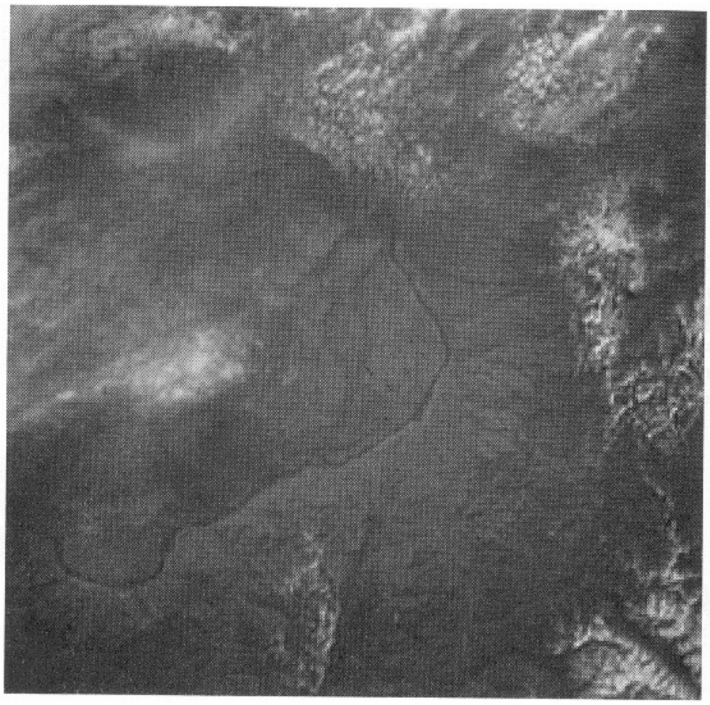

Figure 7. Photo of Wenatchee

2.7 Understanding of scene of parts

At many points of manufacturing processes, parts are transferred on conveyers or in boxes. Parts must be individually placed in machines, packed, inspected, etc. if the operation is dull or dangerous, a vision guided robot might provide a solution. The underlying image of Figure 8 shows three work pieces in a robot’s workspace. By recognizing edges and holes, the robot vision system is able to guess at both the identity of a part and its position in the workspace. .

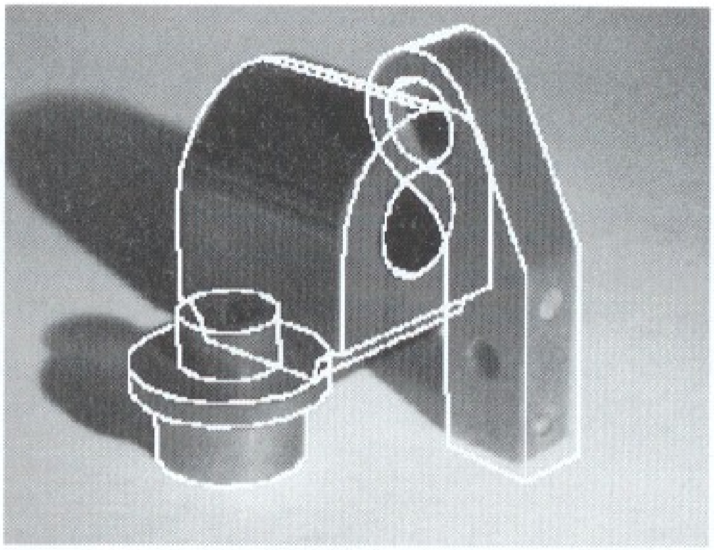

Figure 8. An inspection or assembly robot matches stored 3D models to a sensed 2D image

REFERENCES BIBLIOGRAPHIQUES

→ 1er Ouvrage consacré partièllement à la Vision par Ordinateur :
Duda and Hart : **Pattren classification and scene analysis**, 1973
Reconnaissance de forme, approche géométrique de l'interprétation d'une image,….

→ Ouvrage de Ballard and Brown : **Computer Vision** , 1982
Vue synthétique des travaux de recherche dans les années 80

→ Ouvrage de B.K.P. Horn : **Robot Vision** 1986
Aspects de la vision du point de vue fondamental :

- bases mathématiques de la détection des contours et régions
- propriétés photométriques
- perception du mouvement

→ Ouvrage de Nicolas Ayache :
-Artificial Vision for Mobile Robots- Stereovision and Multisensory Perception, MIT Press 1991
-Vision Stéréoscopique et Perception Multisensorielle, InterEditions, 1989

Utilisation de la vision pour la navigation des robots

→ Ouvrage de O.D. Faugeras : **Three Dimensional Computer Vision : A Geometric Viewpoint** , MIT Press, 1993

→ Ouvrages de R. Horaud et O. Monga : **Vision par Ordinateur : outils fondamentaux**, Ed. Hermès 1995