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Image Analyzers: Its Development and New Application for 3-Dimensional Image Processing

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Abstract. A brief summary of development of image analyzer and basic composition of its system is given. A future scope of constracting 3D image analyzer is noted.

1. History of the Image Analyzers

Images contain so much information that it is often difficult to utilize it for our specific purposes. They say about 90 percent of total information which human beings get by our five sense organs come from our sight. Therefore, the purpose of image processing is defined, in short, to extract only useful information for image analysis from vast amount of it.

Image processing techniques are applied to many various fields, as listed below.

Medical use: cytometry, karyotipe, X-ray photo inspection, CT, NMR, ultrasonic inspection

Office use: character auto reading, facsimile, CCP copier

Remote sensing: LANDSAT

Printing industry: color scanner, dot area

Amusement: animation

Microscopic inspection: metals, cell.

The machine QTM-A, produced in 1963 by Metals Research Inc., UK, was the first stand-alone automatic image analyzer for an optical microscopic inspection. In early 70th, QTM-720 by Imanco UK, QMS by Bausch & Lomb USA, Classimat by Leitz West Germany, and Luzex 100 and 450 by Nireco Japan were marketted. The operating principle of these instruments were to make microscopic image by a CCTV, and to binarize the video signal for determination of features in the image. Various electronic techniques were adopted to label each feature, and to count the number of particles.

After 1975, Micro processors and IC memories were used for industrial image analyzers. Man-machine interactive industrial image analyzers, TAS by Leitz, OMNICON by Bausch & Lomb, Luzex 500 by Nireco, had binary image memory planes and many binary image processing functions built in.

In 80th, image analyzers became to have multiple gray image plane memories and many gray image processing functions built in, such as convolutions, spatial filterings, Affine transformations. QTM-900 by Cambridge Instruments UK, Magiscan II by Joice Loebl UK, IBAS II by Zeiss WG, Luzex 5000 by Nireco were popular among reserchers. On the other hand, big systems as mini computers or main frames combined with image processing, and displaying hardwares were becoming available to everybody, Tospix by Toshiba Japan, Nexus by Kashiwagi Seisakusho Japan are such examples.

Today, personal computers and engineering work-stations are developed in performance and cost, and clearing up the barrier between stand-alone image analyzers and computer-based big systems. Now, many image-analysis systems adopt personal computers as their controllers and data processors.

2. Composition of a Image Analysis System

2.1 Total composition

An image analyser is composed of the following 6 portions:

a. Image input
b. Image memory and display
c. Gray image and Binary image processing and analyzing
d. Data process
e. System control and man machine interface
f. Data and image output

Figure 1 shows system diagram of image analyzer and peripheral devices. Figure 2 shows an example of image analyzer, the Luzex III, a personal computer with a mouse, a keyboard and a high resolution color display.

To analyze an image, video signals from a monochrome or color image is input by a TV camera or other image input device. They are transferred to a gray-image memory through an A-D converter. Then gray-image processing and image binarization follows. After Binary image processing, labelling, and image analyzing, the total process is finished. Man-machine interface should be provided for these processing and analyzing. For data output, analyzed data printer and image hard copier or optical disc memory are used.

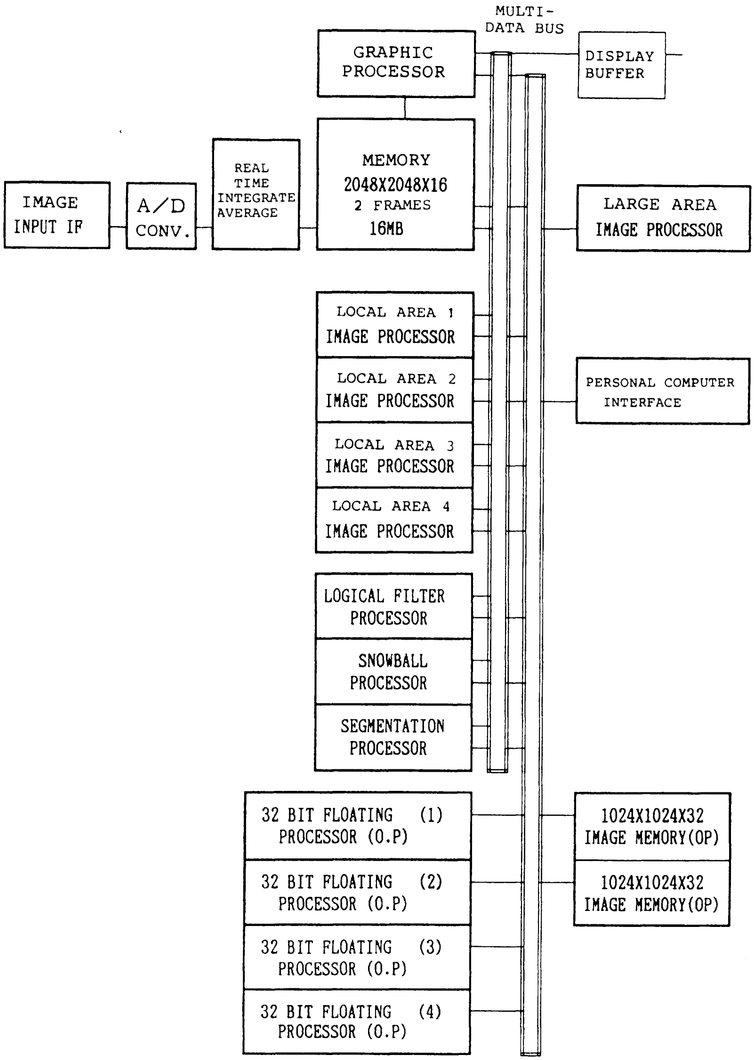

Fig. 1. A typical system of image analyzer.

2.2 Image input device

TV camera have been used as image input devices. Recently, however, SEM (scanning electron microscope) signals can be input directly to image analyzers.

Two kinds of TV camera, image-pick-up tube type and solid-state-element type, are available. For image analysis, today, image-tube-type camera are mostly used because of their good resolution and sensitivity. For the near future, after

Fig. 2. An example of image analyzer, Luzex III by Nireco Cooporation.

development of elements with high resolution and low price, the solid-state type will dominates owing to its linearity superiority. Yet, their favorite area will be limited.

For Moving-image analysis or in some bad environments, VTR is used to get and store images. Those VTR images are analyzed by image analyzers. Caution must be taken here because those VTR images are not so good as these of TV cameras in spatial resolution, intensity dynamic range, and hue.

Recently, electron microscopic images are input directly to image analyzers, because this method does not need photographing, and the reliability of image memories such as optical discs is good enough in some field of techniques.

TEM (transmission electron microscope) images are getting through a high sensitivity TV camera of standard scanning system. SEM (scanning electron microscope) can output images with video signals and synchronizing signals. Scan rates and scanning line numbers differ among SEMs, and depending on images. Scan-converting interfaces for image analyzers are usually adopted.

2.3 Gray image process and analysis

Process of gray images is concerned with the following functions:

a. linear filtering
b. non linear filtering
c. shading correction
d. FFT
e. density conversion
f. Affine transform
g. pseudo color process
h. binarize

2.4 Binary image process and analysis

Binarized image data stored in binary memory are processed and analyzed as follows:

a. inter-image logical operation
b. logical filtering
c. manual modulation
d. labelling
e. geological measurement

3. 3-D Image Process

We are trying to construct three dimensional images from many samples sliced parallel. Since all image analyzing hardwares and softwares have been designed for 2-D images, there are still many problems to be solved for 3-D processing. If a three-

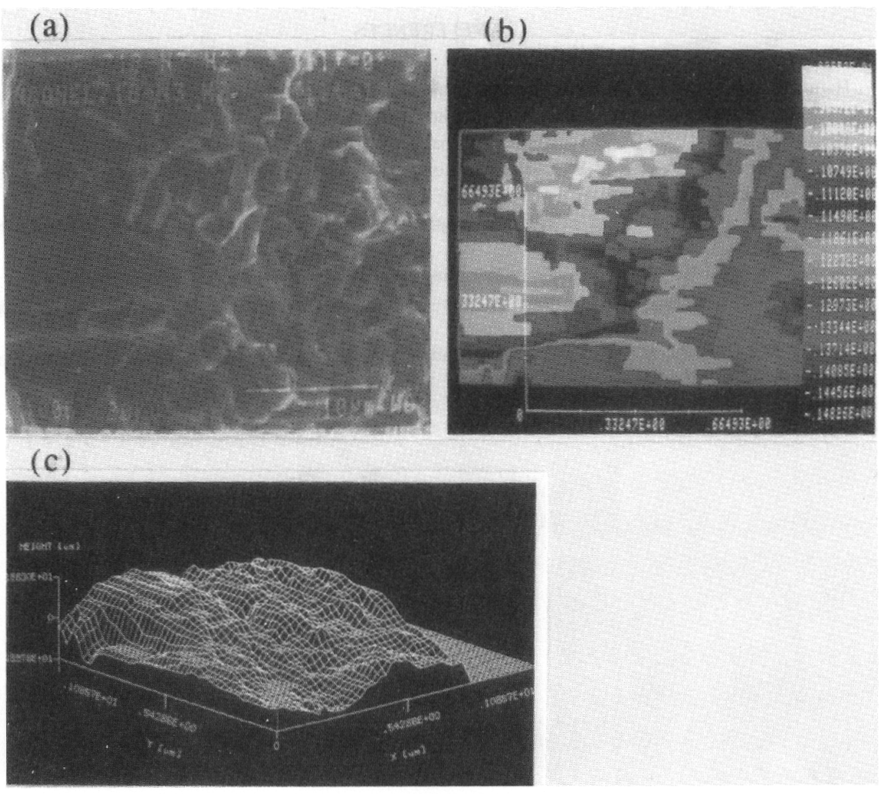

Fig. 3. An example of reconstructed 3-D image from two 2-D images, (a) stereographic view of a metal fracture by electron microscope, (b) pseudo-color presentation of the height distribution of the metal fracture, (c) wire-frame presentation of the metal fracture.

dimensional image memory chip is available, this technique will develop drastically.

Also, a stereoscopic image constructed from a pair of 2-D images are tried by image analyzers. The main problem exists in automatic corresponding-points finding. Many proposed theories and practices exist, but none is satisfactory. An example of reconstructed 3-D image is shown in Fig. 3.

However primitive these results may be, all trials are very important because we can see an imaginary figure by these techniques.

4. Conclusion

Here we summarized the basic construction of image analyzers for quantitative analysis of mainly microscopic images. Detail features and functions are described in catalogs of equipments. Recently, three dimensional image construction by image analyzers is becoming popular, which will promote new scientific activities.

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