Interactive Image Processing System Using General Purpose Computer

Masanori UEHARA
FUJITSU Ltd.
Japan
Working Group II/3

1. Introduction

With the progress in digital image processing technologies, systems for processing remotely sensed data has been improved rapidly. The author developed a minicomputer-based interactive image processing system for remote sensing in 1979. Since then, the system has been constantly upgraded with advanced image processing technology and specific needs of customers in a practical manner.

Under the consideration of current changes in needs of customers and the trend of handling complex digital data, the author developed and implemented the new system on a large scale general purpose computer in April, 1983. This system can handle large volume of data, such as Thematic Mapper, and allow multiple interactive users to use simultaneously.

This system is currently in operation at many computing centers.

In designing a general purpose computer based system for processing remotely sensed data, the design philosophy and system functions are described in this paper. The problems of the system for present and future use are also discussed.

2. Design Philosophy

In designing a system for processing remotely sensed data, the design philosophy behind the system to be configured is to handle large volume of data and then supply the capability of multiple interactive use

(1) The system should supply a wide variety of processing modes to simplify man-machine operation

The image processing does not always arrive at a unique solution. The computer can not evaluate the generated image quality and the computed results, through the colour tone. A large part of image quality evaluation still depends heavily upon human eyes.

The system shall employ the menu method to simplify man-machine interactive operation. The system shall then supply a wide variety of processing modes to customers, having functions for processing large volume of data as a background job and scheduling functions.

(2) The system should be flexible enough to link with other programs

In order to meet specific needs of customers, the system

should be flexible enough to link with existing image processing program libraries. Moreover, the system should be interactively in operation.

A wide variety of tools for developing programs in the most cost effective manner are sufficiently provided on a general purpose computer.

(3) The system should support multiple users

The system should be designed so that multiple users can use the system simultaneously. Such capability should be achieved by taking advantage of the various resources a general purpose computer's operating system has.

3. Hardware Configuration

The hardware configuration is illustrated in Fig. 1.

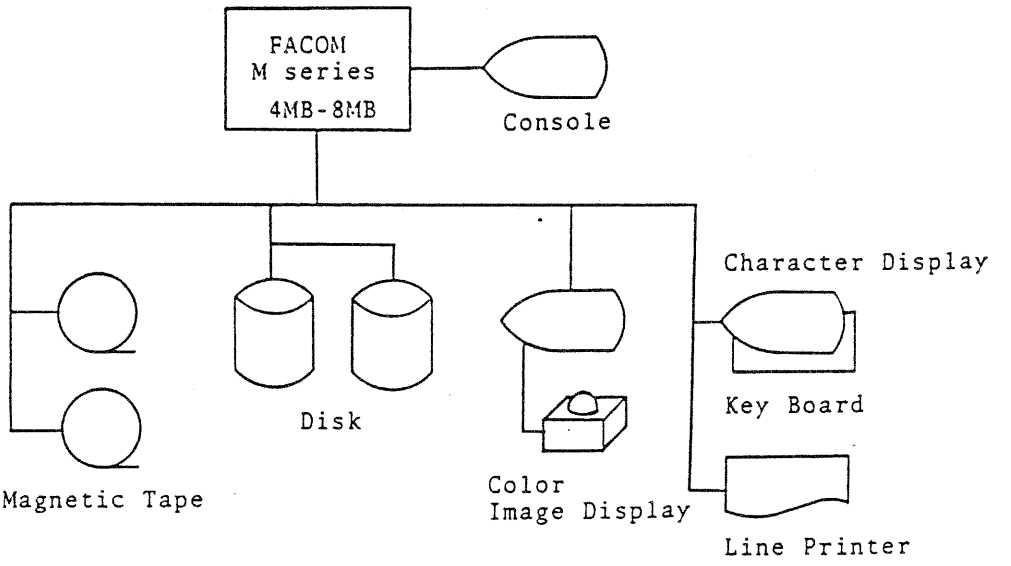

Fig.1 Hardware Configuration

The large volume of data is transfered from and to image display and CPU. Therefore, the image display should be interfaced to the image display unit of Graphica series through high speed data transfer device such as BMC (Block Multiplexer Channel) to send data.

The capabilities of image display unit are tabulated in Table 1.

Table 1 Capabilities of Image Display

Function \ Device	I-5048
Resolution	512(H) x 512(V)
Memory Channels	4
Memory Planes/Channel	8
Intensity Level	256
Input Conversion Table(ICT)	13 bits ICT(convert 13 bits into 8 bits)
Look Up Table(LUT)	R, G, B/Channel, 9 bits (-256～+256)
Output Function Memory(OFM)	R, G, B/Channel, 10 bits (0～1023)
Graphic Plane	512 x 512 x 3(R, G, B), Vectorizer
Zooming	2 and 4 times magnification
Scrolling	X-Y direction
Split Screen & Roaming	Roaming
Cursor	Generate any pattern on 64 x 64 bits (use of track ball)
Video Meter	Compute a histogram of OFM
Feedback-ALU	Feedback loop from the combination logic output to refresh memory

4. Software Capabilities

(1) Image processing function

The user can start the program to meet his own purpose. The image processing functions are tabulated in Table 2.1 and Table 2.2.

a. Data Input/Output
The image data are transfered to and from magnetic tapes and magnetic disks. The magnetic tape format allowable are Landsat CCT format and format specified by Information Processing Society of Japan.

b. Data Transfer
The data Transfer is performed between image display unit and magnetic disk.

c. Image Display
Display false colour, pseudo colour, and zooming

d. Image Operation
Perform arithmetic operation, noise deletion, and edge enhancement.

Table 2.1 Interactive Image Processing Functions (PROSID)

Group Name	Task Name	Description of Function
Input/Output	IMGIN	Create the master image data from CCT
	MTTOMA	Create the master image data from IPS[1] formatted CCT
	MATOMT	Output members to IPS formatted magnetic tape
Data Transfer	MATOID	Transfer the master image data to the refresh memory
	DKTOID	Transfer the image data to the image display subunit
	IDTODK	Create the image data from the image display subunit
	IDTOMA	Transfer the refresh memory to the master image file
	FEEDBK	Feed output data back to the refresh memory
Image Display	DISP	Display false colur
	PSEUDO	Display pseudo colour of the refresh memory
	SCROLL	Scroll the image
	ZOOMIN	Zoom the image
	KL	K-L conversion
	SPLITM	Display on the colour monitor the image spanning on two or more refresh memory units
	LTMSK	Mask or release the LUT
	LOPFLM	Animation
	PCLR3	Assign colours to the intensity levels using trackball
	GRAPLN	Assign colour to graphic planes
	LATLON	Display the image with latitude and logitude lines
Image Operation	ADD	Add two images
	MULT	Multiply two images
	DIVIDE	Divide two images
	FILTER	Enhancement and noise deletion
	FFTFLT	FFT filtering
Image Analysis	HISTGRM	Compute density histograms of an image
	LIKHOD1	Categorize the image data using the ML[2] method
	LIKHOD2	Classify the image data using the ML method
	SIMIL	Similarily analysis
	DNGRF2	Intensity graph of a specified image line
	MICELL	Classify the image data from the histogram
	HISTGM2	Display intensity by 2-dimensional histogram
	FURIE2	Display the image data transformed by FFT
	PICKPS	Display the position specified by positioning device
Image Transform	SLIDE2	Mapping by translation
	AFFIN	Affine transformation
	THRSH	Threshold
	EDGELN	3-dimensional representation of graphic data
	PHOTO	Overlay image data on 3-dimensional graphical data
	PAINT	Paint a specified area
	VIALT1	Generate the image conversion table
	VIALT2	Generate the image data from the conversion table
	MOSAIC	Mosaicing
System Utility	LINEAR	Generate linear conversion tables on ICT, LUT, or OFM[3]
	LOG	Generate logarithmic conversion table on LUT
	EXP	Generate exponential conversion table on OFM
	ANOT	Display annotation information on graphic memory
	CURSOR	Specify the shape and size of cursor
	IMGDMP	Output the image data to a line printer
	DATMAG	Functions for managing data files
	PLINE	Draw a line on a refresh memory or a graphic memory
Support	PATTN2	Write a test pattern on a refresh memory
	IIS	Output the internal status of I^2S to a line printer
	MEMCL	Clear refresh memory
	FALLOC	Allocate file on disk
	PIAGNR	Generate PIA
	TBSVLD	Save and load image data

1) IPS : Information Processing Society of Japan
2) ML : Maximum Likelihood
3) OFM : Output Function Memory

Table 2.2 Batch Processing Functions (PIA)

Group Name	Task Name	Description of Function
Preprocessing	FRMDFN	Extract a subframe from CCT
	STRTCH	Linear tramsformation of image data
	FILTER	Filtering
	OPERTN	Operation beween channels
	IMGMSK	Masking
	CORECT	Graphical corection
	BOUND	Overlay the administrative boundary
	HEIGHT	Overlay the sea level data
	CONECT	Connect the neighbouring images
	FULDFN	Input table scenes and annotations
	DESTRP	Delete the detector noise
	SKEWCV	Correct the skew of MSS image data
	ANNDMP	Annotation dump
Statistics	STATIS	Statistics
	PCACVT	Principal compoment analysis
	CLUSTR	Clustering
	CLASFY	Classification
	SIMILR	Similarity analysis
	SEPRBL	Separability
Image Output	IMGMAP	Output image data on a line printer by intensity patterns
	NUMMAP	Output image data on a line printer by intensity values
	PROFIL	Profile
	PSEUDO	Pseudo colour
	MRKIMG	Convert an image into drum writer format and store into file
	MRKIM2	Convert an image into drum writer format and store into magnetic tape
File Management	FRMLST	List the fram information
	FRMCPY	Copy image file
	FRMDLT	Delete the frame
	FRMSAV	Save the frame to magnetic tape
	FRMLOD	Load the frame from magnetic tape
	BPICNV	Output to BPI format magnetic tape

e. Image Analysis
Compute the statistics of image data, and classify image data by the supervided classification method and so on.

f. Image Transform
Generate new image data by various transform methods.

g. System Utility
System utility available for image processing.

h. Support Fucntion
System Utility available for adding new functions.

i. Image Retrieval
Retrieve the frame information through menu, world map, and commands.

j. Batch Processing
Process large volume of data as a background job.

(2) Control Function

The system has the control functions to simplify operation and process the image data in the most effective manner.

a. Starting Modes of Image Processing Program

The system allows the operator to use two starting modes of image processing program.

- Auto-Mode
- Interactive-Mode

The concept of starting modes is illustrated in Fig. 2.

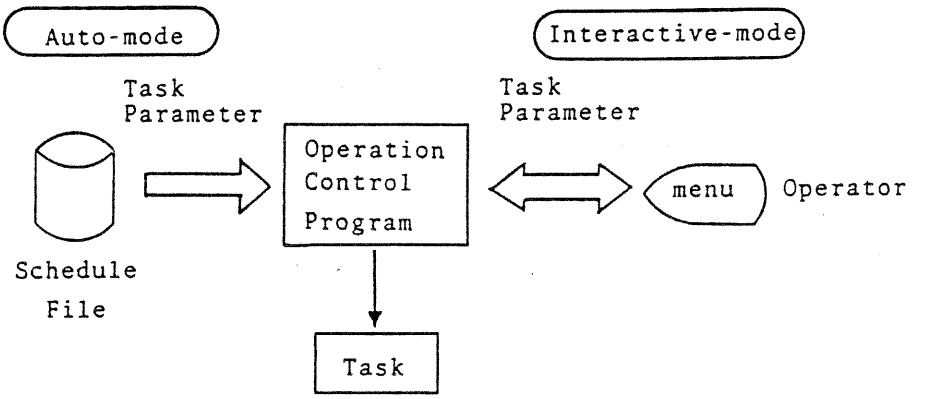

Fig. 2 Concept of auto-mode and interactive-mode

When selecting the auto-mode, the program names and the parameters are derived from the schedule file. Since the program is automatically started with the schedule file, there is no effort to operate. It is more effective to simplify the sequence of processing procedures.

When selecting interactive-mode, the program names and the parameters are specified through the menu displayed on the character display unit. Since image processing is accomplished with the human judgement and trial-and-error, interactive mode may be preferable.

b. Starting Methods

The program can be started with the starting methods.

- TSS (Time Sharing System) controlled program
- Batch program
- Call from user program

When starting the TSS controlled program, both auto-mode and interative-mode are allowable. Therefore, this method is widely applicable.

When starting the batch program, auto-mode is only allowable. This method is appropriate for processing

the long-run program and large volume of data as a background job.

When starting call-from-program, auto-mode is only allowable. When the program has the same logic as the part of system, the programming is negligible.

Fig. 3 illustrates the execution modes and starting methods.

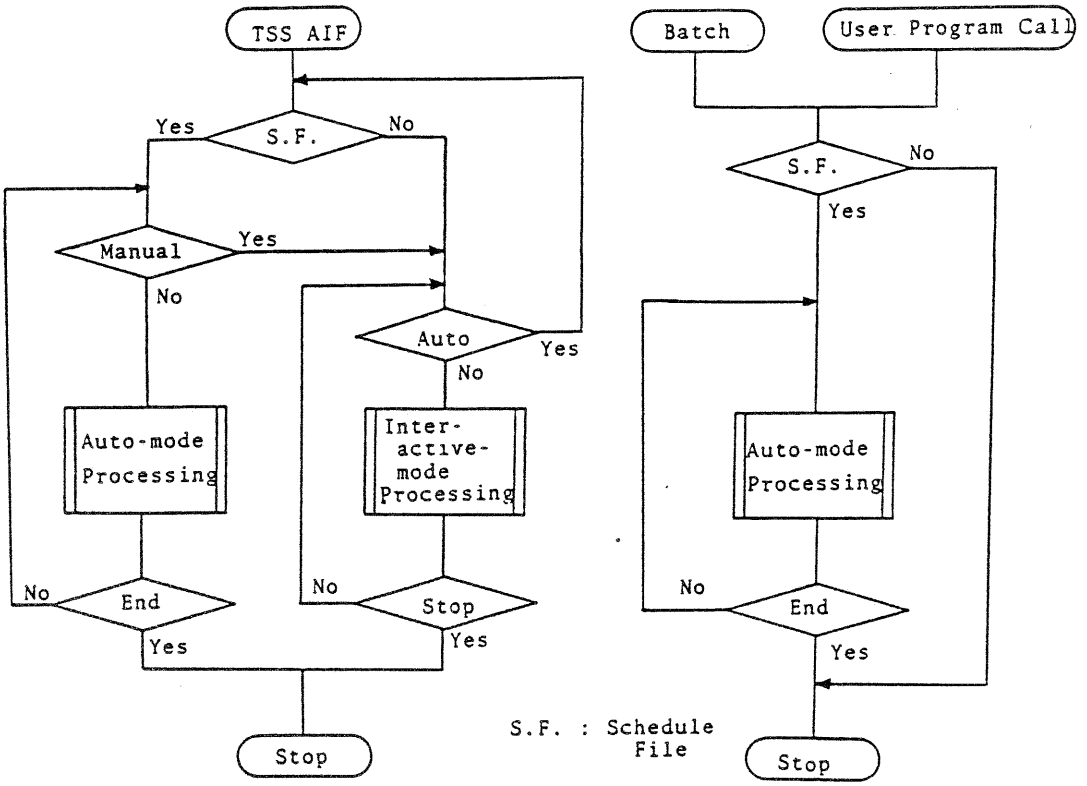

Fig. 3 Execution modes and starting methods

c. Additional program

Since each program is independent from the other, the individual program enables to add the system concerned.

The subroutine library is supplied to the users in an easy manner. The additional programs are supported on the control functions as well as the internal programs.

5. Applications

The application fields for digital image processing are now enlarging with the current knowledge of advanced technology.

FUJITSU has supplied image processing systems for remote sensing to the following listed customers.

- RESTEC (Remote Sensing Technology Center of Japan)

  Sattelite and aircraft based remote sensing data processing

- Kyushu University Computing Center

  Center for co-operative use

- National Institute of Agro-Environmental Sciences (NIAES)

  Forecast the agricultural productivity using remote sensing technology.

- ERSDAC (Earth Resources Data Analysis Center)

  Exploration of earth resources by using remote sensing technology

- Nobeyama Radio Observatory of the Tokyo Astronomical Observatory

  Center for co-operative use of cosmic radio wave analysis

- NASDA (National Space Development Agency of Japan) Computing Center

  Center for co-operative use including data processing for remote sensing

6. Summary

The system developed here could be flexible and expandable enough for present and future use in a practical manner. The problem arises how the system for processing remotely sensed data should be desinged to meet advanced image processing technology and specific needs of customers.

The author would like to express gratitude to RESTEC and ERSDAC for useful comments.