Development of Image Processing Software for Satellite Data

Kwang-Hoon Chi, Jae-Young Suh, Jong-Kyu Han

Korea Institute of Geology, Mining and Materials (KIGAM)
Computer and Information Division
Taejon, Korea
{jysuh, khchi, jghan}@kigam.re.kr

Abstract

Recently, the improvement of on-board satellite sensors covering hyperspectral image sensors, high spatial resolution sensors provide data on earth in diverse aspect. The application field relating remotely sensed data also varies depending on what type of job one wants. The various resolution of sensors from low to extremely high is also available on the market with a user defined specific location. The expense to purchase remote sensed data is going down compare to the cost it need past few years ago in terms of research or private use.

Now, the satellite remote sensed data is used on the field of forecasting, forestry, agriculture, urban reconstruction, geology, or other research field in order to extract meaningful information by applying special techniques of image processing. There are many image processing packages available worldwide and one common aspect is that they are expensive. There need to be a advanced satellite data processing package for people who can not afford commercial packages to apply special remote sensing techniques on their data and produce valued-added product.

The study was carried out with the purpose of developing a special satellite data processing package which covers almost every satellite produced data with normal image processing functions and also special functions needed on specific research field wth friendly graphical user interface (GUI). And for the people with any background of remote sensing with wndows platform.

1. Introduction

The remote sensing technique, as a special technique for spatial data integration, informative attribute migration, storage of huge amounts of data and also analysing upon those integrated data, plays a great role on spatial data processing field especially

on geology, natural resources, environment, social and economic field of study. As the computer technology and sensors used on satellite grows rapidly, data being stored in storage media also grow respectively due to high resolution with large coverage area on earch. The quality of information is preferred instead of quantity of information and also capability of how the information is processed and produce value-added products which would give meaningful information on critical decision making process.

The spatial data used in the field of Geographic Information System(GIS) and Remote Sensing(RS) consists of many different resolutions or formats in more than hundreds of layers. The need to handle large amount and different formats of spatial data in a way that the user can manipulate, overlay and create useful information without any technical difficulty or remote sensing background.

The study was carried out with the purpose of developing a special satellite data processing software which covers almost every satellite produced data with normal image processing functions and also special functions needed on specific research field wth friendly graphical user interface (GUI). And for the people with any background of remote sensing with wndows platform. The newly developed image processing software is composed with two major parts. First part is for importing all the satellite data including Landsat TM, SPOT, Radarsat SAR, NOA, MSS, Air-borne scanner images, and the second part is for storing all the spatial attributes images including DXF, Auto/CAD, MicroStation, .etc. This integrated data format called Kigam Integrated Spatial Data Format (KID) is supplied to give an aids for fast and easy processing of satellite data we collected. It will also play a great role in categorizing satellite data in resolution, location, year, area since there are many channels available in one scene with different spectral visible band. The second part also includes any data which are not raster images such as reports, color table, ground control point (GCP) points, graphics, geo-reference coordinates. The satellite data integrated into one whole format can then be applied to image processing software functions including overlaying, modifing with raster and vector interface and have access to DBMS to supply and maintain spatial attributes information.

With the newly created KID format, this study concentrated an great effort on developing user friend image processing software with special functions with capability of assigning attributes information on each pixels or area contained in satellite data. Also, we focused on the user who doesn't have background on remote sensing nor GIS.

2. Background

Generally, the satellite data is used with other attribute data such as earth information, slope map, elevation model, and other spatial vector layer overlayed on top of satellite data so that more value-added product can be extracted after applying image processing techniques. The image processing systems now needs to support not only satellite data but also capability of handling GIS data in order to produce RS-GIS

related spatially analysed product.

The most GIS system currently available on the market only supports basic image processing functions and if there are satellite data need to be imported into spatial GIS data background, then additional image processing package has to be purchased. The satellite data after applying image processing can then be imported into GIS data. There are many overhead involving the process.

Rectntly, the GIS software companies started to develope integrated GIS system called 'Integrated Geographic Information System' (IGIS) to handle both RS and GIS. The most famous satellite data processing products now available on the market are ER Mapper (Earth Resource Mapping), ERDAS Imagine (ERDAS Inc.), PCI EASI/PACE (PCI Enterprise), ENVI (Research System Inc.). There are also satellite data processing software developed or now upgrading in Korea such as KMIPS (Software Engineering Research Institute, 1987), IMAPRO (Korea Institute of Geology, Mining and Materials, 1994), ERIMS, upgrade version of KMIPS (Software Engineering Research Institute, 1991).

3. Internal Image Processing Software Structure

The first part of our image processing software is to create integrated data called KID. The KID is divided into two categories. One for raster images and the other for segments. The raster images are composed of 8-bit unsigned images such as16-bit unsigned/signed images of RADARSAT, SAR, DEM and also 32-bit floating point images.

The segments are composed of GIS based vector images and other related data such as database generated files, GCPs, color lookup table, etc,. Vector images basically consists of points, lines and polygons to represent geographic feature. The point can be implied as spatial position of certain feature such as location of mine, factory, GCP, etc,. The lines are very common spatial components of a GIS, representing the spatial attributes of objects and their boundaries such as administrative boundary, highway, etc,. The polygons are collection of lines with closed feature. Each entity may contain its own attributes information in text or images. Typically, vector images from third party are stored in ascii DXF format. The Drwing eXchange Format(DXF) format is the international standard drawing format widely used with AutoCAD and is capable of exporting its structure into other drawing program. Figure 1 shows overall structure of KID data structure.

Image header contains : filename, type, size, # of imagery, # of segments, version, creation data, updated data, creator info, description, resolution, pixel sizeetc,.
Geocode header contains : nx, ny, latdeg, latmin, latsec, longdeg, longmin, longsec.
Image header contains : size, type, history, nindex, nx, ny
Segment header contains : type, size, history nindex, nbytes
Imgae8 : actual 8-bit unsigned raster images are stored
Image16 : actual 16-bit raster images are stored
Image32 : actual 32-bit raster images are stored
Segment : each segment starts with its header (header type). GCP, CLUT, Text, Training set, DXF, attributes information .... Header identifies type of segment and stores corresponding images

Figure 1. Internal satellite data structure

4. Implementation of Image Processing Software

We concentrated an great effort on developing user friendly image processing software with special functions capable of basic and advanced image processing technique and assigning attributes information on each pixels or area contained in satellite data. Also, we focused on the user who doesn't have background on remote sensing nor GIS can operate our software. Our software also can import various satellite data format such as TM, MSS, ERDAS, etc., and other graphic format.

4.1 Implementation Environment

Our software system runs on Windows 95/98/NT of any version. The language we used is MS-Visual C++ 5.0. We concentrated creating dialogs and icons as friendly as possible.

We are now on the process of converting on UNIX platform which should be done by the end of this year. The following shows minimum system requirements we recommended.

Hardware	Capacity
CPU	Pentium-100
Main Memory	32 MB
Hard Disk	500 MB
Video Adapter	Memory : 2MB Resolution : 800 x 600 Color : True Color
Monitor	14inch
Mouse	Serial
LAN card	for ODBC connection
DBMS	Oracle, MS-Access

4.2 Functions

Our software system supports supports both spatial data image processing and GIS related functions with integrated KID Database manipulation. The following shows main functions currenty supported on our system.

Functions	Description
False color composite	RGB, Gray, 16-bit, 8-bit, 4-bit, 2-bit
Density transformation	Density slicing, interactive contrast startching, linear stretching, histogram equalization, adaptive transformation
Edge Detection	Sobe, Prewitt, Laplacian, Lineament extraction, 8-direction edge detection, Robinson, Roberts
Enhancement	Smoothing, Sharpening, Brightness, Contrast, High pass, Low pass, Maxmize, Minimize, Median
Classification	Supervised (Maximum likelihood, Parallelpiped, Minimum Distance, Unsupervised
Geometric Correctinon	Image to Imge, Map to Image (will be supported)
Copy	Image extraction, subcutting
View	Zoom in/out, Hash, Chart, 3D (slope map)
Convertion	Vecterization, Rasterization, DXF to KIS, MapEDIT to DXF, LAN to KIS, Raw to KGM Jpg, Tiff, Gif, Raw, ...
Ratio	A+B, A-B, A*B, A/B, User defined equation
Graphic	Graphic Tool (Line, point, rectangle, circle ...)
Overlay	Vector over raster, Raster over vector
KID Format	Load, Save, Browse (delete, add)

5. Main Functions of Image Processing System

Our software system supports many useful functions in terms of RS and GIS. The satellite data needs to be pre-prossed before applying any image processing tecnique or overlaying with GIS data. The geometric correction should be applied to supply spatial information to the satellite image. Geo-coded data then can be overlayed with GIS data to analyse or produce meaningful product.

The functions supported in our image processing software are mainly focused on satellite data in any bit pattern. It is also capable of importing any graphic format available. Figure 2. shows image enhancement technique widely used on pre-processing stage of satellite data. The size of mask can vary from 3x3 to 11x11. In most case 3x3 is used. It will show preview image before actually applying actual image. It shows smoothing, sharpening enhancement. The bottom two images shows edge detection algorithm widely used to detect lineament feature out of satellite image.

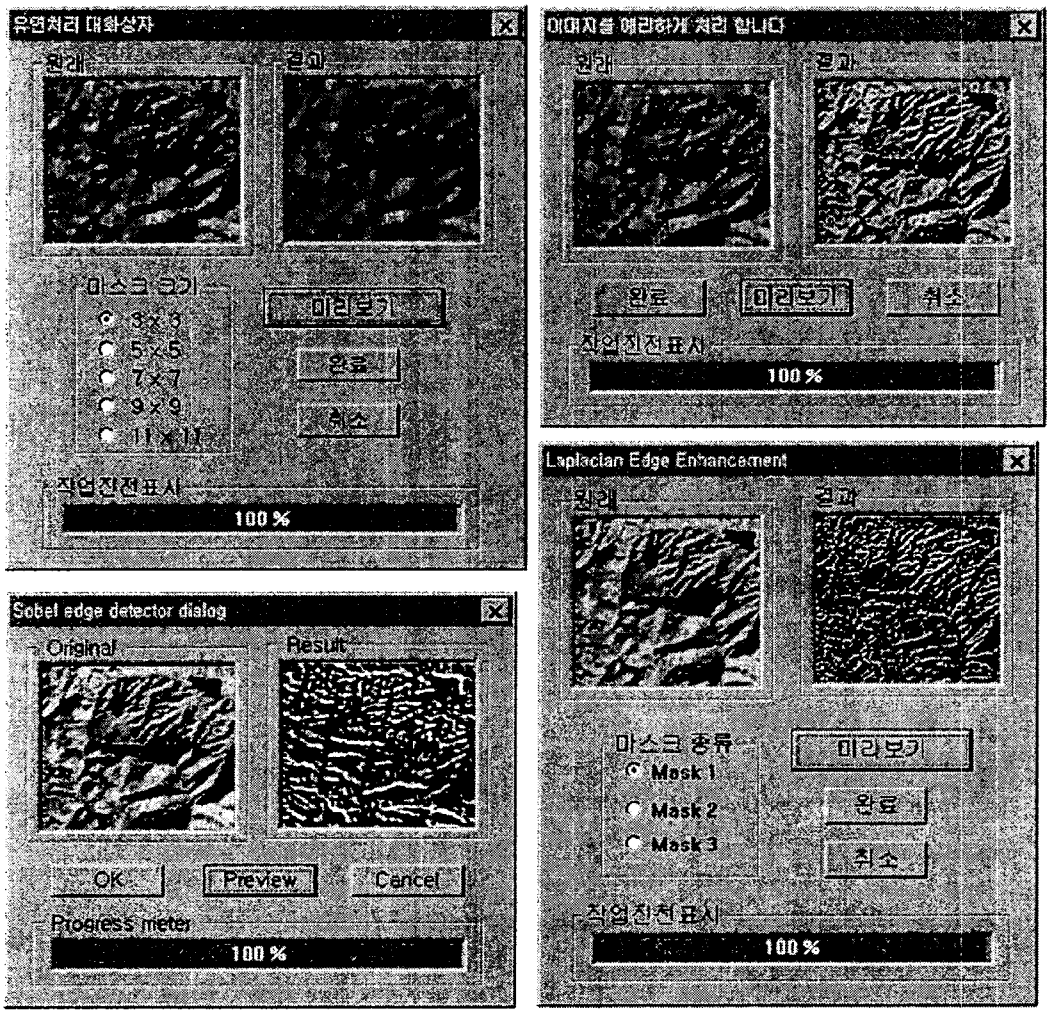


Figure 2. Image enhancement, edge detection

Figure 3. shows the process of applying geometric correction to the raw satellite data. Due to distortion took place in its original satellite image, the coordinates of spatial information should be corrected with reference data to target data. The GCPs should be collected from the same location on both image. The RMS errors generates how much accuracy it would generate. The total RMS error should be less than 1 pixels in order to get precise result. The top left image shows reference image, bottom shows target image. The GCP-collection dialog shows gcp points with their RMS errors. The images can be zoomed in or out by clicking appropriate zooming buttons.

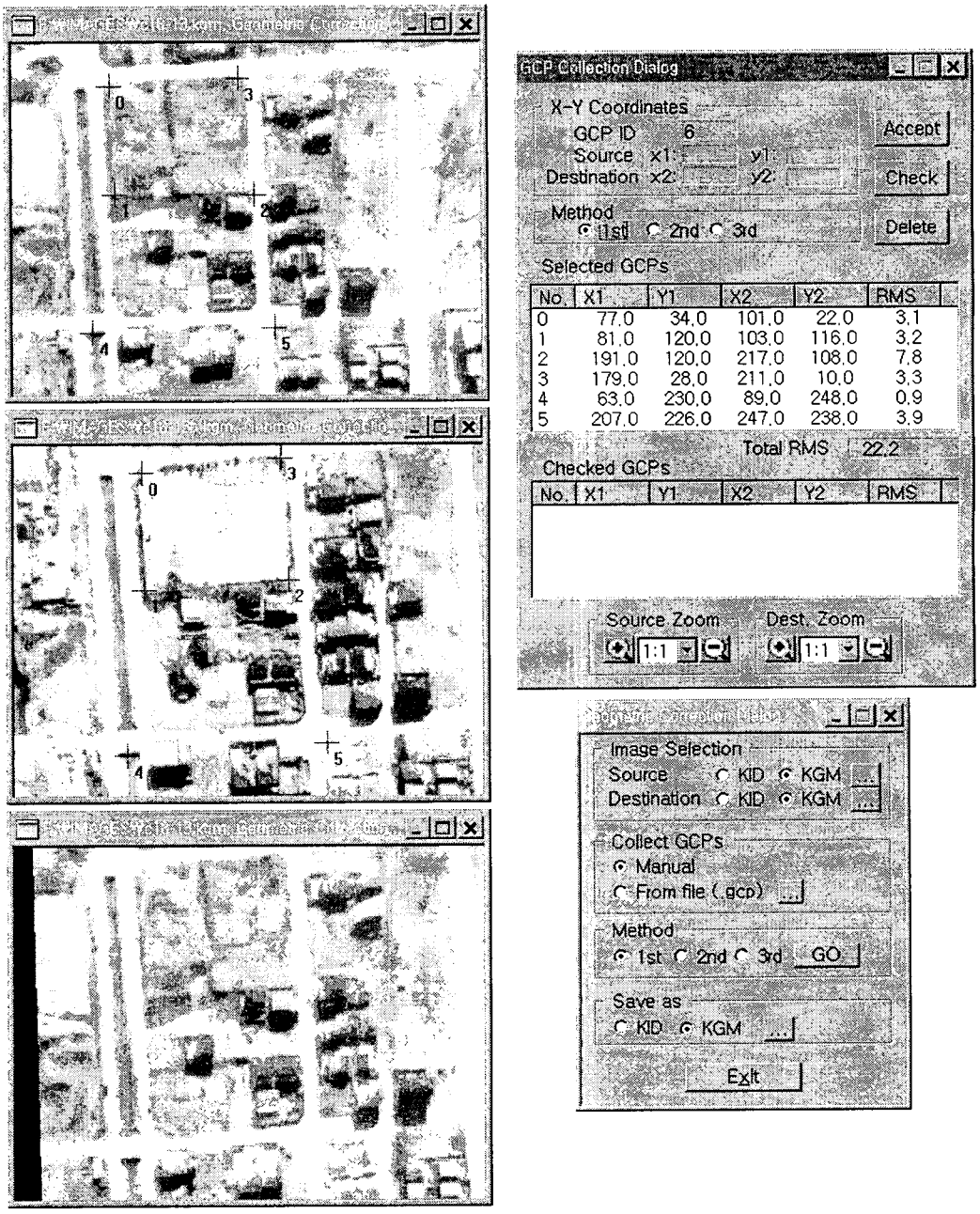
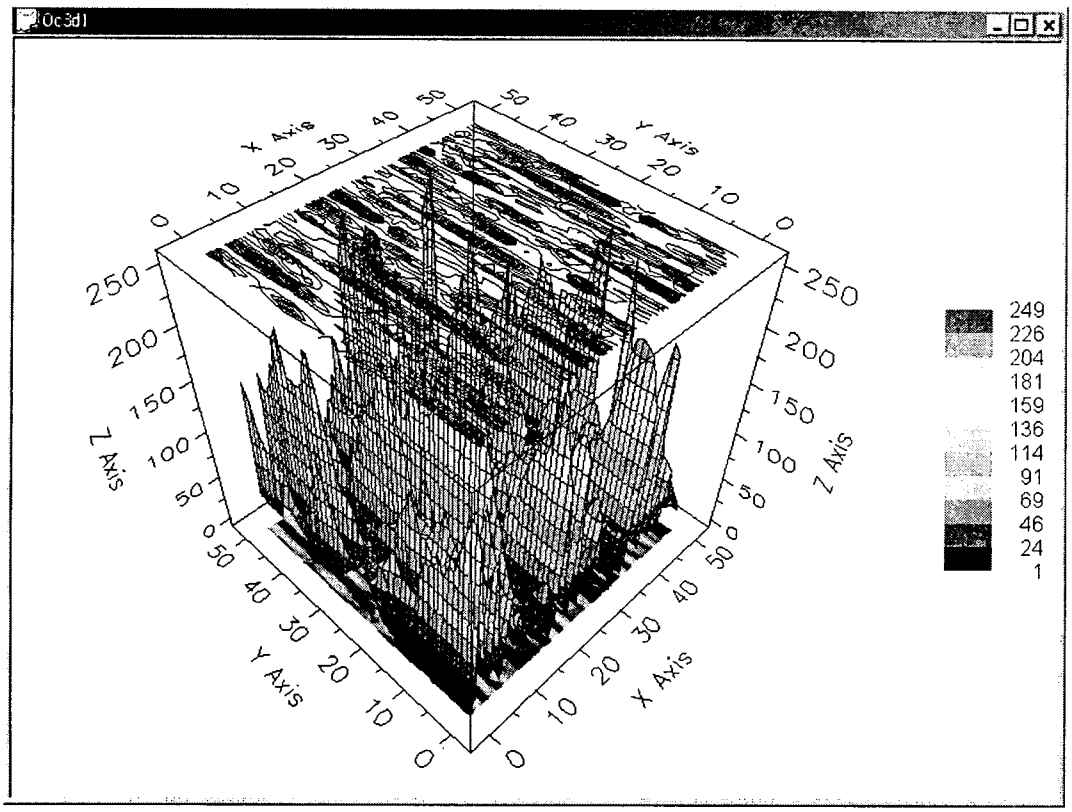


Figure 3. Geometric correction dialog box

Figure 4. represents 3-D view of DEM data. The top image shows contours in black and middle figure implies their contour values in color. The right figures shows its contour values in number. The bottom image shows filled contour with index color shown on right. The view point can be oriented to user's desirable point by moving the mouse.



6. Conclusion

We focused development of image processing software system on creation of integrated spatial data format in to give an aid of spending too much time collecting spatial data geographically due to many different satellite data or vector format available on the market to scientists who handles geoscience data. KID format integrates GIS package generated vector images with various satellite data into one whole data format with same spatial coordination. These data can then be overlayed vector over raster or vice vera with attributes information along to produce meaningful data.

Our system supports basic and enhanced image processing functions like enhancement, geometric correction, classification to make raster images suitable for various research on geology, forestry, forecasting, environmental aspect.

Our image processing software system uses ORACLE DBMS to retrieve and store satellite data in integrated format with their attributes information connected to network.

We implemented interface with ORACLE using ODBC driver. User can search satellite data or maps through administrative name and latitude/longitude data stored in ORACLE DBMS.

Further development of image processing system will be focused on Remote Sensing application with capability of GIS data overlayed among them for desicion critical analysis.

Reference

[1] Worboys, M. F., 1995, GIS : A Computing perspective, Taylor & Francis Ltd, London, 376p.

[2] Jensen, J. R., 1986, Introductory digital image processing, A remote sensing perspective, Prentice-Hall, New Jersey, 397p.

[3] Brower, J. C. and Merrian, D. F., 1990 : Geological map analysis and comparison by several multivariate algorithm, Geological survey of Canada 89-9, p123-134.

[4] David, L., 1993 : A GIS-Based Method for Integrating Expert Knowledge in to Land suitability Analysis, Urban & Regional Information System association, V.II.

[5] Thomas, R. W., Huggett, R. J., 1980 : Modelling in geography: a mathematical approach, Harper * Row Publishers, London.

[6] Scott, Stanfield, Ralph Arveson, 1996, : Visual C++ 4, Waite Group Press 667p.

[7] Kruglinski, D. J., 1995, Inside Visual C++ 4, Microsoft Press, Washington, 896p.

[8] Blaszczak, M., 1996, MFC 4 Programming with Visual C++, Wrox Press Ltd, 871p.

[9] Baxes, G. A., Digital image processing : Principles and applications, John Wiley & Sons, Inc, New York, 452p.

[10] Chi, K. H. and Suh, J. Y., 1995, Quantitative evaluation of geologic data for industrial site selection, MOST, KR-95(T)-11, 71p.

[11] Chi, K. and Suh, J., 1992, Imge processing software for IBM/PC, Journal of Korea Remote Sensing Society, 8, p. 59-69.

[12] Lee, K. W., 1996, Spatial integration of Geoscience data and thematic mapping using Landsat TM data for mineral exploration, Ph.D dissertation, Seoul National University.

[13] Ahn, Chung, H. and Shin, D, 1997, Development of a Remotely Sensed Image Processing/Analysis System : GeoPixel ver 1.0, Journal of Korea Remote Sensing Society, 8, p. 13 - 30