A Proposal for Processor for Improved Utilization of High resolution Satellite Images

Kyeong-Hwan Choi*, Sung-Jae Kim**, Yun-Won Jo*, Myung-Hee Jo*

*Department of Satellite Geoinformatics Engineering., Kyungil University
**Spatial Information Technology Institute, GEO C&I Co., Ltd

ckhace@hanmail.net, sjkim@geocni.com, sorabol00@hanmail.net, mhjo@kiu.ac.kr

ABSTRACT ... With the recent development of spatial information technology, the relative importance of satellite image contents has increased to about 62%, the techniques related to satellite images have improved, and their demand is gradually increasing. Accordingly, a standard processing method for the whole process of collection from satellites to distribution of satellite images is required in many countries for efficient distribution of images and improvement of their utilization.

This study presents the processor standardization technique for the preprocessing of satellite images including geometric correction, orthorectification, color adjustment, interpolation for DEM (Digital Elevation Model) production, rearrangement, and image data management, which will standardize the subjective, complex process and improve their utilization by making it easy for general users to use them

KEY WORDS: High resolution satellite image, Standardization, Geometric correction, Orthorectification, Image coloring, DEM (Digital Elevation Model), Manufacture, Resampling, Image data management

1. INTRODUCTION

Recently, as the importance of information infrastructure is increasing, satellite imaging which can periodically collect latest information over a wide area is becoming the foundation of various spatial information such as topographical maps and thematic maps for national GIS projects.

Furthermore, with the successful launch of KOMPSAT-2 last year which was a satellite developed by domestic technology, the utilization of high-resolution satellite images is gradually increasing in Korea as well. Satellite images are not only used by the central and local governments, but their relative importance in information service area has increased to about 62% with the rapid development of spatial information technology. As the technology development using satellite images and their demand are increasing, a standard processing method for the whole process of collection from satellites to distribution of satellite images is required in many countries for efficient distribution of images and improvement of their utilization.

In order to further facilitate the use of the rapidly developing spatial information technology, we are going to improve the utilization of KOMPSAT-2 through standardized satellite image data and integration with the GIS of local governments. Accordingly, this study presents an effective utilization method for satellite image data by standardizing the preprocessing.

This study presents a process standardization technique to maximize the public utilization of high-resolution satellite images, opens up new applications through their integration with GIS databases and systems developed by local governments, and provide standardized processing technique based on systematic operation to the related workers in the field to build a social infrastructure for the spread of a favorable mindset toward the efficiency and science of high-resolution satellite images.

2. DEVELOPMENT OF STANDARDIZATION TECHNIQUE FOR MAXIMIZATION OF UTILIZATION OF HIGH-RESOLUTION SATELLITE IMAGES

This study presents process standardization techniques to maximize the utilization of high-resolution images

2.1 Geometrical Correction

Geometrical correction removes geometrical distortions from satellite images. It clearly and quantitatively preprocesses the correspondence between coordinates of satellite images and geographical coordinates by a coordinate conversion equation. The latest satellite image data is corrected by a sensor model (radiometric correction, geometrical correction). Precise image correction is essential to put the satellite image data to actual use, and using the latest digital topographic map as a reference for geometrical correction leads to good results. Moreover, as shown in Fig. 1, we achieved the highest accuracy of geometrical correction when the RMS (Root Mean Square) error was under 0.4 and 14 ground reference points at the minimum were evenly distributed (based on 1:25,000 scale).

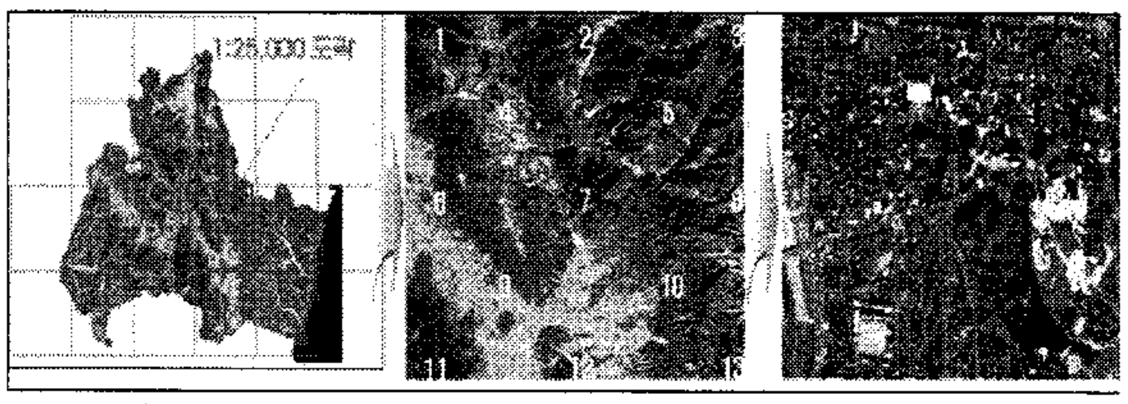

Fig. 1 Geometric correction by developing the standardization

2.2 Orthorectification

Orthorectification requires the setting of a sensor model by the geographical information and sensor position at the time of photographing received as an RPC file. Figure 3 shows the result of orthorectification when the reference data for orthorectification was based on the most recently constructed digital topographic map, the RMS error was under 0.4, and 13 ground reference points at the minimum were evenly distributed (based on 1:25,000 scale).

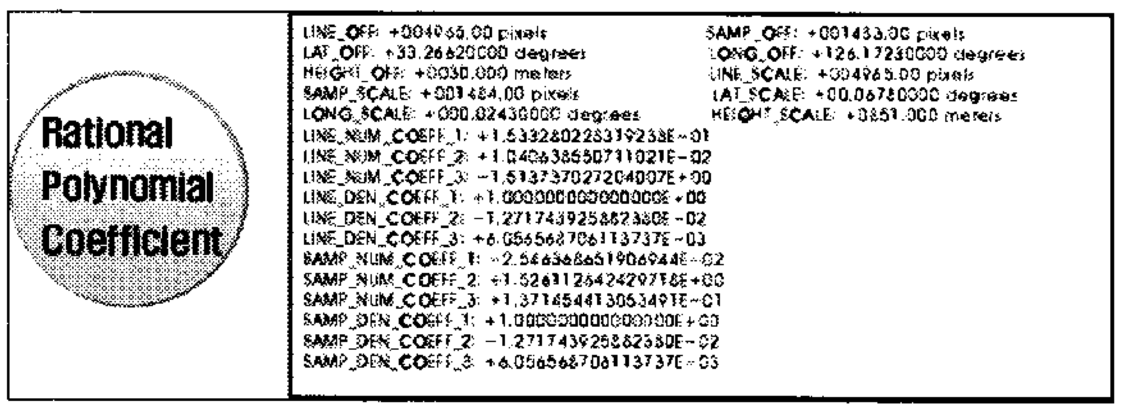

Fig. 2 Orthorectification RPC

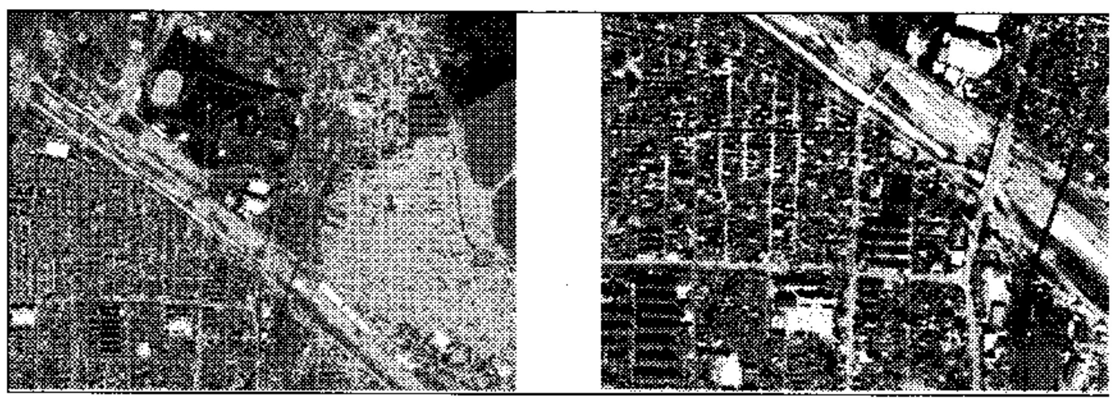

Fig. 3 Orthorectification by developing the standardization

2.3 Color Adjustment

Because satellite image data often has noises according to the conditions at the time of photographing (photographing angle, reflections and shades of sunlight), additional color adjustment is required depending on the application such as urban, forest, agriculture, river, and sea. Therefore, this study considered efficient processing measures for color adjustment from loading to saving o high-resolution satellite images.

Table 1. Color Adjustment Steps and Techniques

Step	Description	Adjustment Technique
1	Load image	Copy the layer to use, clip the margin of the image and adjust it.
2	Adjust color by area	To adjust the color of a specific area such as forest, land, river, or sea, create a layer for each area, and combine them into one layer.
3	Modify water part	Modify the broken pixels or black parts.
4	Modify buildings	Modify the buildings which are difficult to identify because they are too bright or dark.
5	View adjacent area and save	Modify adjacent areas to remove boundaries between images when creating a mosaic of multiple images. Cut the joining parts of each image and combine them again. Remove black from the margines using color range, change the value of black color in the image to R:1,G:3,B:1, and save it as a Flatten Image.

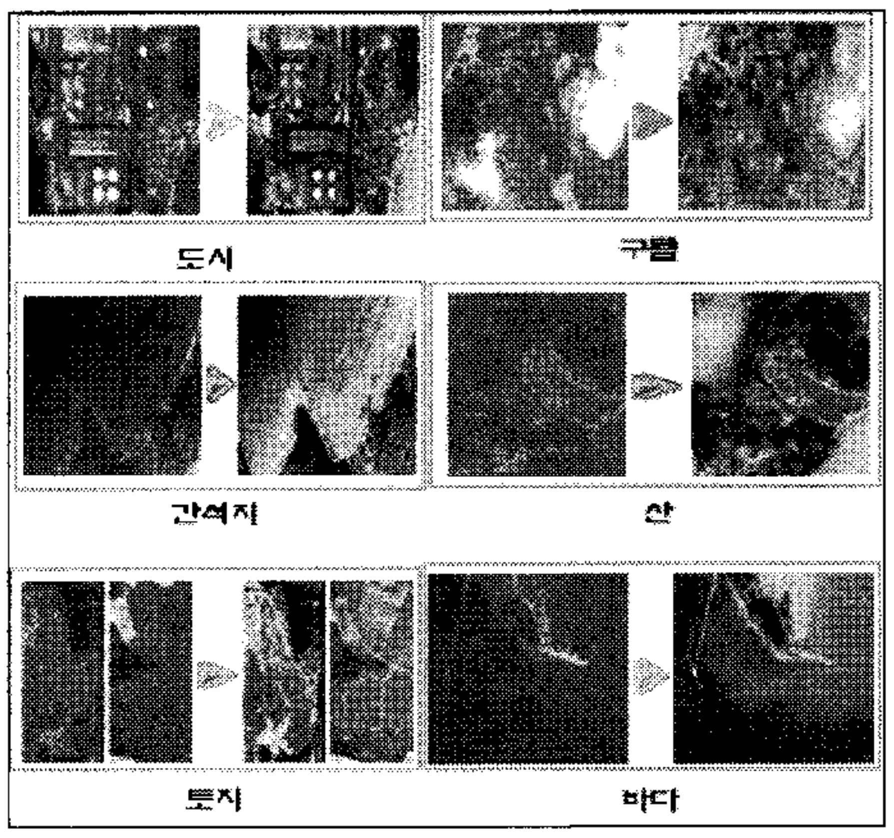

Fig. 4 Color adjustment by developing the standardization

2.4 Resampling

When the coordinate conversion equation is determined by ground reference points, we calculate the image size and obtain a reverse conversion equation which is a relational expression between the corrected image and the image before correction. Using this relational expression, we find the original positions of pixels of the corrected image in the image before correction and resample them.

The processed image data has minute changes in spatial resolution depending on the photographing conditions, the satellite images need to be resampled to the standard spatial resolution. For example, the resolution of the IKONOS satellite image in Fig. 4 is 1 m, and each satellite image requires accurate resampling of the spatial resolution.

In the future, we must consider resampling resolutions for high resolution satellite images of IKONOS 1m-class or higher resolutions.

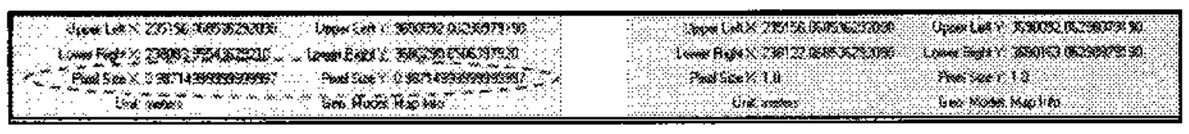

Fig. 5 . Example of IKONOS resampling

2.5 Management and Storage of Image Data

The processed image data is converted to the Geo-TIFF format, and compressed to LZW (Lempel Ziv Welch) when necessary. The recommended data size is 2.5 Gbytes or less. It will be more efficient for local governments to process and manage a single image of the total administrative district or images of each administrative district rather than by rectangular index.

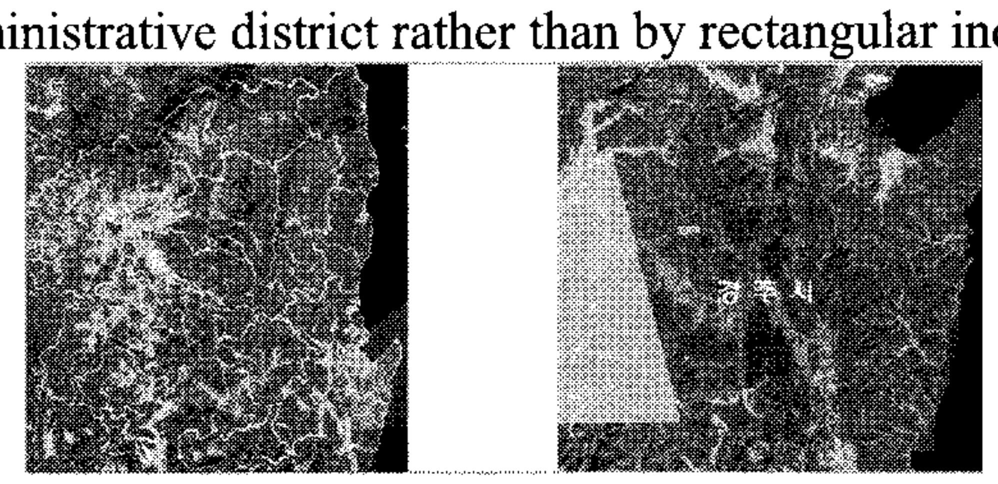

Fig. 6 Managements of satellite on each administrative district

2.6 Conversion and Management of Coordinates

The coordinate system is constructed to match the digital topographic map of the National Geograpahic Information Institute. In consideration of convenience for practical applications, the coordinates are converted to and managed in conventional local or global geodetic data.

The authors of this study also thinks that the coordinates must be managed in global geodetic data for efficient integration of different spatial data in the future.

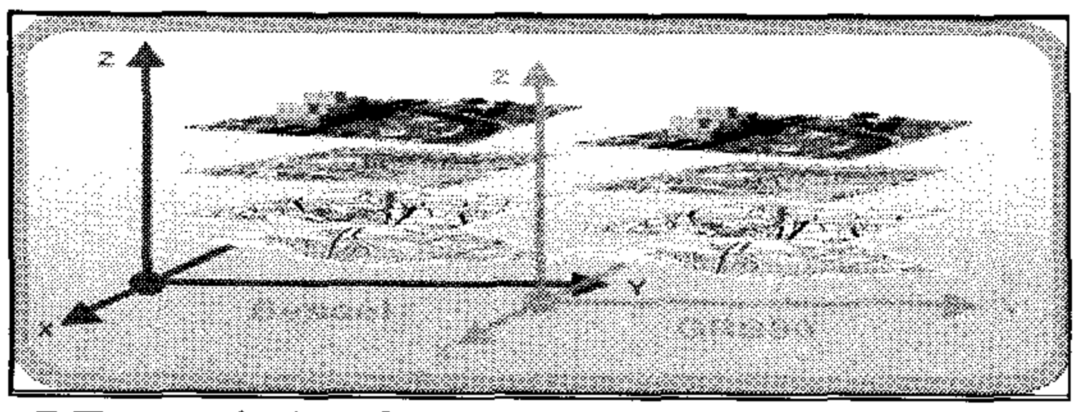

Fig. 7 Transmission from Bessel coordination to GRS80

2.7 Metadata Construction

For efficient management and utilization of satellite image data, we must construct metadata. Metadata allows users to find satellite images rapidly and conveniently by searching data by conditions such as satellite type, photographed area, resolution, and coordinates.

Table 2. Example of Metadata

Satellite type	Satellite image photograph version	Satellite ID	Photographing mode	Photographing direction	Photographing date	Photographing time	
QUICKBIRD	AA	QB02	FullSwath	Forward	2006-10-31	28:17.0	
Cloud quantity	Resampling method	Image expression unit	Satellite image width	Satellite image height	Satellite image supply version	Satellite image product standard	
-999	Cubic convolution (CC)	OD	31836	22428	LV2A	Standard	
Radiometric correction step	Radiant quantity emphasis	Copy resolution	Compression type	Number of bands	Sensor type	Header file	
Corrected	off	16	None	4	multispectral	.RPB	
Spatial resolution	Ellipsis	Coordinate system	Solar azimuth	Solar altitude	Satellite azimuth	Satellite altitude	
0.54	Bessel	Geographic (Lat/Long)	166.7000	39.3000	89.1	63.7	
Top left coordinate (Longitude)	Top left coordinate (Latitude)	Top right coordinate (Longitude)	Top right coordinate (Latitude)	Bottom right coordinate (Longitude)	Bottom right coordinate (Latitude)	Bottom left coordinate (Longitude)	Bottom left coordinate (Latitude)
128.7855963	35.94490290	128.90670210	35.94490290	128.906702	35.77299390	128.78559630	35.772993
Top left coordinate (x)	Top left coordinate (y)	Top right coordinate (x)	Top right coordinate (y)	Bottom right coordinate (x)	Bottom right coordinate (y)	Bottom left coordinate (x)	Bottom left coordinate(y)
128.7855963	35.94490290	128.90670210	35.94490290	128.906702	35.77299390	128.78559630	35.772993
Dong/Ri	Eup/Myeon	Si/Gun/Gu	Do	Country			
Buhori	Hayangup	Gyeongsan-si	Gyeongsangbuk-do	Korea			

2.8 DEM Production and Interpolation

A DEM (Digital Elevation Model) expresses the numerical information of geographical altitudes arranged in fixed intervals as a height matrix of the point model. It is often used in the DEM production and interpolation method which generates a DEM to improve the matching rate with the digital topographic map and uses it for orthorectification or three-dimensional digital topographic model.

The standardization technique for creation of DEM requires intermediate contour (7111), index contour (7114), and altitudinal points (7217) that have been recently established which can create the topography of a digital topographic map. The accuracy of the altitude values of the contour line and altitudinal points must be checked for errors because they form the basis of the DEM. Moreover, when creating a DEM for one index, you must consider eight surrounding index simultaneously in order to minimize the mismatches among index and the step heights (a topography like a stairway) of altitude.

Interpolation after DEM creation is a numerical method to infer the information in between the given data points, and calculates the intermediate points by obtaining an equation that encompasses all the given data points. Among the many interpolation methods, the standardization techniques include weighted moving average, natural neighboring point interpolation, spline interpolation, and Kriging interpolation. Table 3 describes the standardization method for interpolation in tune with each topography when creating a DEM.

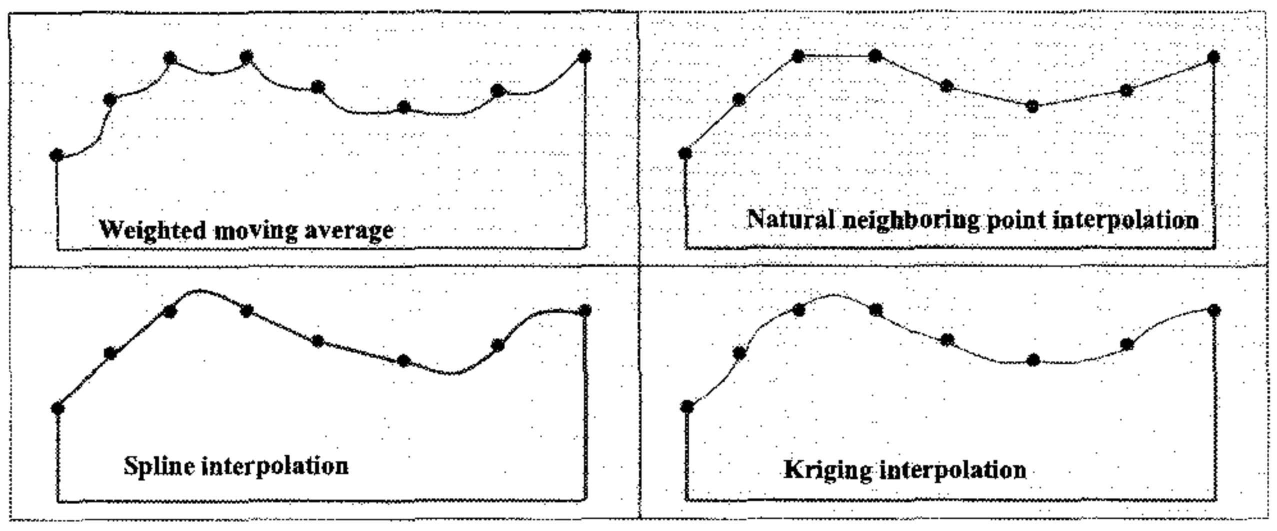

Fig. 8 Interpolation methods

Table 3). Interpolation Methods and Standardization Technique

Type Of Interpolation	Use of Standardization Technique
1.Weighted moving average	Not appropriate for topographical interpolation. Typically used for analysis of purchasing power of consumers in a commercial area within a certain range.
2.Natural neighboring point interpolation	Well applied to both regular and irregular grid pattern models, and often used to express mountains and valleys.
3.Spline interpolation	Interpolation is possible for points outside the sampling range. Interpolation can be used for rivers and valleys for which no data has been collected.
4.Kriging interpolation	A geographic statistical interpolation, and applies weights to sample altitudinal points to interpolate arbitrary altitudes.

The DEM by standardization technique is shown in Fig. 9.

Fig. 9 DEM creation product

3. UTILIZATION EXAMPLES OF STANDARD SATELLITE IMAGES

Fig. 10 shows an electronic map created using the satellite image standardization processing technique. In this way, standard satellite images can be easily used by local governments and general public besides the central government to efficiently manage and operate the national land including cities, seas, forests, environment, agriculture, and industries.

Furthermore, we can provide the basic infrastructure to improve the utilization of high-resolution satellite images through the analysis of related information, identification of supporting policies, and accumulation of strategic utilization know-hows.

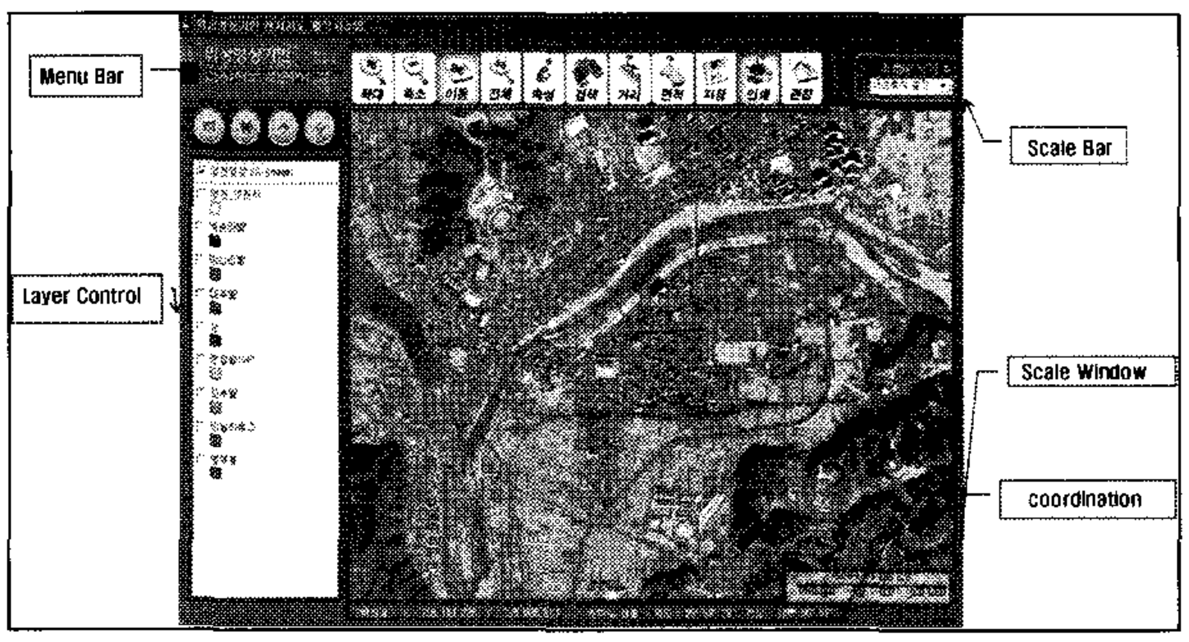

Fig 10. Case of satellite image pre-processing sandazation

4. CONCLUSION AND FUTURE TASKS

This study presented guidelines to satellite image processing through an investigation into the standardization techniques for the preprocessing of satellite images to maximize the utilization of high resolution satellite images. To that end, this study reviewed the geometrical correction, orthorectification, color adjustment, resampling, management and storage of image data, coordinate conversion and management, metadata construction, standard techniques for DEM production and interpolation, and the utilization examples of high-resolution satellite images.

Providing a quantified high-resolution satellite image processor will improve the efficiency of image processing by field workers from the aspects of cost and manpower.

In order to more efficiently use high-resolution satellite image after the successful launch of KOMPSAT-2, we must pursue economic gains and technical independence by supplying domestic satellites for which demand is increasing by domestic technology without depending on imported technology. Furthermore, we must move away from the intial government-leading development and expand the roles of the private sector in technical development in space industry. The development and acquisition of advanced space technology will generate ripple effects to other technical areas so as to improve the overall technology level of the industries and create new industries.

REFERENCE

1. Korea Aerospace Research Institute, 4th Aerospace Development Symposium, 2006

2. Korea Research Council of Public Science and Technology, A study on the public utilization of satellite data, 2006

3. Korea Research Institute for Human Settlements, "A study on the national resources analysis method using satellite image data", KRIHS Research Report, 2000

4. Korea Research Institute for Human Settlements, "Status and plan for the construction of a distribution system for national geographical information", KRIHS Research Report, 2006

5. M. H. Cho, B. G. S, J. S. Kim, H. S. Kim, "Development of a 3D Web GIS system for management of coastal dangerous and vulnerable areas", Spring Academic Conference Paper Collection 2005 of the Korean Association of Geographic Information Studies, pp.337-345

6. M. H. Cho, Y. W. Cho, S. J. Kim, W. Y. Jeong (2006), "Development clinical classification technique for southern Jeju area using high-resolution satellite images and SML", Spring Academic Conference Paper Collection 2006 of Korea Society of Remote Sensing

7. The Korean Association of Geographic Information Studies, Spring Academic Conference, 2007

8. The Korean Association of Geographic Information Studies/National Assembly Digital Forum, Prospects for operation and utilization of Arirang satellite for efficient national land management, 2006

9. The Ministry of Science and Technology, A study on the commercialization strategies for high-resolution satellite images, 2006

10. The Ministry of Science and Technology, KISTEP, Technology Level Evaluation Report 2005, 2006

11. The Ministry of Science and Technology, KISTEP, The prospects for future society and Korean science and technology, 2005

12. Y. S. Kim, A. S. S, M. H. Cho, E. N. Kim, G. J. Shin, Y. R. Jang, Introduction to Remote Sensing, 2004, Dongah Technology Trading