Development of Basic Application Software for KOMPSAT High Resolution Images

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Abstract: This paper outlines the development of image processing system, which will allow the general users in Government and Public organizations easily to use and apply KOMPSAT EOC images in their own business. The system includes an import/export module of EOC image distributed in Hierarchical Data Format (HDF) file and various image processing analysis modules. Especially, the image mosaic and subset functions are designed to use EOC image as an image map, generating the Ortho-image module. To update the various spatial data with EOC image, some essential modules such as change detection by pattern recognition, overlay between images and vector data, and modification of vector data are implemented in the system. The system is developed based on the user request analysis of government agency, and suited for more efficient use of satellite image in public applications. Such system is expected to contribute to practical application of KOMPSAT-2 that will be launched in 2005. Further efforts will be made to accommodate the KOMPSAT-2 MSC data.
Keywords: KOMPSAT, Application Software, Ortho Image

1. Introduction

Recently, the application areas of satellite images become various. The satellite images are used not only for institute or university to study and make researches but also for Government and Public organizations to apply in their business. Nowadays use of satellite images have changed not to choice but to essential. For example, Ministry of Environment, one of Government agencies, has established the foundation of Environment-GIS to solve complex environment problems using aerial photos, satellite images and digital maps. The Forest Service has updated the digital forest map by satellite images. But necessity and demand for satellite images are getting increased, nevertheless satellite image processing software are still expensive and difficult access to general users. Therefore, we developed the application software for KOMPSAT high resolution images which could be distributed free to Government and Public organizations for wide use and easy access of satellite images.

2. System Design and Implementation

The system contains three modules in it as shown in figure 1. File IO module is basic input/output functions which import and export raster data, vector data. Display & Effects module is about viewing on computer monitor. This module supports displaying data according to the zoom ratio, the requested region by calling the panning. Data Processing module which could handle the satellite images contains image enhancement, filtering, sensor modeling, ortho-image generation, change detection and vector editing.

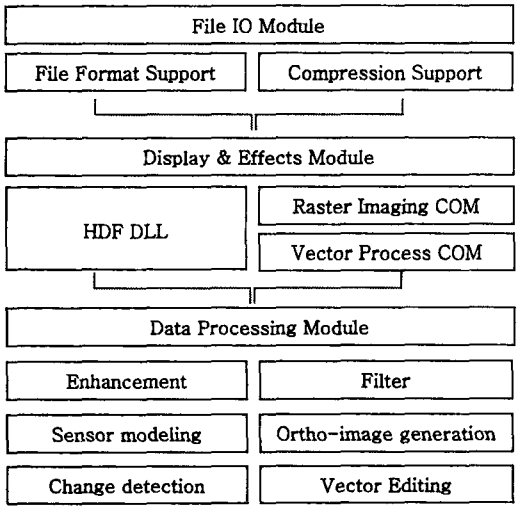

Fig. 1. system composition flow

2.1. File format

This system supports the following raster and vector formats.

- Raster data files of BMP, JPEG, TIFF, HDF format can be imported. HDF is the standard file format for storing and distributing KOMPSAT EOC data.
- Vector data files of DXF, Shape format can be imported.

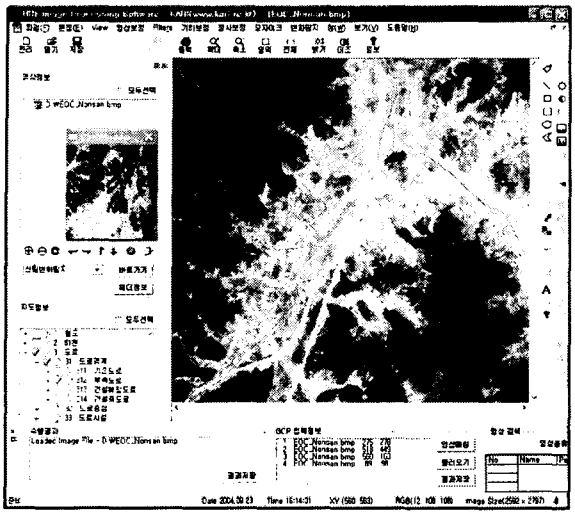

Fig. 2. software user interface

2.2. Image processing

Essential image processing functions for satellite images are included in the system.

- Enhancement – brightness, contrast, hue, histogram equalize, histogram stretch, histogram contrast, etc.
- Filter – sharpening, edge detect, noise, spatial filters such as gradient, laplacian, sobel, prewitt.

2.3. Ortho-image generation

Ortho-image is a geo-referenced image generated from a perspective image in which displacement of objects due to sensor orientation and terrain relief have been removed. This process is needed for overlay between satellite images and vector data. The figure 3 shows the process of ortho-image generation.

- Sensor Modeling –Direct Linear Transform
- Ortho-image by backward projection

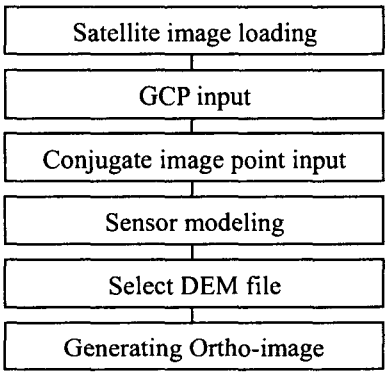

Fig. 3. flow of ortho-image generation

Sensor modeling should be performed for generating ortho-image. There are various sensor modeling methods such as physical, abstract and mathematics sensor models for satellite images. Direct Linear Transform (DLT) is the one of mathematical sensor models which can extract 3D geospatial information without ephemeris or ancillary data of the satellite. Also DLT doesn't need approximate value of unknown parameters as a linear equation. Figure 4 is concept drawing of DLT sensor model.

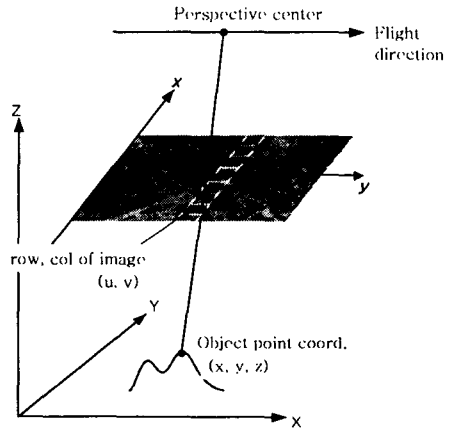

Fig. 4. DLT sensor model

Equation 1 is generic form of DLT sensor model. x, y, z are object point, u is row number on the basis of center line of image, v is column number on the basis of center pixel of image and w is a scale. M is 3x4 matrix. Equation 2 is arranged form of equation 1. and it's homogenous form, so it need to be changed to non-homogenous form for least squares method.

$$\begin{pmatrix} u \\ wv \\ w \end{pmatrix} = M \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} \tag{1}$$

$$\begin{aligned} & m_{11}x + m_{12}y + m_{13}z + m_{14} = u \\ & m_{21}x + m_{22}y + m_{23}z + m_{23} \\ & -m_{31}vx - m_{32}vy - m_{33}vz - m_{34}v = 0 \end{aligned} \tag{2}$$

This software used the differential rectification method which removes distortion of image using DEM and coefficients of DLT for digital ortho-image generation. Especially, the spatial density of DEM data, which is used for removing relief displacement, is related to the quality of ortho-image. And the software contains two resampling functions, nearest neighbor interpolation and bilinear interpolations.

2.4. Change Detection

Spatial database which is generated by satellite images should be updated periodically or modified as the occasion demands. Change detection function of satellite images is recommended for efficient and economical update of database.

Presumably the simplest strategy for detecting changes in an image sequence is image differencing. This method is taking the pointwise difference between consecutive frames and labeling as "changed" the pixels for which this difference exceeds a predetermined threshold, t.

The input is an image sequence, $I_1, I_2, \ldots, I_n$, and a positive real number, t for each image pair(I_k, I_{k+1}). And the image difference could be computed as following.

$$\Delta k(i, j) = I_{k+1}(i, j) - I_k(i, j) \quad (3)$$

if $| \Delta k(i, j) | > t$, label pixel (i, j) of the frame k

2.5. Vector data processing

Manipulation of vector data is the one of the important functions in satellite image processing software.

- Vector display and handling
- Basic manipulation function such as editing, adding, deleting features
- management of layers
- Vector overlay with the raster data

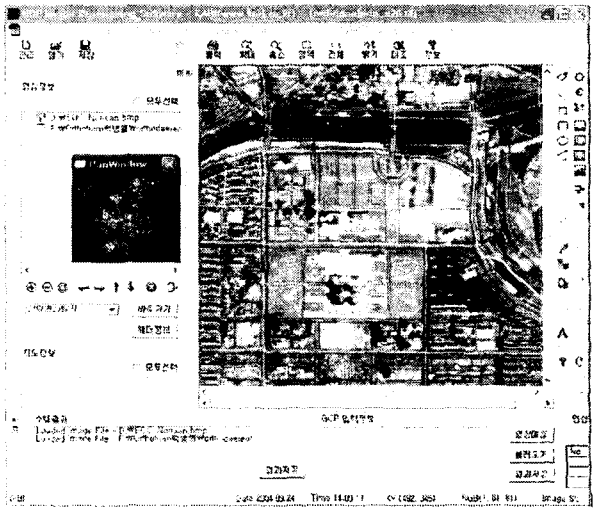

Fig. 5. overlay between ortho-image and digital map

The satellite image could be resampled to ortho-image and overlaid with digital map through the software as shown figure 5.

3. Conclusions

The system is developed for easy access and application of satellite image processing to general users. It includes an import/export module of image, various analysis modules, sensor modeling function, generating the ortho-image function, change detection function and vector processing function. All of the modules and functions are developed in consideration of the user request. Such system is expected to contribute to the efficient use of KOMPSAT-1 EOC data in public and practical application of KOMPSAT-2 MSC data.

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