A Study on the Technique of Stereo Image Generation and Simulation for the Construction Highway Design

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ABSTRACT

- The technology for the three-dimensional terrain perspective view can be used as an important factor in planning and designing for the various construction projects. In this study, the stereo image perspective view has been generated for the multi-dimension analysis by combining useful digital map and remotely sensed satellite images. In the course of experimenting with the three-dimensional topography generated by the combination of the orthoimages by the precise GCP and DEM from the contour line, the technology has been developed to offer the multi-dimensional access to the potential construction sites from the nearby main roads. This stereo image bird's eye view has made it possible to make multi-dimensional analysis on the terrain, which provides real-time virtual access to the designated construction sites and will be a versatile application for development planning and construction projects.

KEYWORDS : Satellite Image, DEM, GCP, 3D Image Map, Perspective View

Background and Objective

Practical use of 3D Perspective Image Map in Construction field is on an increasing trend after going through many changes in creation method and technology and ever since the composition of various Geographic Information became possible by Ortho-Projection technique using Digital Map and Satellite Images.

Since the construction planning and designing through the composition of pictures, image data and three-dimensional presentation of Digital Topographic Map is possibly carried out, the application of Spatial information system to the construction field is being considered as a great solution for a new construction planning technique. Because High resolution Remote Sensing

Image and GPS Information to substitute for the existing Digital Topographic Map and Thematic Map have been already provided and it seems that field application to various fields is highly possible, in this study, we collected detailed topographic information about the routes of expressway and local road which is now construction-expected and carried out Stereo Terrain Analysis of the construction-expected planned-routes to supply basic topographic spatial information for the most reasonable optimum route selection.

To get local environmental information about the chosen districts, you can collect topographic map, air-photo and satellite image data and create 3D Perspective Image Map using those information and then make use of the 3D Perspective Image Map for analysis of local environment. To explain the steps that we took in this study briefly; we firstly created Ortho-Image of Yangsan using satellite images from Arirang 1, LANDSAT TM(America), SPOT(france) and topographic map made by National geographic institute (NGI) and other information about the target district. And created 3D Perspective Image Map using the Ortho-Image and DEM. And then performed simulation using the multidirectional 3D Perspective Image Map.

After all, the objective of this study is to find the optimum route and carry out the most reasonable construction planning/designing through this whole procedure.

3 Dimensional Image Creation

1. Preparation

For the 3D Terrain Analysis of satellite images, collect satellite images of target district according to the purpose and property of objects and use them after color-composite. Differentiate Road network files from Contour Line files of Digital Topographic Map which was made to get DEM(Digital Elevation Model) of target district and use the suitable software for processing of collected topographic information. The three requisites which should be primarily prepared for this study are as follows:

- the initial file of the HDF formated satellite image of target district(Yangsan) captured by EOC sensor of Arirang 1, and the IMG formated satellite image of the same district captured by TM sensor of LANDSAT 6;
- The files of 15,000 Topographic Map made by National geographic institute (NGI) as a digital map and road's planned route data;
- CAD files of road's planned route of the target district.

Then survey the suitable s/w solution for integration of Vector and Raster. In this study, PCI Geomatics is adopted as the digital image processing s/w for Spatial analysis

2. Procedure

After preparation of images and data which is suitable for the purpose of this study, we've got to find the precise geographic coordinate of target district on the images. For this reason, we carried out Geometric Correction using GCP(Ground control point) to make three images, which are different from each other in resolution, fit into Geographic Coordinate and after that, carried out Close Ortho Correction using TM Coordinate, a geographic coordinate especially used for the current construction design.

(1) Projection on Geographic Coordinate

The basic map projection method for Ortho Correction Image Mapping is TM E002 Projection. And that is the map projection method being used by National geographic institute (NGI) for mapping.

(2) Data Input

The primary satellite image used in this study is the image from Arirang1 (hereinafter KOMPSAT). Purchase HDF formated Pancro Band(1 channel, black-and- white) captured by EOC sensor and calculate the orbit information of the moving satellite.

(3) DEM Creation

Convert DXF formated file of 1/5,000 Topographic Map to PIX formated file. It's because the format of Ortho Engine, the image processing s/w, is PIX. After format conversion, you can create DEM.

Picture 1. The results of 10m interval DEM creation by using vector of Contour Lines of target district(Yangsan, Kyongnam)

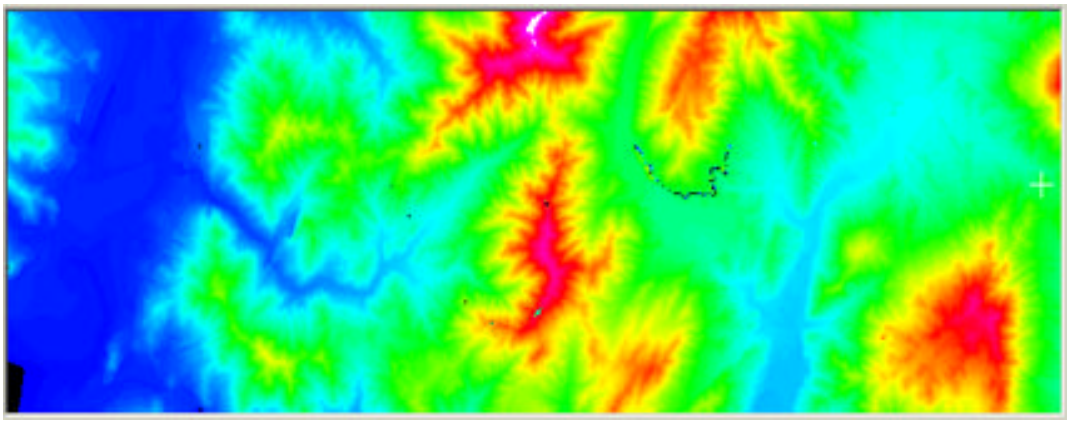

FIGURE 1. DEM of RGB expression

(4) Ortho Correction Image Mapping)

1) Collecting GCP(Ground Control Point)

To get precise ortho-correction image, we collected coordinate values of GCP

corresponding to specific points of satellite image using files of 1/5,000 Topographic Map and DEM files. In this study, once we found the location of a fixed construction such as a building roof, end point of a bridge and a corner of road, we could get TM coordinate and the altitude of the construction on digital map. Table 1. The results of Collecting GCP

TABLE 1. Matching point of image and map for GCP

GCP ID	Column(x)	Line(y)	X coordinate(m)	Y coordinate(m)	Elevation(m)
G001	262.0	362.0	129722.9323474	404132.4205284	256.005
G002	186.0	419.0	129302.1066103	403677.9346743	244.722
G003	229.0	238.0	129318.4339672	404912.2170734	257.712
G004	376.6	429.3	130570.0526935	403826.6145471	251.024
G005	395.6	222.5	130376.9777344	405205.1795519	278.005
G006	353.4	512.5	130547.2260974	403245.3045438	251.908

To confirm the matching accuracy of these GCPs, we evaluated the accuracy of GCP which was used for final close correction by using RMSE(Root mean square error) method. As the results, RMSE value of the above table turns out to be 5.08 m(0.74 pixel). In case the RMSE value for final one pixel is about 8 m, this result can be considered to be within the allowance. Since this RMSE value is below than the Spatial Resolution of Arirang satellite image before color-composite(6.6 m/1pixel), it's definitely considered to be within the allowance

2) Correction Estimation

To create Ortho-Projection Image, we carried out the following two corrections:

, BAM(Bundle Adjustment Method): Estimation of exterior orientation using GCP;

, Algorithm of SOM(Satellite Orbit Modeling): Correction of systemic distortion.

Picture 2. The result of overlapping Road network on top of the color-composite image after Ortho-Correction.

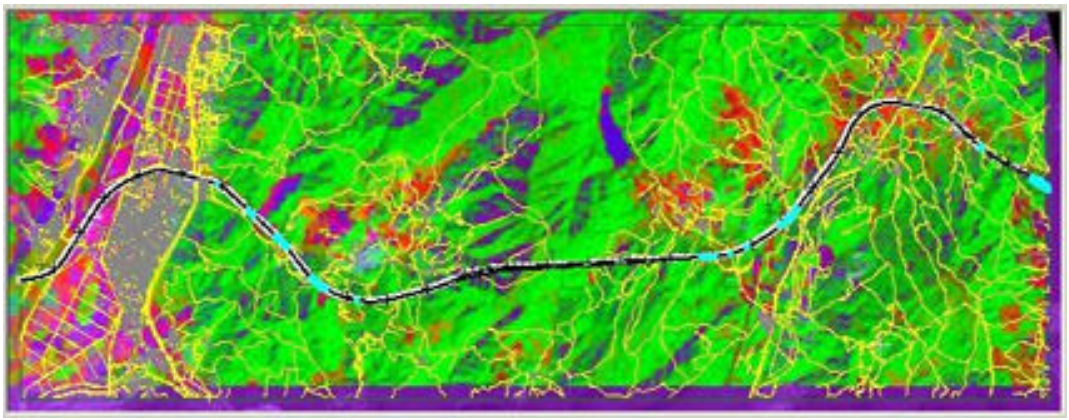

FIGURE 2. Road network overlaid on correction image

3D Perspective Image Mapping Using Satellite Image

1. Preliminaries to Perspective Image Mapping

For Perspective Image Mapping, we used the image creation techniques based on Projection View Method. As preliminaries to Perspective Image Mapping, we prepared information like table 2. and set up fusion-image mode to express textures of terrain softly.

TABLE 2. Image data of perspective map

..	../...
RGB Images	Image Composit Channel of Kompsat and landsat Images
DEM files	DEM Generated Channel from Digital topographic Data
Vector Layers	..... Roads Planning Route Layers from Digital Map

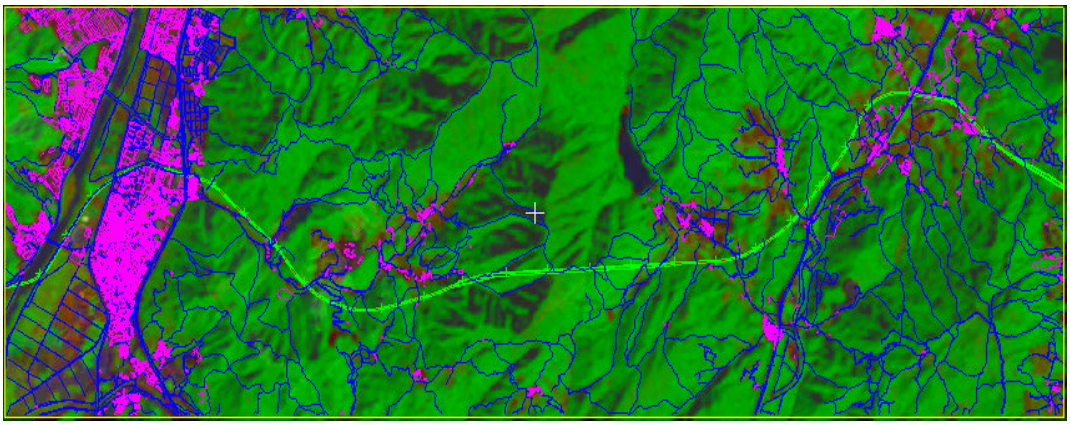

FIGURE 3. RGB image + vector road

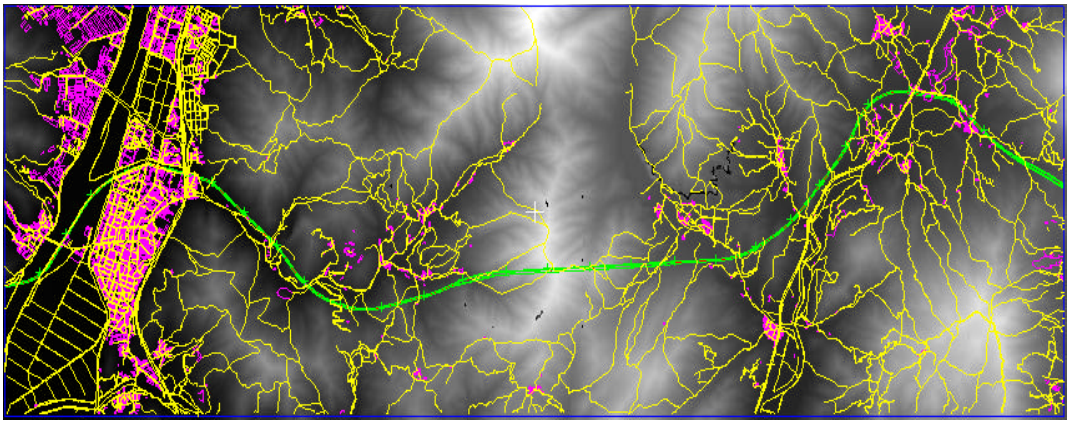

FIGURE 4. DEM + vector roads

2. Perspective Image Mapping by Projection View Method

In this study, Perspective Image Mapping model was made through the composition of various files to express in Perspective Map using PCI Modeler. To describe it briefly, the process is as follows; Inputting RGB channel, DEM channel and Vector layer through IMPORT module Creating projected image through Image Projection Algorithm of PSGIMAG module Showing the results on the computer screen through VIEWRGB module Creating the files of 3D Perspective Image Map through EXPORT module.

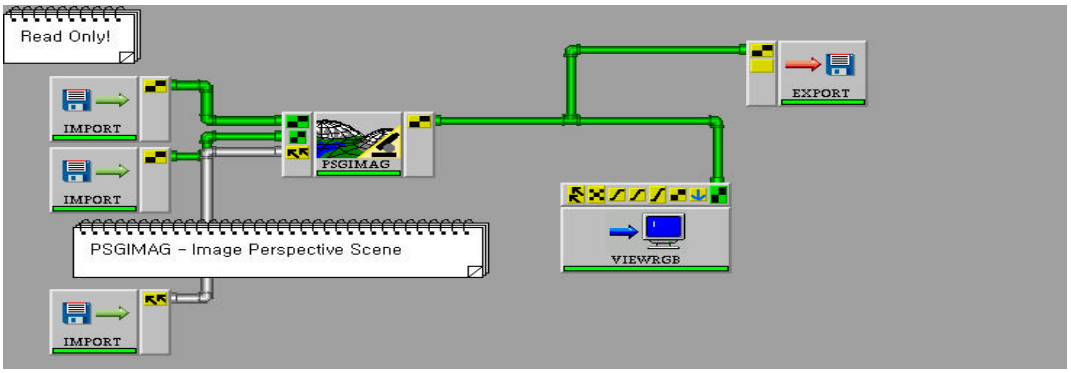

FIGURE 5. Perspective formation diagram

TABLE 3. Perspective production model

psgimag-east-45.mod	East	From Right-ends to Left Direction
psgimag-west-45.mod	West	From Left-end to right Direction
mag-south-45.mod	South	From Down-Center to Upper Direction
psgimag-north-45.mod	North	From upper-Center to Upper Direction

Perspective Image Map which is supposed to be made through this study is a 3D Image viewed from 45 angle in the four cardinal directions and the detailed features are like table 4.

TABLE 4. Contents by model

Direction	Location	Elevation	Angle	Perspective angle	ratio
East	From Right-ends to Left Direction	6000m	45	60	Real
West	From Left-end to right Direction	6000m	45	60	Real
South	From Down-Center to Upper Direction	1800m	45	60	Real
North	From upper-Center to Upper Direction	1800m	45	60	Real

(Full-Scale: 1:1 expression without any exaggeration)

3. Result of Perspective Image Map Creation

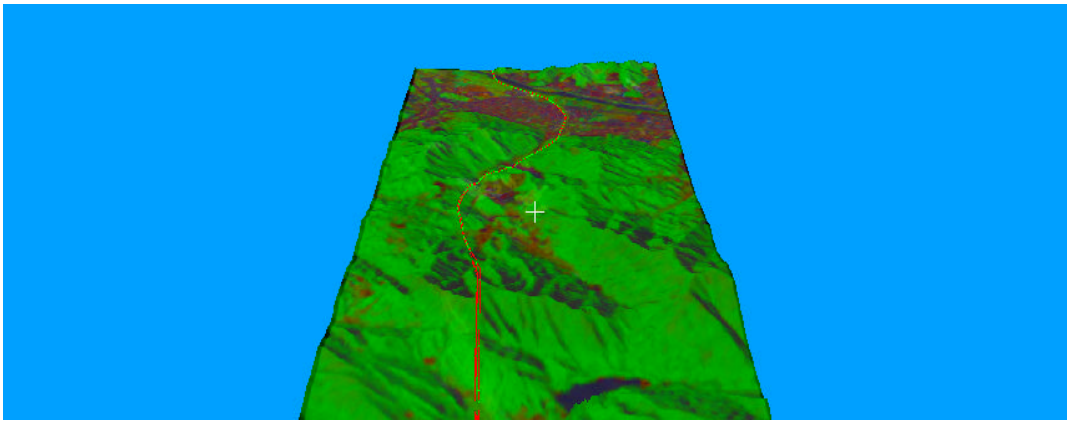

FIGURE 6. Perspective View from the east

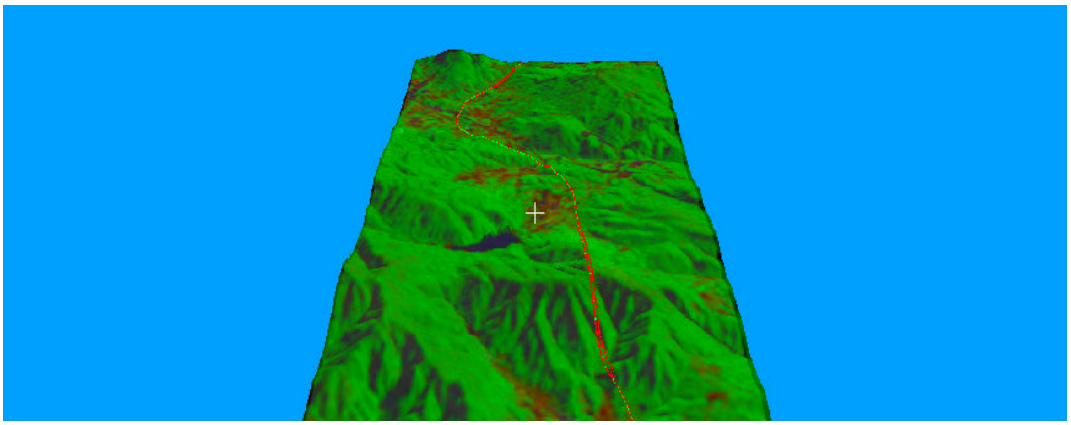

FIGURE7 . Perspective View and Highway Route from the west

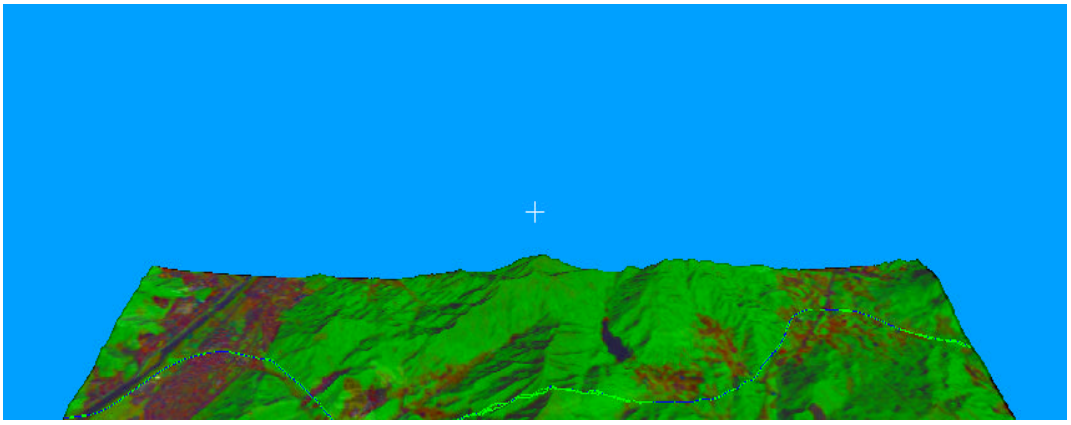

FIGURE 8 . Perspective View and Highway Route from the south

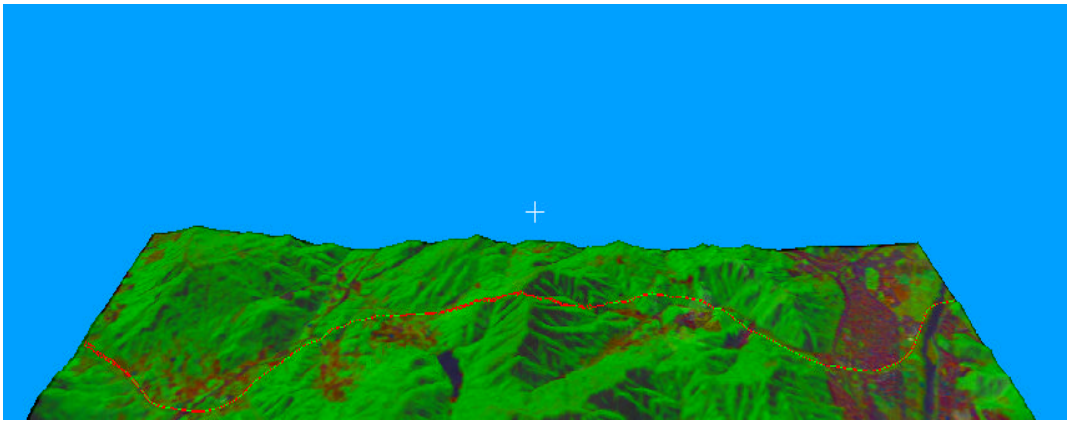

FIGURE 9 . Perspective View and Highway Route from the north

Results and Prospect

This study has been accomplished as a experimental study for 3D Perspective Image Map analysis of terrain along the 16km long section between Yangsan and east Busan which is under consideration for a new expressway construction. Through this study we could have some satisfactory results to carry out multidimensional terrain analysis of remote place using the field survey data of Satellite image, Topographic map and road's planned route. To carry out Stereo Terrain Analysis using various spatial information of topography, we made Perspective Image Map of districts around construction-expected road from various directions and altitudes and produced moving images of the construction-expected road for virtual driving along the planned route. Therefore, on the construction planning phase, 3D analysis based on the results of this study can be simulated with various geographical features and facility conditions. 3D Perspective Image Map to carry out stereo terrain spatial analysis in the four cardinal directions can be considered as a great solution for a new construction planning technique and for the most reasonable optimum route selection.

Lately, as various sensors of satellite and aircraft made collecting of spatial information easier and we can easily get spatial information with high resolution, and more than 3D spatial analysis techniques and time-spatial analysis techniques are being developed, we can expect to make good use of much more realistic Perspective Image Map in real life.

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