

# 3D VIRTUAL MODEL OF TURKEY

A. Yilmaz, M. Erdogan, O. Eker

General Command of Mapping, Photogrammetry Department, 06550 Dikimevi Ankara, Turkey  
(ayilmaz, merdogan, oeker)@hgk.mil.tr

## Commission IV, WG IV/6

**KEY WORDS:** Photogrammetry, Remote Sensing, Orthorectification, DEM/DTM, Virtual Reality

### ABSTRACT:

With the developments in computer technology, 3D models of objects are transferred to the digital form from the hardcopy form. Sometimes, the visualization of topography from the classical maps or orthophoto maps, which are enhanced with contour lines, can be difficult for users. So firstly, embossed maps have been used for topographic visualization. But the production of these kinds of maps is very difficult, very costly and time consuming. This visualization can be done digitally faster, cheaper and continuously.

In this Project, Landsat-7 images covering all Turkey are used. Firstly, panchromatic band and multi-spectral bands of the images were merged. For the best result, different merging algorithms were tested. In the second step, these images were ortho-rectified by using the ground control points and digital elevation models. The ortho-rectified images were mosaicked.

3D visualization was performed by using Erdas Imagine Virtual GIS module. The model was enhanced with some additional data. Since the model covers a very huge area, gazetteer information was added to the model to show the location names. Also some boundaries and road network was superimposed to the visualization. The images of important and historical places were added.

As a result of Project, a user can fly over all Turkey, may watch the topography, cities, historical and touristical places by using this model. Thanks to the computer technology, user can do this seamlessly with the preferred detail and scale. This technology is taking place of the classical embossed map with its inexpensiveness, flexibility and easy production.

## 1. INTRODUCTION

With the developments in computer technology, 3D models of objects are transferred to the digital form from the hardcopy form. Sometimes, the visualization of topography from the classical maps or orthophoto maps, which are enhanced with contour lines, can be difficult for users. So firstly, embossed maps have been used for topographic visualization. But the production of these kinds of maps is very difficult, very costly and time consuming. This visualization can be done digitally faster, cheaper and continuously.

Geographic Information Systems (GIS) has developed rapidly in recent years. The need for a base in GIS arouse in small scales, especially for a whole country. The representation of information is as important as the information itself. It requires accuracy, completeness, exquisiteness. By using aerial photography it was nearly impossible to produce orthophoto mosaic of Turkey. Nearly 12500 aerial photos with a scale of 1:35.000 were necessary to cover Turkey, let alone the time needed for photogrammetric and flight processes. Landsat 7 imagery was decided to be used. It has 15 meters resolution in panchromatic mode and 30 meters in multispectral mode. These resolutions are enough for a nearly 1:1.000.000 scale base. So it was suitable for a base map covering whole Turkey. Had the high resolution imagery (1-5meters) been used, the volume and the cost of the mosaic would have been very great.

The project will help the pilots to fly over Turkey, instead of using 1:250.000 scale hardcopy maps in airplanes or helicopters. They can use it prior to the flight in flight planning process by 3D visualization.

It can also be used as a base in vehicles' trip computer system or in vehicle tracking system of a transportation company.

## 2. THE PRODUCTION OF TURKEY MOSAIC

### 2.1 Information About LANDSAT 7

LANDSAT 7 was launched on April 15, 1999 from the Western Test Range at Vandenberg Air Force Base on a Delta-II launch vehicle. At launch, the satellite weighed approximately 4,800 pounds (2,200 kilograms). The spacecraft is about 14 feet long (4.3 meters) and 9 feet (2.8 meters) in diameter. It consists of a spacecraft bus, built by Lockheed Martin Missiles and Space in Valley Forge, Pa., and the Enhanced Thematic Mapper Plus (ETM+) instrument, developed by Raytheon Santa Barbara Remote Sensing in Santa Barbara, Calif.

The ETM+ instrument is an eight-band multispectral scanning radiometer capable of providing high-resolution image information of the Earth's surface. It detects spectrally-filtered radiation at visible, near-infrared, short-wave, and thermal infrared frequency bands from the sun-lit Earth. Nominal

ground sample distances or "pixel" sizes are 49 feet (15 meters) in the panchromatic band; 98 feet (30 meters) in the 6 visible, near and short-wave infrared bands; and 197 feet (60 meters) in the thermal infrared band.

The satellite orbits the Earth at an altitude of approximately 438 miles (705 kilometers) with a sun-synchronous 98-degree inclination and a descending equatorial crossing time of 10 a.m. LANDSAT Worldwide Reference System will be maintained with periodic adjustments for the life of the mission. A three-axis attitude control subsystem stabilizes the satellite and keeps the instrument pointed toward Earth to within 0.05 degrees. The LANDSAT World-Wide-Reference system catalogues the worlds landmass into 57,784 scenes, each 115 miles (183 kilometers) wide by 106 miles (170 kilometers) long. The ETM+ will produce approximately 3.8 gigabits of data for each scene, which is roughly equivalent to nearly 15 sets of encyclopedias at 29 volumes per set.

An example of the combination of 3,2,1 bands were given in Figure 1.



Figure 1. LANDSAT Imagery of Marmara Sea (Bands 3,2,1)

Researchers familiar with earlier Landsat 4 and 5 data will note the addition of a 15-meter panchromatic band, two gain ranges, the improved 60-meter spatial resolution for the thermal band, and the addition of two solar calibrators that contribute to improved radiometric calibration accuracy (Table 1).

Band Number	Spectral Range <i>microns</i>	Ground Resolution <i>m</i>
1	.45 to .515	30
2	.525 to .605	30
3	.63 to .690	30
4	.75 to .90	30
5	1.55 to 1.75	30
6	10.40 to 12.5	60
7	2.09 to 2.35	30
Pan	.52 to .90	15

Table 1. LANDSAT 7 Spectral and Spatial Resolution

Imagery is available from EROS Data Center DAAC in Level 0R (essentially raw data), 1R (radiometrically corrected 0R)

and 1G (radiometrically and systematically corrected 0R) processing levels. During processing, the 0R image data undergo two-dimensional resampling according to user-specified parameters including output map projection, rotation angle, pixel size, and resampling kernel. Standard data are provided via CD, 8mm tape or electronically via FTP (LANDSAT Project).

## 2.2 The Production Process of Turkey's Orthophoto Mosaic

It was decided that Landsat imagery would be used for the project. After planning and looking for the archives, 60 Landsat images (between years 2000-2004) that have overlap and sidelap were selected. Orthoengine Tool of PCI Geomatica software was used to produce orthophotos and the mosaic. 1:50.000 scale topographic raster maps were used as a base for Ground Control Points.

The production process followed the workflow as seen in Figure 2:

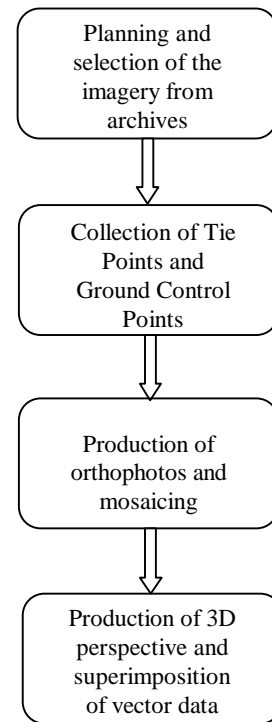


Figure 2. Production workflow

A total number of 400 Ground Control Points (GCP) and 720 Tie Points (TP) were collected for triangulation. After bundle block adjustment, the results; XRMS=16.42 m., YRMS=24.46 m. for GCP and XRMS=12.93 m., YRMS=12.56 m. for TP were obtained. The results were very good if the 30 meters pixel size was taken into consideration. It corresponds nearly the accuracy of 1:100.000 scale maps, but the detection of the features is good for 1:250.000 scale maps. A part of block is shown in Figure 3.

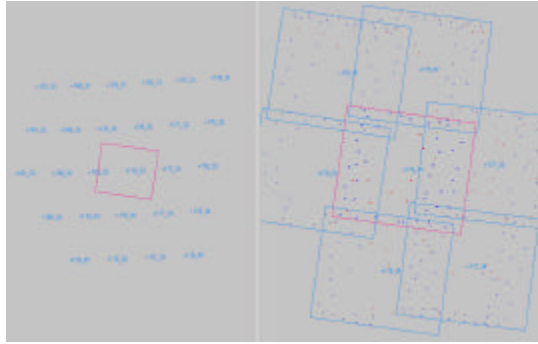


Figure 3. A part of LANDSAT block

After the adjustment, the orthophotos were produced. In the production of the orthophotos, 100 meters interval Digital Elevation Model (DEM) was used. Then, the orthophotos were mosaicked. The resulting product was Turkey's mosaic.

3D visualization was produced in Erdas Virtual GIS module. Road and railway network, city boundaries, names of the cities, towns, rivers, lakes and dams (Figure 4).



Figure 4. Perspective view with the settlement names.

Also with a program produced in Photogrammetry Department of GCM, it is possible to superimpose location names and some other vector data on to the orthophotos (Figure 5).



Figure 5. Vectors over Landsat orthoimagery

The panoramic view of the same area is shown in the Figure 6.

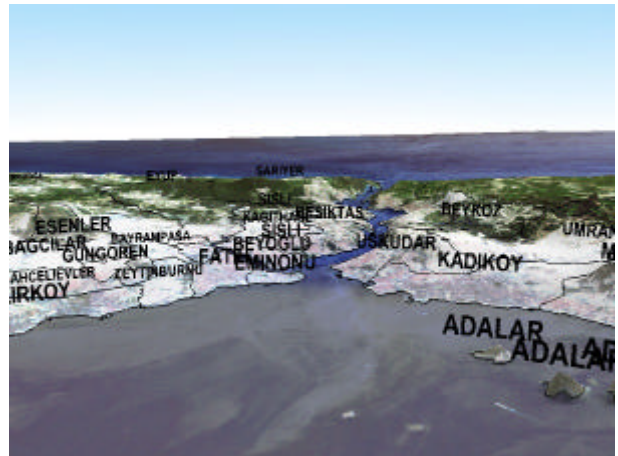


Figure 6. Panoramic view of Istanbul

### 3. CONCLUSION AND PROPOSALS

The need for a base in small scales comes out in every technologic field. The accuracy, completeness, exquisiteness and visuality are the important prerequisites for a base. By the classical maps, one might not understand the topographic structure of interested area. Also, it is expensive and time consuming to produce classical or vector maps. If the high resolution imagery and aerial photos are used for a base, the costs and storage need will be very high. So the optimum solution should be cheaper, less time consuming and should need less storage capacity. Landsat imagery best fit the above mentioned conditions. As a result, Turkey's mosaic was produced from Landsat imagery with an accuracy of 1:100.000 scale maps.

With the help of the computer technology, seamless images can be created and used quickly. The computer technology enables everybody to use such geographic materials easily.

The resulting product (Turkey's mosaic) is open to every possible application field. Especially, it is useful in areas where overall view of Turkey is necessary. It has many application areas: By enhancing the mosaic with some vector data, names of historical places, settlements, accommodation it serves as a valuable tourist map. It can also be used as a base in vehicles' trip computer system or in vehicle tracking system of a transportation company. The mosaic will help the pilots fly over Turkey, instead of using 1:250.000 scale hardcopy maps in airplanes or helicopters. They can also use it prior to the flight in flight planning process by 3D visualization. It is possible to construct Turkey's Geographic Information System (GIS) based on this mosaic. Such a GIS will help everybody who needs planning over whole Turkey.

#### References from websites:

LANDSAT Project,  
<http://www.landsat.gsfc.nasa.gov/project/satellite.html>  
 (accessed 05 May 2004)