

# CREATING AN INFORMATION SYSTEM TO INTEGRATE REMOTE SENSING DATA WITH GIS DATA FOR RAILWAY DESIGN

Xie Wei  
Southwest Jiaotong University  
Chengdu, Sichuan  
The People's Republic of China  
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## ABSTRACT

In the mid-1970s the Chinese Railway Administration began to use remote sensing data for railway design. Many successful samples showed that using remote sensing data for railway design was the most effective and economical alternative. The remote sensing data can provide rich geographic information such as geologic, hydrologic and vegetative data. However, the railway design is a very complex procedure. Only using remote sensing data can not satisfy the requirements of the engineering design. The main reason is the lack of accuracy of remote sensing data in both classification and position. Recently, the geographic information system (GIS) has been recognized as effective and utilizable to prepare basic data for engineering design. This paper describes how to build an automatic railway design system, how to integrate remote sensing data and GIS data to choose the best railway line. A case study in southwest China has shown how to choose the data structure and data informative layers. Some suggestions have been made for improving the accuracy of the information system.

KEY WORDS: Remote sensing, GIS, Integrate, Classification, Railway Design.

## INTRODUCTION

The railway designer is increasingly using various types and sources of spatial information to select an optimum railway line. This has created a demand for an integration of the GIS data and remote sensing data within the same system. Although many general purpose GIS systems are commercially available, they are very expensive and can hardly satisfy the requirements of the railway design.

This research work try to establish an information system to solve the practical problem. This GIS system can improve the analysis of the spatial image data, guarantee the railway design accuracy and store the engineering database for long time. Reversely, the image data can update the GIS data in an automatic way. The designer can grasp the present condition of nature.

In developing countries, after a new railway line has been selected, in some reason, the railway line cannot be constructed, or original plan has been canceled. After several years, the authority requires to build the railway as soon as possible. Although the topography can not be changed, the phenomena on

the surface of the earth changes rapidly, especially by human interference. The field investigation of the railway line has to be done again. These spend a lot of money and time. If we stored the original engineering data in this system, the remote sensing data can provide the newest information on the surface of the earth to update the GIS data. This system can rapidly provide the basic accuracy data for railway design.

The purpose of this research work is creating an information system to integrate remote sensing data with GIS data for railway design. This project supported by the railway ministry of the People's Republic of China.

## STUDY AREA AND DATA

The study area is located in the west of Xi' an city in Shaanxi province. This area includes urban area of Xi' an city, and Qinling mountain. The trains are very difficult to pass through this area. Along the railway line it needs to build a lot of tunnels and bridges. Within the study area are very complex vegetation cover. The transportation is very difficult.

Data On Nov. 11, 1987; Landsat TM were selected for the research, because of the absence of cloud cover, channel data quality and time period most favorable to vegetation classification. The other kind of data are topographical maps (scale of 1 : 50000 and 25000), geological and hydrological maps, the field investigation data. The SPOT data has a better spatial resolution than Landsat, so SPOT images would be more suitable to establish an engineering data base, but at the time no SPOT images of the test area were available. A second reason is that SPOT image is very expensive and very difficult to get.

The hardware IMCO — 1000 Image processor incorporate a high performance programmable microprocessor and a large random access dynamic memory (up to 512 Mbytes for image plus 512 Mbits for graphics from KONTRON Bildanalyse. The software <Geo-Jars> is a package of image processing and analysis for remote sensing applications developed by MICROM E SPANA, and designed for use on IMCO 1000 image processor.

#### METHOD OF DATA PREPROCESSING

Various data required for GIS were preprocessed as follows, block diagram of data preprocessing is shown in Fig. 1.

1. Digitizing existing topographic maps (scale 1 : 50000 and 1 : 25000) by DK2436 table digitizer, generate a digital terrain modle (DTM) to store in this system. The contour map; slope map; aspect map; relief shade map; 3D-perspective map were derived from the DTM to use for railway design.

2. Geological and hydrological map get from digitized existing geological map hydrological map and some field investegate data. A complex pacel structure are used.

3. Feature extraction from the TM data was carried out. Selecting useful information for railway design, eliminating redundant information, removing uncorrect information. A house and artificial building map; water and road system map are got from the feature extraction procedure.

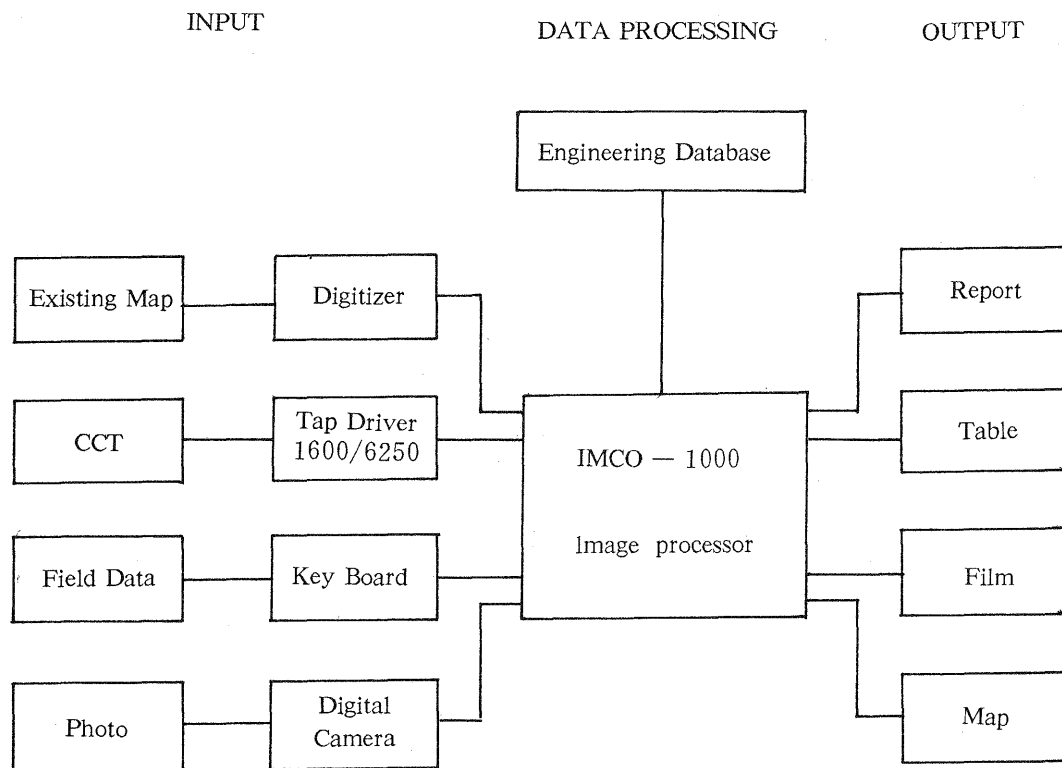


Fig. 1; Flow Diagram of Data Processing

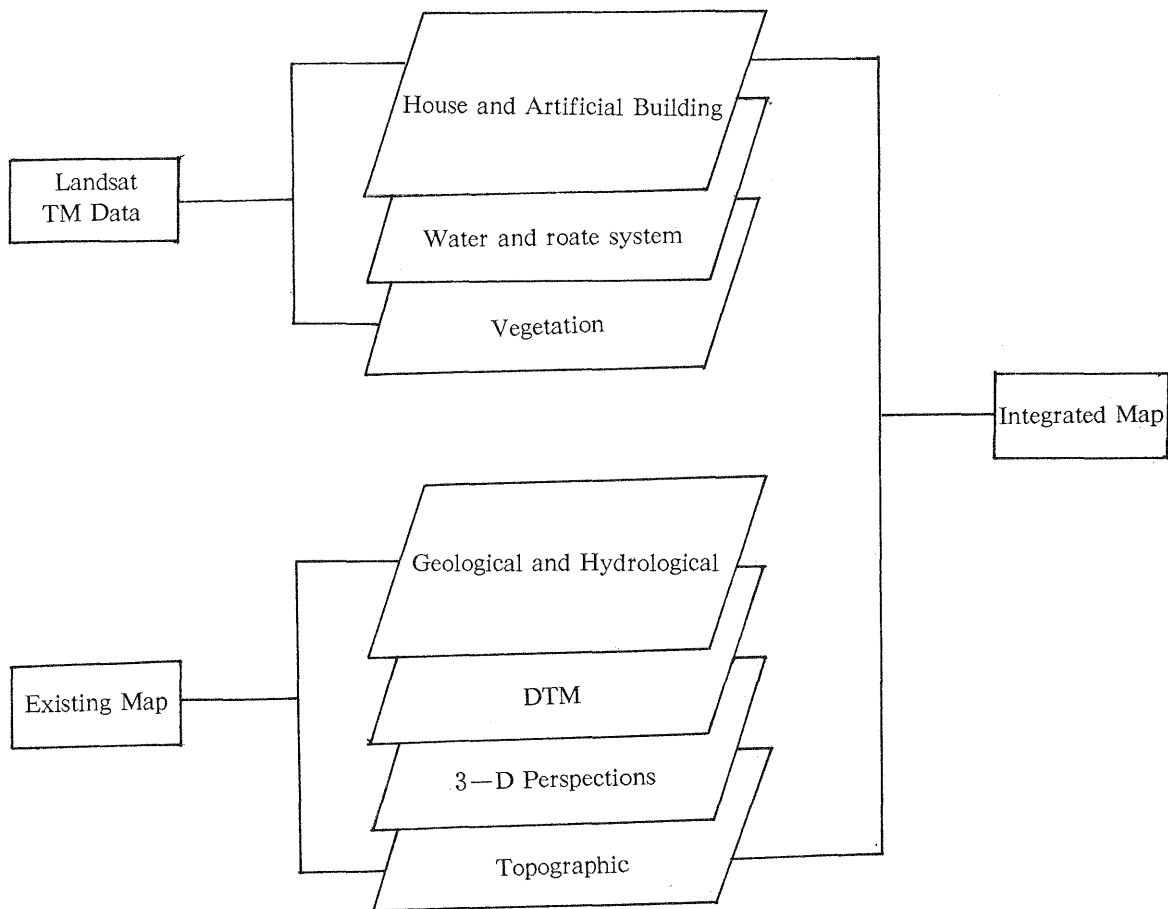


Fig. 2; Conceptual Framework of GIS Database in this Study

4. Landsat TM data were set to classify land covers with the supervised maximum-likelihood classify. These classification categories were forest area; agriculture area; urban area and artificial building area; water and road systems. The classified vegetation map store in the system.

5. Field investigation data input to the system.

#### CREATING A GIS SYSTEM FOR RAILWAY DESIGN

This GIS information system for railway design contains 7 information planes (IPs)

1. Topographic information plane.

This is the basic map to determine the railway line location and profile. This IP can guarantee the engineering design accuracy.

2. Geological and hydrological information plane

On this IP, the designer keeps the railway line in the strongest geological foundations and avoids natural hazards.

3. Vegetation information plane.

On this IP, the designer can calculate that how many agriculture and forest areas are in the route corridor.

4. House and artificial building information plane.

On this IP, the designer can calculate how many area of the house and artificial building have to move out from this route corridor.

5. Water and road system information plane.

On this IP, the designer can determine the railway line, how to cross the river and road system. How many bridges will be built in the route corridor.

#### 6. DTM information plane

On this IP, the designer can check the topographic conditions in the route corridor and determine where tunnel should be built to pass through the mountain; where bridge should be built to across the deep crayon.

#### 7. 3D-perspection information plane.

On this IP, the designer can check the correction of the bridge and tunnel sites and drainage system.

A mathematical reference system should provide the linkage between individual layers.

The conceptual framework of GIS for railway design is shown in fig. 2.

### RAILWAY DESIGN

This GIS system provide the basic data for railway design. In reconnaissance and feasibility stage, The design steps is follows:

1. The designer collects all kind of data from different sources to establish the engineering database.

2. determine the political, social, topographic Control factors. The meaning is that the railway line has to pass these control points.

3. The designer could interpret the engineering feature on the three-band colour composition imges directly from the screen, finding out the factors of influencing the railway line location on the ground, such as the natural environmental, geological and hydrological condition; the main rivers and road systems; the catchment areas of the main rivers, the building material sources. The designer selects all possible railway line between the start point and the end point in the topographic information plane on the screen.

4. The designer evaluate all feasible line, calculate the amount of earthwork, the length of tunnels and bridges. The final optimum railway line will get from the shortest distance, lowest construction cost and vehicle operating cost.

5. Checking the correction of the bridge and tunnel sites, drainage structure on the 3D — perspect information plane.

6. The designer put the selected railway line on the topographic information plane and output the design documents and maps.

### CONCLUSION

This paper exploits the integration of remote sensing data with GIS data, their effective utilization in the railway design. The following can be concluded in this study.

1. The system has demonstrated that it is technically feasible to solve the engineering practical problem. Designer can directly choose the best railway line on the screen in preventing wasteful repetition of survey effort.

2. Determining the railway line on the topographic information plane can keep the accuracy of the railway design.

3. Using Landsat image data updating the GIS data to keep the reliable engineering data base.

The whole system is so far in the testing status.

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