

CHAPTER 16

Image Analysis

16.1 ANALYSIS PROCEDURES

Studies for various disciplines require different technical approaches, but there is a generalized pattern for geology, soils, range, wetlands, archeology, hydrology, agronomy, forestry, habitat, land use, or other similar study purposes.

Information system databases can be multidisciplinary, and several studies can run concurrently. The combined information may be correlated so as to form the database necessary for a multifaceted GIS study. Prior to beginning a project the objectives of the study must be defined. In the past, the analysis and mapping work was accomplished by manual methods, mostly utilizing monoscopic aerial photographs. Since this procedure does not remove inherent object displacement, the accuracy of the mapping may have been suspect on intensive studies in areas exhibiting terrain relief. Softcopy mapping has revolutionized these procedures, since this mapping methodology depends upon stereoscopic procedures where the integration of vertical data creates an orthogonal base map.

The progression of an image analysis investigation may include the techniques discussed in this chapter.

16.1.1 Data Acquisition

Project managers must acquire appropriate information packages pertinent to the project site, such as:

1. Aerial photographs and/or digital data from multispectral scans, thermal scans, radar imagery, or a combination of several of these sources
2. DEM or DTM or LIDAR elevation point data to generate a vertical base
3. Cadastral data relevant to rectifying the digital information to its true geographic scene
4. Tabular and textual material germane to analyzing the created thematic polygons

16.1.2 Rectify Data

Upon merging the digital image information with the vertical database and the geographical datum in a softcopy machine, electronic mapping can proceed.

16.1.3 Thematic Map Generation

Specific classification themes relative to the prime discipline (soil, crop, forest, habitat, wetlands, hydrology, geology, urban, land use, and others) are thematically classified. Currently, the trend is to achieve this through electronic assistance involving computers and complex software. The use of interpretation keys may be of use to carry out this task.

Computer hardware, peripheral facilities, and software capable of storing, manipulating, and outputting the vast amounts of generated data are costly. Potentially, these data analysis systems can be of great value to the image analyst in various scientific specialties relative to capturing GIS data from photographic images exposed with aerial or metric cameras and raster data collected by remote sensors.

With judicious guidance from the technician, these systems are capable of classifying themes, measuring acreage, creating contours and shaded relief, producing aspects and perspectives, and gleaned other information from the images automatically. Utilized properly, softcopy mappers allow the scientist to reduce time spent on mundane labor-intensive processes so that quality time can be devoted to matters requiring professional acumen.

The electronic classification procedures create a thematic map automatically. Satellite imagery in digital form is especially useful in GIS studies that dictate small-scale cartography. Multiple scenes can be mosaicked to form a single composite.

It is possible to automatically create theme maps (water, urban, woodlands, crops, wetlands, soils, fallow) from photographs or images generated by digital data in at least two fashions: supervised and unsupervised classification.

16.1.3.1 Supervised Classification

In supervised classification the technician selects training sites, which are sample areas representative of specific thematic signatures on the image. Sample signatures can be based on ground truth, interpretation keys, or some other knowledge of the particular theme. The computer will then select other areas of similar brightness value and paint these on the viewing screen. This is a valuable system characteristic if the user has access to valid knowledge of the various thematic classes. Interpretation keys may be helpful in selecting training sites. Refer to [Color Figure 3*](#) for an example of a thematic map created by supervised classification procedures.

16.1.3.2 Unsupervised Classification

In unsupervised classification the technician requests the computer to make a thematic segregation. The computer then breaks the range of reflectances into the

* Color figures follow page 42.

number of separate classes suggested by the technician and paints areas of this group of brightness value ranges on the screen. Once these computer themes are available, the operator must devise a method such as field investigation or low-altitude aerial photography to identify the computer-selected classes.

16.1.4 Areal Mensuration

Once the thematic separation is made, by whichever process, the system can measure areas and apply these acreages to other information appropriate to the project. Perimeters, percentages by class, and other pertinent mensurational data are also electronically extracted from the classification map.

16.1.5 Ground Truth Sampling

Field visitation is necessary to visually verify the integrity of the image classifications. Collecting ground truth information from sample areas scattered throughout each class may entail considerable temporal and monetary expenditures. In fact, this field procedure could require more effort than that required to complete office routines.

16.1.6 Data Correlation

Areal measurements within a theme are correlated with the relevant ground truth data and tabular information gathered at the ground sampling stations in order to assess the characteristics of the total project area.

16.1.7 Reporting

Project reports are prepared, often with a great deal of input from the computer, to include graphs, charts, tables, maps, etc.

16.2 IMAGE INTERPRETATION KEYS

Image interpretation keys are graphic and/or textual aids that may help identify thematic classes from image feature characteristics. Some keys may be available from varied sources. Sometimes it is necessary, at the beginning of a project, to construct a key to be employed in that specific or in similar studies. The technician, when selecting class target samples in supervised classification, should keep in mind the concept of interpretation keys, because that is the basis for this procedure. Not all objects can be identified by use of an interpretation key only. Photo interpreters must possess an intuitive deduction trait.

16.2.1 Composition of Keys

Interpretation keys are usually comprised of one of two methods of presenting the discriminating information: stereograms and descriptive text. Some keys may combine both.

Interpretation keys may be composed of a collection of stereograms, which are pertinent portions of stereopairs which when viewed in three dimensions form graphic illustrative samples of various objects.

Interpretation keys may be composed of word descriptions defining the characteristics of various features.

16.2.2 Types of Keys

Basically, interpretation keys can be one of two generic types: selective and elimination.

Selective keys are used by the analyst to search through the stereograms and/or word descriptions until a match is made with the photo image object.

Elimination keys are composed of word descriptions ranging through various levels of broad to specific characteristic discrimination. The analyst progresses down through this hierarchy, making choices at branching description paths. Finally, by the process of eliminating all differing features, the object is identified.

16.2.3 Interpretation Characteristics

A number of image characteristics are scrutinized in order to identify ground objects.

16.2.3.1 Shape

The form or configuration of an object can eliminate or identify objects. Race-tracks are seen as elongated ovals on the image. Not too many objects exhibit this particular shape characteristic, other than athletic tracks and raceways.

16.2.3.2 Size

The relative size of an object can help to discriminate features. A soccer field and a tennis court can exhibit somewhat similar rectangular signatures on a photo. The standard dimensions of these features are significantly different. By measuring the size of these features on the image, the discrimination is apparent, as would be the difference in size between a residence and a doghouse.

16.2.3.3 Pattern

Spatial arrangements can definitely aid in identifying objects. Both orchards and woodlots are composed of trees. The trees in a natural woodlot are situated randomly and, since the individual trees are not all the same age, attain various heights. Orchards and plantations are planted with grids of evenly spaced trees that are all, since they are planted at the same time, roughly the same height.

16.2.3.4 Shadows

The characteristic forms of some features are difficult to identify, except by the shadows they cast. A utility pole is sometimes difficult to see on the image, but it can be more easily located by its shadow.

16.2.3.5 *Tone*

The relative brightness of an object's spectral signature can help identify that feature. The highly reflective surface of a sand trap on a golf course may appear lighter on the image. Conversely, a putting green reflects limited light and will appear darker on the image.

16.2.3.6 *Texture*

The frequency of tonal change of an object's surface may give an indication of its identity. The varying diameters and heights of individual plants in a soybean field create a "cobbled" effect on an image. On the other hand, a pasture is composed of relatively short grass which exhibits an even texture on the image.

16.2.3.7 *Site*

One can expect to find objects in certain environmental situations. Grain fields are not cultivated in marshes, yet tracts of wild rice may be found there.