ENGINEERING APPLICATIONS OF DIGITAL TERRAIN MAPPING

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The Riverside County Flood Control and Water Conservation District has taken the pragmatic approach to Digital Terrain Modeling beginning approximately ten years ago with the District's engineers using photogrammetric equipment to capture digital information to describe the surface of the ground. Initially this involved the extraction of cross sections along a prescribed alignment through the use of a stereo plotter. This experience lead to the construction of simple Digital Terrain Models of borrow areas and sanitary landfills for the purpose of volume computations.

A major breakthrough in the use of digital ground information occurred in 1976, with the development of a procedure to produce engineering quality orthophoto contour maps from Digital Terrain Models. Unlike earlier Digital Terrain Models generated from cross sections, the mapping D.T.M. had to represent the ground surface within the relative accuracies of the aerial photography from which it was derived. This was accomplished by recording numerous ground elevations (40,000 per stereo model) during the production of the orthophotograph. An orthophotograph is a true scale photograph that is used in place of the traditional hand drawn planimetric data as the base for the contour map. The digital elevation data is converted into a D.T.M. using sophisticated computer programs and a finished orthophoto-contour map is produced on a high speed flatbed plotter. This process not only produces maps that meet U.S. Map Standard Accuracy, but also provides the engineers with a D.T.M. of the same accuracy.

A closer look at this Automatic Orthophoto-Contour Mapping procedure will illustrate the precision with which the digital elevation data is collected. The process begins with the set-up of a stereo model within the Santoni IIC Orthophoto Plotter. The digitizing procedure starts with the recording of all horizontal and vertical control points. The stereo model is then scanned for the production of the orthophoto in a series of vertical profiles. As mentioned earlier, relative coordinates and elevations of more than 40,000 points for a single model are recorded in terms of X, Y, and Z. When the scanning is complete, spot elevations are read and recorded at normal locations: the hilltops, saddles, culverts, street intersections, and most importantly, where scanning of the vertical profile might have lost contact with the ground. These spot elevations replace data obtained from the vertical profile scan. When the digitizing is completed the data tape is fed into the computer where the scan data are rotated and translated into a uniform elevation grid based on the State Plane Coordinate System. Several models are processed and held in the computer's disk storage until an area larger than the defined limits of the desired map sheet is processed. Contour mapping begins by defining the limits for each map sheet in terms of the California Coordinate System. The computer extracts all survey data and elevation grid values falling within these limits to produce a Map Grid. Overlapping grid values for common points from various stereo models are converted to single values. In addition, an extra one-inch strip of vertical data is extracted for the area immediately outside the limits to insure proper edge matching of adjoining models.

Once the Map Grids are complete, the engineer may elect to produce a contour map to a specific scale and contour interval or he may utilize the D.T.M. data for engineering computations. If a contour map is desired, it is constructed using a Contouring Program that outputs a magnetic tape used to draw and label the contours on the flatbed plotter. At the same time another tape is prepared to plot the survey data, State Plane Grid, spot elevations, and title information. Meanwhile, the orthophoto conforming to the previously defined map limits is enlarged, screened, and photographically printed on a title block.

After the orthophoto is printed on stable base material for processing on a Diazo White Printer, the finished orthophoto transparency is placed on the CalComp 748 Flatbed Plotter and registered to the ground control, then all the data stored on the two plot tapes are plotted directly on the orthophoto in ink. Currently, inking and labeling of the contours is done on the reverse side, while control points, grid, borders, title, spot elevations and control descriptions are drawn on the right side. This technique permits correction to be made to contours without disturbing grid values or control point information and vice versa.

The D.T.M. is available for use by the engineers once the Map Grids are complete. The engineers access D.T.M.'s through computer terminal, a series of computer programs that provide for computation of volumes, extraction of cross sections and alignment profile plots.

Cross sectioning is by far the most prevalent method of volume computations. With the D.T.M. the engineer can evaluate alternate alignments by merely inputing the coordinates and curve data that describe the alignments, the cross sectioning frequency and the left and right limits of the sections. The computer program computes elevations for each cross section and stores this data in a computer cross section file which may be utilized by the earthwork computer program as well as the cross-section plot program.

An alternate method of volume computation, now available to the engineers, is grid to grid computations within a prescribed boundary. This process utilizes two D.T.M.'s representing the before and after conditions and is well suited for stockpiles, borrow pits, reservoirs and land fills. The D.T.M.'s can either be produced by the Automatic Orthophoto-Contouring procedure or through contour tracing of existing and design maps or from cross sections. The engineers have found that this method of volume computation provides accuracies comparable with traditional methods and are using this method for final payment quantities.

Through the use of the D.T.M., the engineer is able to display his design through the use of perspective views. This method of conveying the visual effects of a project has been found to be invaluable when interfacing with the general public.

In conclusion, the District has found that the Automatic Orthophoto Contour Maps using D.T.M.s is a cost effective alternative to traditional line mapping and the engineers have found the use of D.T.M.'s an exciting new approach to solving traditional problems.