

Terrain modelling in surveying and civil engineering

G Petrie and T J M Kennie*

This paper is a review of the application of terrain modelling to surveying and civil engineering. The first section considers the theoretical background to the subject and two distinct approaches are identified based on the use of either grid or randomly located heights data. The relative merits of each are discussed and the most frequently used algorithms for interpolation and contouring are examined. This is followed by a review of the characteristics of a selected number of terrain modelling and contouring packages. Five distinct groups of packages are identified. Finally, a review of applications is presented together with some views on the future trends in this field.

terrain modelling, civil engineering, landscape planning

Surface modelling is a general term used to describe the process of representing a physical or artificially created surface by means of a mathematical expression. Terrain modelling is one particular category of surface modelling which deals with the specific problems of representing the surface of the earth.

The term 'digital terrain model' was originally coined in 1958 by Miller and Laflamme¹. Since then, the subject has developed considerably and is currently an area of widespread activity in surveying, geology and geophysics, civil and mining engineering and other disciplines in the earth sciences.

The paper is divided into three distinct sections. The first section examines the theoretical background and considers the advantages and limitations of the various interpolation and contouring techniques which are used by the program packages described in the second section. The paper concludes by listing the range of projects where terrain modelling may be applied and considers the most likely trends for the future in this field.

THEORETICAL BACKGROUND

As the review in the later part of the paper will show, a very large number of program packages have been devised and written for terrain modelling applications in surveying and civil engineering. Each program package has been written independently and usually has been optimized for a specific

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This paper was presented to the Conference on State of the Art in Stereo and Terrain Modelling held by the British Computer Society — Displays Group, 28th May, 1986.

application or for use on a specific computer or uses a different programming language, or has a distinctive user interface. However, in spite of this diversity, when their characteristics are analysed, it can be seen that basically they follow one or two main approaches (see Figure 1). Either they are based on, or make use of, height data which has been collected or arranged in the form of a regular (e.g. rectangular or square) grid or they are based on a triangular network of irregular size, shape and orientation, and use randomly-located height data.

Grid based terrain modelling

The first approach is in many ways the simplest, in that the data comprising the terrain model is measured or collected in the form of a regular grid. This is in widespread use, e.g. in the grid levelling of building sites carried out by surveyors and civil engineers and in the acquisition of profile data measured photogrammetrically in stereoplottling instruments, in the latter case, especially when derived automatically or semi-automatically during the production

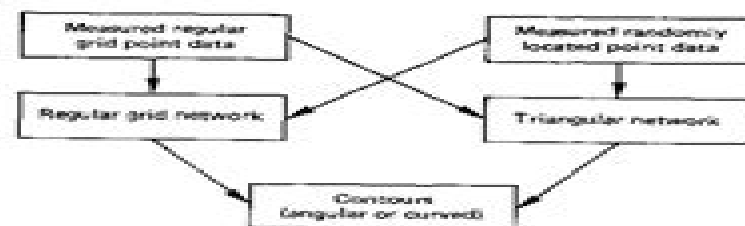


Figure 1. Overall relation between measured point data, networks and contours in terrain modelling

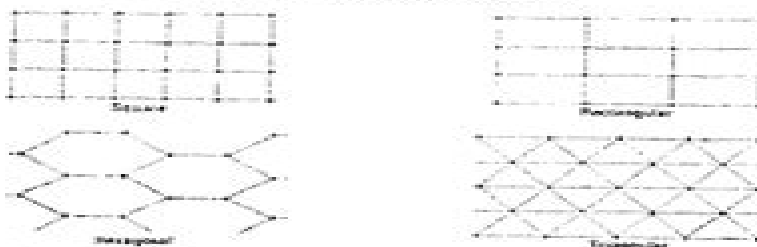


Figure 2. Regular grid patterns

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Geomorphometry Tomislav Hengl, Hannes I. Reuter, 2008-09-25 Geomorphometry is the science of quantitative land surface analysis It draws upon mathematical statistical and image processing techniques to quantify the shape of earth's topography at various spatial scales The focus of geomorphometry is the calculation of surface form measures land surface parameters and features objects which may be used to improve the mapping and modelling of landforms to assist in the evaluation of soils vegetation land use natural hazards and other information This book provides a practical guide to preparing Digital Elevation Models DEM for analysis and extracting land surface parameters and objects from DEMs through a variety of software It further offers detailed instructions on applying parameters and objects in soil agricultural environmental and earth sciences This is a manual of state of the art methods to serve the various researchers who use geomorphometry Soil scientists will use this book to further learn the methods for classifying and measuring the chemical biological and fertility properties of soils and gain a further understanding of the role of soil as a natural resource Geologists will find value in the instruction this book provides for measuring the physical features of the soil such as elevation porosity and structure which geologists use to predict natural disasters such as earthquakes volcanoes and flooding Technical details on a variety of software packages allow researchers to solve real life mapping issues Provides soil and agronomy researchers best practice techniques for soil data analysis to assist in enhanced land use and planning Offers geologists essential tactics for better environmental management by providing a comprehensive analysis of the physical features of soil Companion website includes access to the latest technological advancements previously unpublished in any other comprehensive source geomorphometry software DEM data sources and applications

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