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Visualization of 2-D and 2.5-D Spatial Data in Arc/Info Environment

Alias Abdul Rahmart
Jabatan Geoinformatik
Fakulti Ukur dan Harta Tanah
Universiti Teknologi Malaysia

Tan Lye Siang
Fakulti Ukur dan Harta Tanah
Universiti Teknologi Malaysia

Abstract

Paper maps were traditionally used to portray terrain reliefs. IWs was the only known method to represent the terrain and other terrain features, e.g. by using contour lines, hachures, spot heights, etc. This paper attempts to describe some of the favourable and effective techniques for visualizing terrain from 2.5-D spatial datasets (i.e. planimetric data with height as an attribute) such as contour lines. The 2-D datasets is draped on top of the generated DTM surface using TIN Surface Module of Arc/Info Rev. 6 software (workstation-based). Some realistic three-dimensional models are presented.

1.0 INTRODUCTION

Representation of topographic terrain is normally portrayed by map makers on 2-D media, e.g. paper maps. This technique of presentation has some limitations to geoinformation users in order to understand, analysed, or explained any phenomena on the terrain surface. Thus the technique reduced the value of some of the related terrain data management and decision making tasks. Buttenfield and Mackaness(1990) stated that visualization increasingly has become important in GIS as the volume of digital spatial data grows tremendously. Other author such as Cassettari(1993) noted that by having a proper way jf visualizing terrain features (i.e. by using any DTM software) certainly will improve and make the decision making process far better. This study attempts to look into a portion of the whole visualization issue that is to visualize the available spatial terrain datasets using available terrain surface generation package. A spatial datasets representing height of the ground surface above datum (i.e. 2.5-D data) plus other topographic features e.g. rivers, roads, forest boundaries, etc can be used to create better digital three-dimensional maps (Alias 1992; Walker 1992; Pilouk 1992; Roshannejad 1992; Tan 1994). This paper attempts to present tine most favourable and realistic impression of three dimensinal maps than the visualization portrayed by the traditional flat surface map. A data sets of 2-D data (e.g. rivers, roads, town and village boundaries) and 2.5-D spatial data (e.g. contours) are the major input to the Arc/Info TIN Surface Module.

2.0 STUDY AREA

The study area is within the administration of a local authority called 'Majlis Daerah Kluang Utara', it is approximately stretched from (N 214875 m, N 241400 m) to (E 613550 m, E 574000 m). The area is covered by six topographic maps of scale 1:25000. The total area is about 27 km x 40 km square.

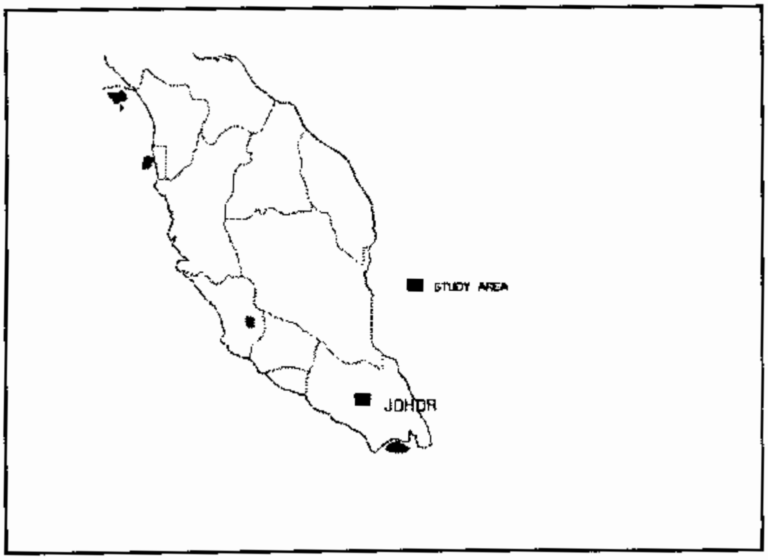

Figure 1 Location map of the study area (Majlis Daerah Kluang Utara, Johor)

3.0 THE 2-D AND 2.5-D SPATIAL DATA

A digital terrain model (DTM) provides a 2.5-dimensional digital representation of a portion of the Earth's surface. The term 2.5-D data is meant for topographic surface datasets having unique z-values over x and y coordinates. Typical example is digital contour lines. On the other hand, the predominant 2-D datasets (i.e. planimetric data) of any linear features, e.g. rivers, administrative boundaries, landuse boundaries, etc. A visualization and interpretation of topographic terrain can be made far better if the generated DTMs were superimposed or draped with linear features. One 2.5-D and six types of 2-D data (linear features) were used in this study, namely,

- Contour lines (20 meter interval)
- Spot heights
- Roads
- Buildings
- Rivers
- Landuse, e.g. rubber, oil palm, paddy, and swamps
- Town/villages, and
- Administrative boundaries, e.g. district boundaries

These spatial data were manually digitized from the existing topographic maps. Contours is used to generate DTMs. In order to visualize all the selected features on the topographic surface, few digital terrain models (DTMs) were generated. The following section explains how to generate the DTMs.

4.0 DTM GENERATION

Digital terrain models (DTMs) can be generated using several data types, e.g. field surveying data, photogrammetric data, cartographic/graphic digitized data, etc., (Alias 1992 and Pilouk 1992). The most common and popular one is by using the manually digitized contour data from existing topographic maps.

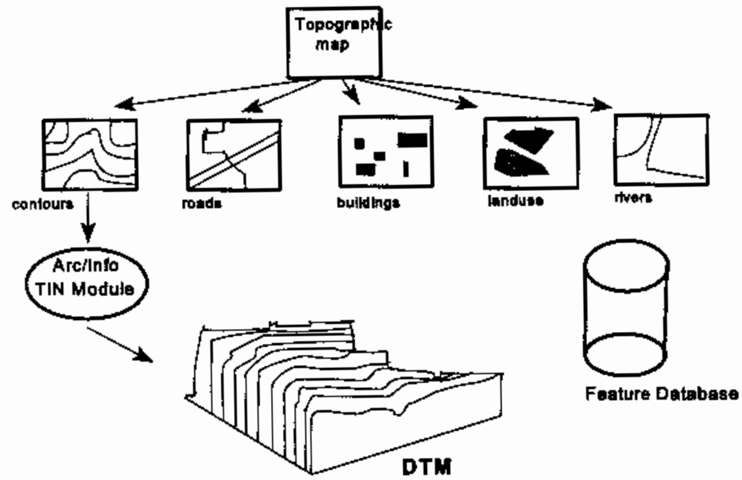

Figure 2 Brief DTM and features database generation

In this study, DTM were generated from digitized contours with 20 meter interval. Contours from each topographic map sheet were combined with the adjacent sheet. Later, a 'coverage' of contours for the whole study area is established. Then, Arc/Info's TIN Surface Module is used to generate the surface. The module converts the contours into TIN structured surface.

5.0 TERRAIN VISUALIZATION OF KLUANG DISTRICT

Weibel(1993) and Walker(1992) noted that visualization of terrain-related data gain increased importance in GIS, e.g. for finding the best infrastructures sites. The 'Majlis Daerah Kluang Utara' planning authority can make used of the generated DTMs for any terrain-related management and decision making tasks. The possible tasks are the determination of telecommunication tower sites, water catchment areas, planning for any potential highway routes, and any large engineering structures. In general, the topographic terrain of the study area is visualized in the following forms, namely,

- Orthographic display, e.g. contours, hillshading, and orthophoto.
- Perspective display, e.g. block diagram, panoramic view, etc
- Draping display, a combination of the above two or with other products (i.e. the orthophotographic and perspective displays)

5.1 Contours

In digital terrain modelling, contours is one of the most simple products. However, it is hard to interprate and analysed the terrain in detail, thus contours is the most least effective DTM product compared to other forms. The DTM interpretation can be enhanced by overlaying the contours on top of the DTM surface, see Pilouk(1992). One of the problems associated with contour maps is that the information lies between the contour lines were not presented. Thus contours is generally not suitable for accurate terrain mapping and analysis.

Figure 2 Contours draped on DTM (After Pilouk, 1992)

5.2. Hillshading

It is the depiction of the relief by shading the terrain according to the slope angle and position of a fixed light source. This technique has been widely used on paper maps and in GIS solutions. The following hillshading visualization was generated with 115° sun azimuth and 45° altitude. The terrain relief is better portrayed compared with the contours.

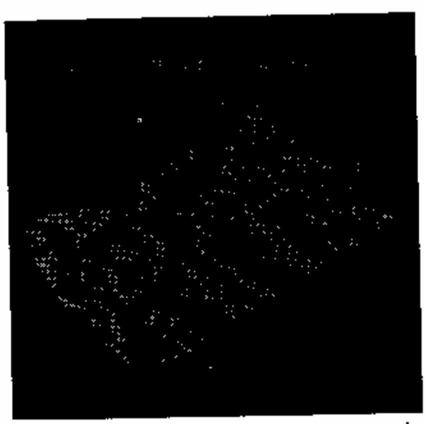

Figure 3 Hill shading of the study area

5.3 Perspective Views

This is a better approach compared to the previous types. It provides a better relative spatial context of a relief features. One problem with this view is that it required vast computer processing time.

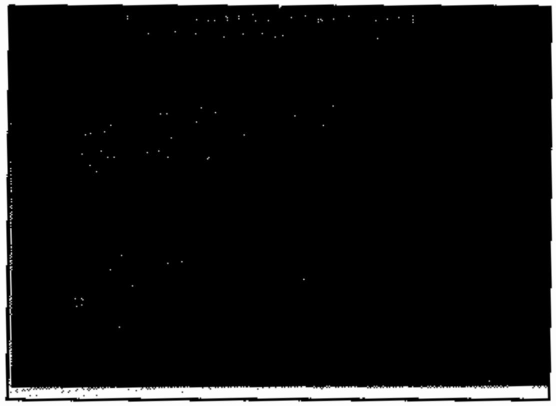

Figure 4 Perspective view s of the study area

5.4 Slope and Aspect Maps

From DTM, slope and aspect maps can be produced. Slope of a surface, e.g. pixel surface or triangle surface is a ratio of the surface's gradient height and it corresponding horizontal component. Aspect is the direction (i.e. azimuth) of the gradient. Authors such as Alias(1992), Ritter(1987), and Monmonier(1982) developed the package with different algorithms. One of the main usages of these maps is to find local drainage flows, water catchment areas, flood planes, etc. These derived morphological features will help the terrain interpretation, analysis, and visualization.

5.5 Draped Models

Draped models can be generated using a layer of datasets or more and then overlayed them on top of the digital terrain models (DTMs). This is a further enhanced of the terrain surface. The following figures visualize some of the models draped with other 2-D spatial datasets, e.g. rivers, landuses, etc.

Figure 5 Road networks draped on DTM

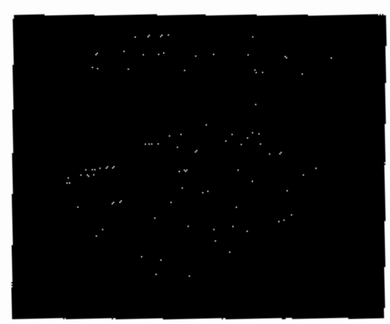

Figure 6 Administrative boundaries (i.e. mukim) draped on DTM

Figure 7 Rivers draped on the DTM

Figure 8 Swampy areas draped on the DTM

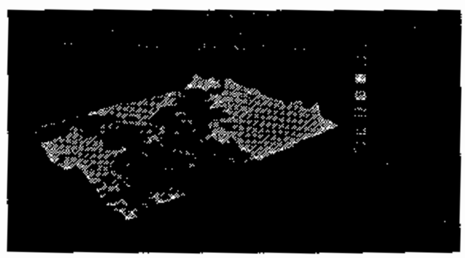

Figure 9 Landuse draped on the DTM

6.0 DISCUSSIONS

The study evidently shows that the visualization of 2.5-D spatial datasets of topographic surface (i.e. DTMs) gains more effective when displayed together with the 2-D datasets. Finally, we noted that the draped models were the most desireable form of 2.5-D topographic display compared with the others, i.e. perspective views, and contours. Thus the surface interpretation task becomes easier and faster compared to the traditional technique i.e. using paper maps.

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REFERENCES

Alias, A.R., 1992, Triangular Irregular Network In Digital Terrain Modelling, M.Sc. Thesis, ITC, Enschede, The Netherlands

Buttenfield, B. P and W.A. Mackaness, 1990, "Visualization", In: Geographical Information Systems, Principles and Applications, Vol. 1, Maguire Goodchild, and Rhind (Edt), pp. 427-443

Cassettari, S., 1993, "Visualisation", In: Introduction To Integrated Geo-Information Management, Chapman & Hall, pp. 169-193

Pilouk, M., 1992, Fidelity Improvement Using Contours, M.Sc. Thesis, ITC, Enschede, The Netherlands

Ritter, P., 1987, "A Vector-Based Slope and Aspect Generation Algorithm", Photogrammetric Engineering and Remote Sensing (PERS), Vol. 53, No. 8, pp. 1109-1111

Roshannejad, A. A., 1992, Mathematical Morphology In Automatically Deriving Skeleton Lines From Digitized Contours, M.Sc. Thesis, ITC, Enschede, The Netherlands

Tan ,L. S., 1994, "DTM: Visualisasi Dalam Sistem Maklumat Geografi (GIS)", Projek Sarjana Muda, Fakulti Ukur dan Harta Tanah, Universiti Teknologi Malaysia, Skudai, Johor, 90 ms.

Walker, R. S., 1992, "Application of Digital Terrain Modelling", *URISA Journal*, Vol. 4, No. 2, pp. 91-93

Weibel, R., 1993, "On The Integration of Digital Terrain and Surface Modelling Into Geographic Information Systems", Proceedings of 11th. International Symposium on Computer-Assisted Cartography, AUTOCARTO 11, Minneapolis, pp. 257-266

Alias Abdul Rahman is a lecturer at the Department of Geoinformatics, Faculty of Surveying and Real Estate, Universiti Teknologi Malaysia, Skudai, Johor. His research interest lies in the areas of topographic visualization, DTM, and the integration of DTM/GIS.