

DEVELOPMENT OF TRANSMISSION ROUTE ADVANCED DESIGN SYSTEM (TRADES) BY USING VISUALIZING SOFTWARE

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ABSTRACT

This paper presents the Transmission Route Advanced DEsign System (TRADES) developed for designing optimized route of power transmission lines on a digital map by using terrain visualizing software. The system has been constructed on a super graphic work station. The time consumption and costs are drastically improved comparing with the conventional manual works.

1. INTRODUCTION

The development of computer graphic (CG) technologies of recent years presents us so called the virtual reality that visualizes numerical images as like as a real worlds on computer screen. The three dimensional (3D) CG is particularly powerful for visualization of complicated scientific phenomena and for visual entertainments. Not only that, the computer technology has potentiality also in industrial applications.

In this paper, a computer aided designing system named Transmission Route Advanced DEsign System (TRADES) developed for designing optimized route of power transmission lines on a digital map by using terrain visualizing software is presented. The system has been constructed on a super graphic work station and is capable to display landform with series of electric tower in 3D format as a result of numerical optimizing processing made behind.

It may be easily understood how effective the computer 3D presentation by TRADES is, remembering the conventional ways, in which the 3D image of the landscape was constructed in mind of the operators and the work thus requires special skill and is very time consuming.

TRADES is, in present, under final exam at Electrical

Engineering Department of Hokkaido Electric Power Co..

2. BASIC DESIGNING PROCEDURE

The basic designing procedure of the transmission line route takes account of the tower height, that must be selected as to keep the wire separation from ground not less than the lowest standard anywhere along the line, and the tower locations giving minimized cost in total. Note that the tower height therefore depends on the landform and it strongly affects the construction costs. In decision of the final practical route, some more additional parameters must be also considered and therefore the design procedure becomes extremely complicated. TRADES may be invaluable in the design work providing user friendly visual digital tools.

3. MAIN FEATURES OF TRADES

TRADES has been developed approaching to a user friendly and powerful computer aided engineering (CAE) tool and constructed on a super graphic workstation with the following features.

- (1)Data format
 - The digital terrain model (DTM) standard format, as used in digital maps, is directly readable.
 - The DTM data are transformed into our original triangle

polygon form, which may be more suited for the 3D display of landform and is also adaptable to usual data base system.

(2) Contour line drawing function

· A new contour line drawing technique is performed by continuously drawing between every pairs of two points having same elevation found by slicing 3-D topographic polygon model along a constant horizontal level. This reduces the use of image scanner nor manual digitizing equipment.

(3) User interface

· A large icon panel is used for easy operation.
 · Detailed design work can be performed by click icon from menu bar located in upper part of the operating window.

(4) Data base server

· The landform data including topographic information and geography information are concentrated into a data base server.
 · The data base server can support plural clients operated in parallel.

(5) Language

· The software of TRADES is written by using C language and thus it may be easy to transplant to other computer systems.
 · OpenGL and Motif are used for graphics process and for window text and button process, respectively.

(6) Functional modules

· The software consists of some functional modules divided depending on type of practical processes, as will be described in the next section. The landform data processor is assigned apparently as the core module (Figure 1).
 · Each module works independently from previously mounted modules and therefore no interference will be happened when new functional module is added.
 · The modules mounted in TRADES can be executed in any order even following to the traditional designing schedules and thus carrier of the work may not be destroyed.

4. MODULIZED FUNCTIONS

4.1 Elevation and Location Visualizing System (ELVIS)

ELVIS is the core module of TRADES and starts at first when TRADES is executed. This module accepts

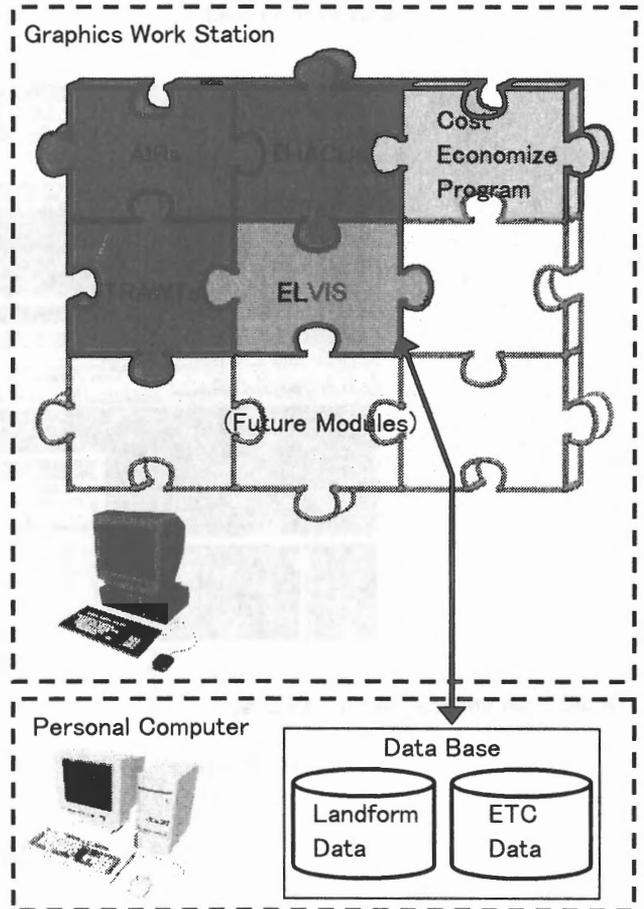


Figure 1. Construction of TRADES

landform data and save them into data base. The following functions are also included.

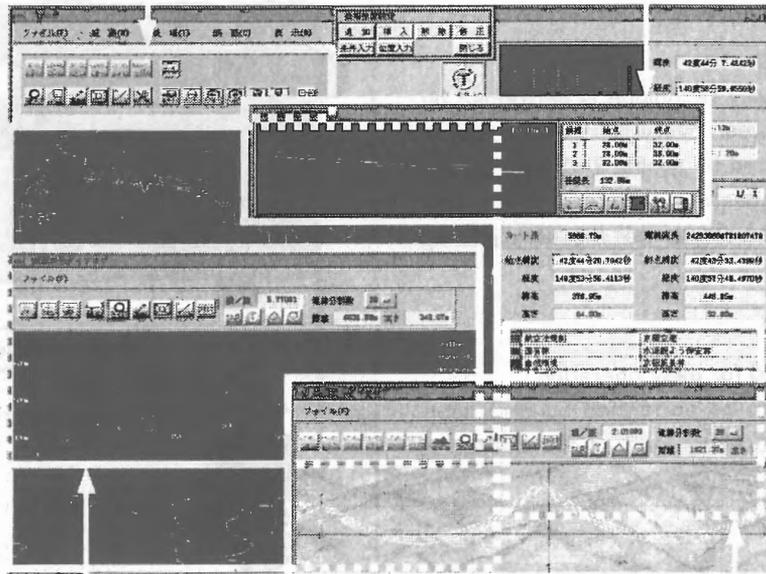
(1) This function checks users permission: general users are permitted to use modules for the normal design works only and administrative users can replace the contents of data base, such as DTM data, geographical map image data, user information and others by up-to-date.

(2) A stack of the triangle polygons of 25 meter base and 12.5 meter height is generated from a DTM data having 25 meter mesh. Linear interpolation is used if no mesh data is allocated. The structure of the landform data base is extremely flexible and arbitrary mesh interval is accepted.

(3) This function creates contour lines by a new technique, in which a pair of points having same height found by slicing the 3-D topographic polygon model at a constant height are connected with straight lines. We do not use scanner read commercial map nor manual digitizer.

Large icon panel

Real time display of vertical section
Diagram of single span



Whole span vertical section Display

Contour line map

Attribute information list

3-D cross section display of any direction

Figure 2. THACUs display hard copy

4.2 Attribute Information Re-build System (AIRs)

AIRs accepts various attributed information indicating environmental conditions for deciding whether the area is suited for construction of the power transmission towers. We usually use the module to remove the restricted areas from the considerations before route designing. The restriction may occur by many reasons from natural environment, social environment and technical environment. AIRs imports digital data of attribute information and provides them to a draw-tool. Finally, the attribute information are saved into a library made in the data base server.

4.3 Tower Height Advanced CUstomize System (THACUs)

THACUs plays the most major role of TRADES (Figure 2) since it performs the following functions:-

- (1) Display of the geographical maps with attribute information at each layer.
- (2) The cross sections of any direction can be displayed up to five at the same time on the screen. It effectively

helps us to compare among different routes.

(3) The module is also capable to present the optimum height of each tower for a finally given route. The tower height is optimized as to keep the minimum wire separation from ground throughout the whole transmission route. The results of these optimum tower height under the given condition are also saved in a base library.

(4) Vertical-section display along the route may be useful to exam the results, as like as the traditional way.

(5) The resultant data of transmission line route determined by using TRADES is transferable to other assessment system, such as Cost Economize Program. The assessment results can be also fed-back to TRADES for improvement.

4.4 TRANsmission route Walk Through System (TRAWTs)

TRAWTs is a module for dynamic 3-D landform display tool, which is used to final check of looking of towers along the transmission route from arbitrary angles. The system is equipped with the functions:-

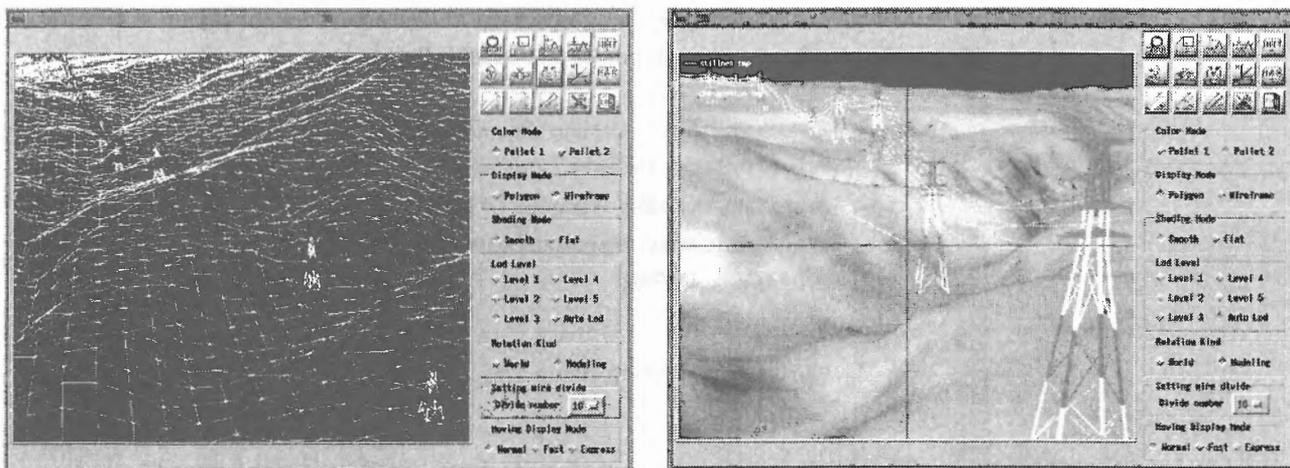


Figure 3. Wireframe display (left) and shading display (right) of landform in TRAWTs

(1) Dynamic display of 3-D land form

• 3-D landform can be dynamically displayed referring information from the landform data base with shading on the polygon and wireframe, following required move and rotation (Figure 3).

(2) Fast data processing

• For supporting fast data display, the clipping omits calculation technique is used.
 • LOD (Level Of Detail) according to distance from view point which is calculated simultaneously with clipping is used. The use of the function is selectable by a switch.

5. RESULTING EFFECTS

TRADES has been constructed on a super graphic work station and tested to confirm the resulting effects listed below:-

(1) Reduction of field examinations because 3-D landform displaying system takes place.

(2) Easy visual control and display of data bases, consisting of topographic information with attribute and geographic information with contour lines.

(3) Extremely fast processing permitting us to operated the system parallelly with discussion and thinking.

6. CONCLUSIONS

Transmission Route Advanced DDesign System

(TRADES) has been successfully developed for designing electric power transmission route on a 3-D display with using computer graphic techniques. The system was constructed on a super graphic work station, in practice, with full graphical functions and user friendly key operations.

By experimental tests of the system, we have confirmed that time consumption can be drastically improved by using the system comparing to conventional manual works.

The system is still under improvements for :

(1) Easier user interface of graphical icon and menu bars for more smooth and dynamic graphic operations,

(2) Transplanting the system into low cost personal computer equipped with graphic accelerator for OpenGL, which is remarkably improved in recent years.