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THE FEASIBILITY OF AUTOMATING RAPID RESPONSE TERRAIN  
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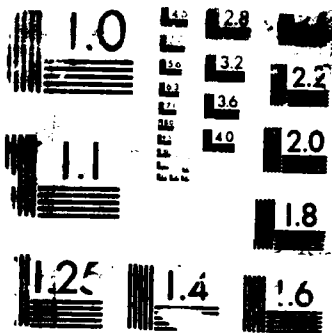
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THE FEASIBILITY OF AUTOMATING RAPID RESPONSE  
TERRAIN ANALYSIS STUDIES

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ABSTRACT

The Terrain Analysis Center (TAC) provides the military with accurate, timely information about terrain. Automated techniques are rarely used in performing analysis at TAC because it is not feasible to complete a rapid response study on a timely basis with currently available digitized terrain data. Synthesizing terrain information for any geographic area in the world on a timely basis requires tremendous amounts of data from numerous sources. The terrain analyst repeatedly is confronted by conflicting information. Decisions have to be made to insure the validity of the data base prior to inputting the data into any automated system. Remote sensing techniques are the preferred means of deriving the correct data, but imagery is not always available or adequate.

To date a minimal amount of data in automated data bases exists, and methods to automate the retrieval of that data are developing slowly. Presently, TAC uses mostly manual methods of extracting information and synthesizing the data from all sources.

INTRODUCTION

The Terrain Analysis Center's (TAC) mission is to provide the military with accurate, timely information about terrain. TAC is the only operational element at the U.S. Army Engineer Topographic Laboratories (USAETL) with such a specific mission. The other elements of USAETL are research and development laboratories involved in a wide variety of Army research projects and Army systems development. This juxtaposition of an operational element amidst an R&D laboratory can be particularly advantageous to TAC as we integrate automated tools into TAC's program.

PROGRAM

TAC's program consists of producing terrain analysis studies and maintaining a worldwide data base of source materials for terrain information, foremost of which is water resources data. This data base is accessible to the entire DOD topographic community. Studies which TAC is currently producing are the Army Intelligence Survey

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(AIS)-Military Geography Volume II, the Worldwide Water Resources Data Base, the Tactical Terrain Analysis Data Base, the terrain data for the Army Training Battle Simulated System (ARTBASS), and special studies on an ad hoc basis, primarily hydrology studies which are performed by TAC's Water Detection Response Team. The data base of terrain information which TAC maintains consists of a bibliographic data base, which resides on a VAX 11/750 under the Data Base Management System (DBMS) ORACLE, and consists of the available sources including manuals, journals, maps, and photography that an analyst needs when researching a study.

#### AUTOMATED TOOLS

Examples of software and new technologies that TAC now uses, partly because their existence at USAETL conveniently coincided with our need to implement them into TAC's program, are many. As previously mentioned, TAC uses the DBMS ORACLE to maintain all the support data that have been accumulated. Also, TAC is part of USAETL's Local Area Network (LAN) which has dramatically increased communication between TAC and the rest of USAETL by enabling analysts to share programs and files. Also, TAC has on occasion used the digitizing capabilities of the Analytical Mapping System (AMS), to aid in identifying geographic positions of terrain features. In addition, TAC can use USAETL's Digital Image Analysis Laboratory (DIAL) when the need to process multispectral imagery arises.

#### CURRENT METHODOLOGY

However, TAC's rapid response study methodology has not developed to the point where it can rely on one automated system for extraction, manipulation, and analysis of the information necessary to produce the quality of study required by the military. Specialists in remote sensing, hydrology, geology, geomorphology, geography, and soil science must all be available to accomplish TAC's mission. The quality of any study TAC produces is inherently dependent upon the quality of the sources used. The terrain analysts ability to synthesize conflicting information accurately is still an irreplaceable human capability. When an analyst researches a topic and finds, for example, that one map indicates a road has a paved surface while another map may indicate the same road has a loose gravel surface, then he needs to clarify this discrepancy with the imagery.

A terrain analyst must return to the imagery to correct discrepancies by using his remote sensing techniques. The remote sensor imagery types used by an analyst, may

include any photography available for that particular geographic region, which means the terrain analyst must have a working knowledge of normal black and white photo interpretation procedures as well as procedures for other imagery i.e., multispectral, radar, and infrared thermal.

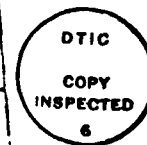
The analyst derives information from the remotely sensed imagery in three ways -- detection, measurement, and analysis. Using detection, he must rely on differences of color, temperature, shape, size, and that an image exists that can show these differences. The measurement methods consist of determining dimensions (width, length, height) area slope, gradient, volume, etc. The procedures for measurement vary depending on the availability of stereo imagery or single images. Since mostly manual methods of measurement are practiced in TAC, the classic photogrammetric instruments, the correct camera parameters, and the formulas are needed for determining necessary dimensions. In analytical procedures, the burden is on the terrain analyst and his background knowledge, because he derives information by inferential means from details observable on the imagery. He uses inductive and deductive reasoning from associated clues and convergent lines of evidence to derive information not directly apparent in the imagery. These analytical procedures require more ability, training, and knowledge than the direct and measurement methods.

We are acutely aware of the research being performed to develop an automatic feature extraction capability and of existing GIS software which partially satisfy the complex requirements of synthesizing spatial data and textual data. Even with the technology available, the quantity of terrain data available for processing is limited. For certain accessible areas of the world, such as the United States and West Germany, detailed terrain data is available. The terrain data of Western Germany has been splendidly manipulated into elaborate models depicting the standard terrain analysis products of cross-country movement, cover and concealment, and lines of communication. But these same models do not work the same in other parts of the world as they do in Germany. The two most prevalent deficiencies are the lack of terrain data and the dissimilarity of the terrain, such as desert and rain forest. As these deficiencies will not soon be overcome, TAC's most precious resource will continue to be its analysts.

## CONCLUSION

TAC's methods will become more automated in the future, as both the technology and the terrain data are developed. But until then, analysts will use the classic manual methods to derive information for their studies and simultaneously be aware of the progress in automating terrain analysis in R&D projects at USAETL.

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