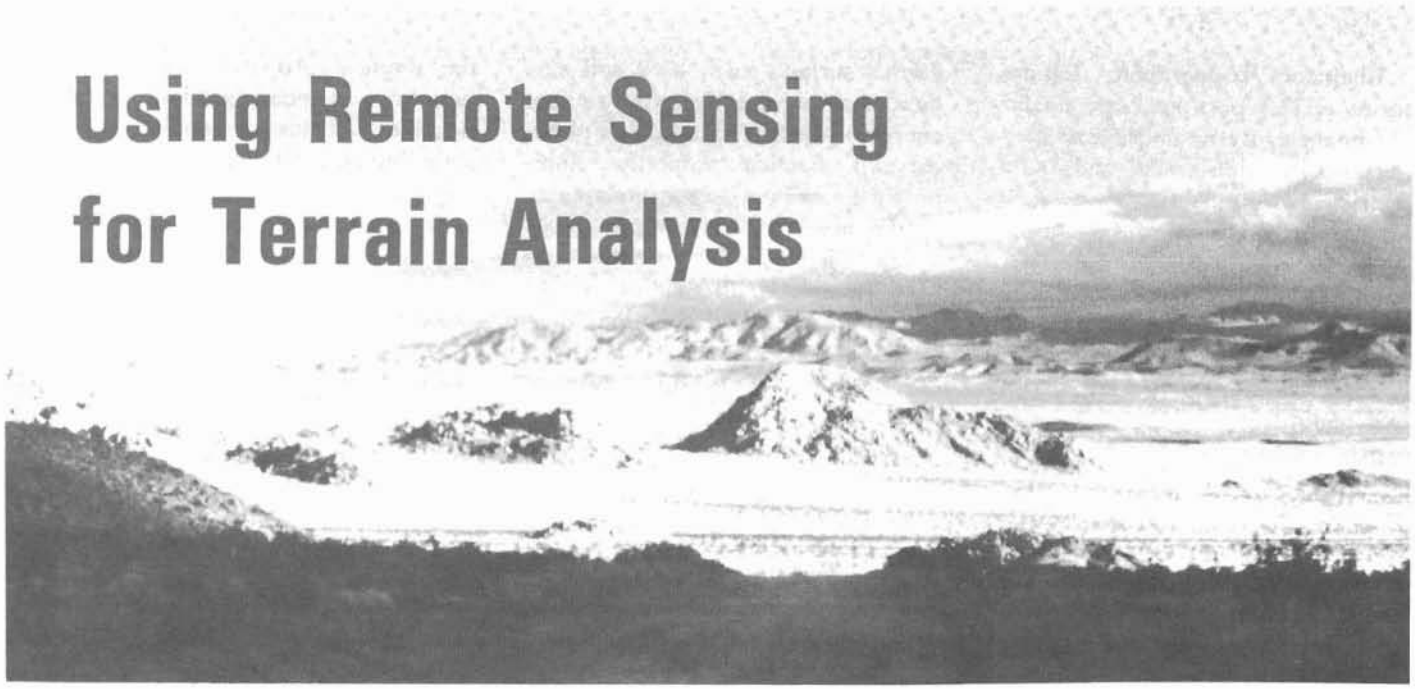
Using Remote Sensing for Terrain Analysis



"Terrain and weather have more impact on battle than any other physical factor" (FM 100-5)

by Dr. M. Merrill Stevens

The battlefield of the 21st century will be more challenging than those of the past. Its topographic boundaries will be less well defined, with greater areal extent, and so will have a propensity for more varied terrain conditions. We can also expect more obscurants to visibility and greater lethality. Engineers, the terrain experts, are preparing to meet this challenge.

A keen knowledge and the ability to readily assess battlefield environmental conditions is a force multiplier to the battlefield commander. Terrain conditions are critical in military planning and operations. As LTG Henry J. Hatch, Chief of Engineers, has said, "Terrain is neutral. Ignore it and it becomes your enemy. Use it and it is your ally."

Ground reconnaissance, the most accurate means of evaluating terrain conditions, is not always possible because of inaccessibility and time limitations. Since future military operations are not likely to permit physical access to the battlefield and time will be critical, a remote means of evaluating terrain will be necessary. Remote sensing of the ground surface can also provide terrain information not immediately apparent from ground reconnaissance or by visual observation from the air. The use of remotely sensed terrain data from space-, air-, and ground-based sensors will help commanders see and assess the battlefield in time to affect the outcome of the battle.

On the 21st century battlefield, information gathered from remote sources will be integrated with information previously generated and stored in digital terrain data bases. These data will be processed on knowledge-based expert systems using artificial intelligence tools and advanced microcomputer and graphic display capabilities. Finally, the data will be disseminated to the battlefield commanders in time to influence their decisions.

Standard digital terrain data bases, under development, will provide the basis of the Army's land combat operations mapping, charting, and geodesy (MC&G) requirements. The real-time remotely sensed data will be merged with terrain data to enhance the standard data bases. Knowledge bases are being assembled which will characterize unique terrain features by processing germane sensor record signatures. Each feature signature will have geometric fidelity to allow the locations of militarily significant terrain features to be identified analytically. Hyperspectral (narrow band) and multispectral (multiple band) analyses will be used to extract information and monitor the physical surface conditions of the battlefield.

Several remote sensing techniques are being tested at U.S. Army Corps of Engineers laboratories. Engineers are analyzing and interpreting physical aspects of terrain for various applications.

Waterways Experiment Station (WES) personnel use satellite imagery to assess mobility. They are classifying land cover to gather information on modeling parameters such as surface roughness, slope, vegetation spacing, and visibility.

Engineer Topographic Laboratories (ETL) personnel are analyzing image patterns and spectral reflectance, luminescence, and radiometric measurements. These techniques are used to estimate cross-country mobility, predict dust generation, discriminate targets and backgrounds, and detect camouflage.

Cold Regions Research and Engineering Laboratory (CRREL) staff use multiband imaging systems to gather information on the surface conditions of snow, ice, and frozen ground. The information is then used to assess mobility and trafficability, evaluate mine emplacement, and locate water supplies.

In a study performed in conjunction with the Center of Remote Sensing at ETL, I used data obtained by remote means to predict the characteristics of selected desert terrain features. The purpose of the study was to estimate such militarily significant surface conditions as trafficability and susceptibility to dust generation.

The application was based on the assumption that each feature of the earth's surface, such as a soil surface, absorbs or reflects the radiant energy of the sun based on its physical and chemical properties. Similar to the analogy of the uniqueness of the human fingerprint, it is believed that everything in nature has its own unique distribution of absorbed and reflected radiation. Measurement of this reflected energy can be used to spectrally evaluate the physical and chemical properties of the soil. This measurement is a critical step in determining natural terrain conditions.

The soil characteristics responsible for the physical condition of the desert terrain in the study area were identified. When compared with the soil properties that can be spectrally measured, the following soil characteristics were similar: soil moisture, particle-size distribution, salinity and alkalinity of the soil, and clay-mineral composition.

The analysis, which proved successful, was performed to determine if these soil properties could be remotely detected under field conditions. This provided an indication of the physical properties of the soil pertaining to such conditions as trafficability and dust susceptibility. Results indicate that remote sensing can be used to gather information with greater protection for personnel and equipment while actually providing much more information than "that which meets the eye."

The 21st century battlefield commander will use remote sensing techniques extensively. These techniques will provide topographic engineering information on such militarily significant operations as trafficability, dust susceptibility, cross-country movement, camouflage, cover and concealment, selection of aircraft landing sites, and registration of inertial navigation systems.

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