



Machine vision approach to auto-generation of high resolution, continental-scale geomorphometric map from DEM

J. Jasiewicz (1,2) and T.F. Stepinski (1)

(1) University of Cincinnati, Dept. of Geography, Cincinnati, OH 45221-0131, USA, (2) Adam Mickiewicz University, Geocology and Geoinformation Institute, Dziegielowa 27, 60-680 Poznan, Poland

Geomorphometric map (GM) is a map of landforms delineated exclusively on the basis of their morphology; it depicts a classification of landscape into its constituent elements. GM is a valuable tool for visual terrain analysis, but more importantly, it's a perfect terrain representation for its further algorithmic analysis. GMs themselves are auto-generated from DEM. We have developed a new technique for auto-generation of GMs that is based on the principle of machine vision. Such approach approximates more closely the mapping process of human analyst and results in an efficient generation of GMs having quality and utility superior to maps generated by a standard technique based on differential geometry. The core of the new technique is a notion of geomorphon. A geomorphon is a relief-invariant, orientation-invariant, and size-flexible abstracted elementary unit of terrain. It is calculated from DEM using simple ternary patterns defined on a neighborhood which size adapts to the character of local terrain. Geomorphons are both terrain attributes and landform types at the same time; they allow for a direct and highly efficient, single-step classification and mapping of landforms. There are 498 unique geomorphons but only a small fraction of them are found in typical natural terrain. The geomorphon-based mapping technique is implemented as a GRASS GIS extension written in ANSI C and will be available in the public domain. In order to showcase the capabilities of geomorphons we have calculated the GM for the entire conterminous United States from the 30m/pixel NED DEM. The map shows ten most abundant landforms: flat, peak, ridge, shoulder, spur, slope, hollow, footslope, valley, and pit; a lookup table was used to assign each of the remaining 488 infrequent forms to a morphologically closest mapped form. The result is a unique, never before seen, type of map that clearly shows multiple geomorphic features and indicates the underlying geologic processes. The auto-generation of GM from this high resolution, continental size raster having 168000x104000 cells took 60 hours on a single processor computer. Future applications of such GM include coupling it with a search tool capable of querying the continental-scale GM in order to identify all instances of a given type of local landscape.