Object-based Image Analysis of Astronaut Photography

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Object-based image analysis is a subdiscipline of the geoinformation science devoted to partitioning remote-sensing imagery into meaningful image-objects, and assessing their characteristics through spatial, spectral, and temporal scale. This is particularly useful for analyzing high-resolution imagery.

A dataset comprised of high-resolution digital astronaut photography from the International Space Station is potentially useful for ecologic, geologic, and land use/cover studies. The entire public domain digital astronaut dataset, available from http://eol.jsc.nasa.gov, consists of imagery amassed from 1961 to the present and includes data for much of the Earth's surface (figure 1). We have a collaborative data collection and research agreement with the Long Term Ecological Research (LTER) Network of the National Science Foundation to assess the quantitative potential of digital astronaut photography. The LTER Network, which consists of 26 sites, represents a wide range of biomes, including temperate and tropical forest, deserts, grasslands, tundra, and urban, human-dominated ecosystems. We use this network to compare digital astronaut photography with remotely sensed data (i.e., Landsat) as well as field-based validation and measurement data.

In contrast to traditional, narrow-bandwidth, remote-sensing instruments, digital astronaut photography is acquired using off-the-shelf digital cameras that are sensitive to the visible red, green, and blue wavelengths; decisions to acquire imagery are made on-the-fly by astronauts. The wide bandpasses of the camera make traditional classification approaches difficult, as discrete spectral information is not typically obtained. We are thus using a multilevel, object-based image analysis approach to high-resolution digital astronaut photography of LTER Network sites that represent the range of continental and island biomes. This approach emphasizes the spatial relationships of similar pixels – through image segmentation – in addition to spectral information, and takes advantage of the high density of the spatial information captured in astronaut photographs. Digital astronaut photography, used with remotely sensed satellite and airborne data, can increase the temporal resolution of observed variables such as land cover, land use change, vegetation dynamics, and surface soil processes, as shown in figure 2.

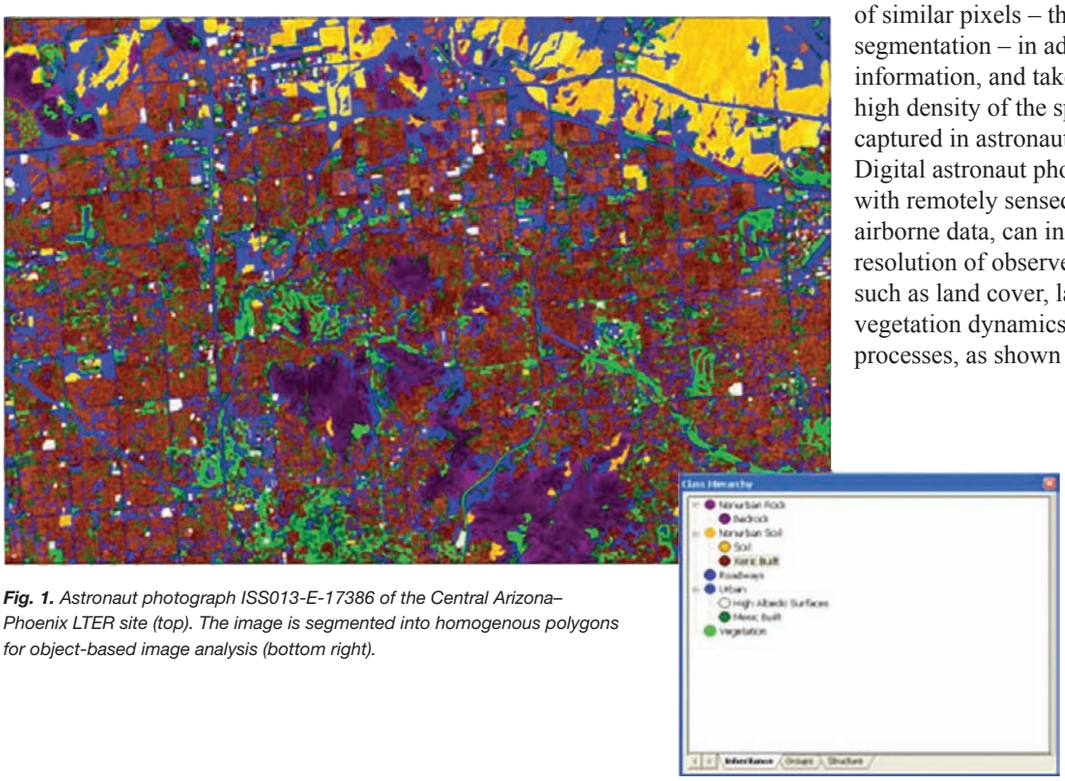

Fig. 1. *Astronaut photograph ISS013-E-17386 of the Central Arizona–Phoenix LTER site (top). The image is segmented into homogenous polygons for object-based image analysis (bottom right).*

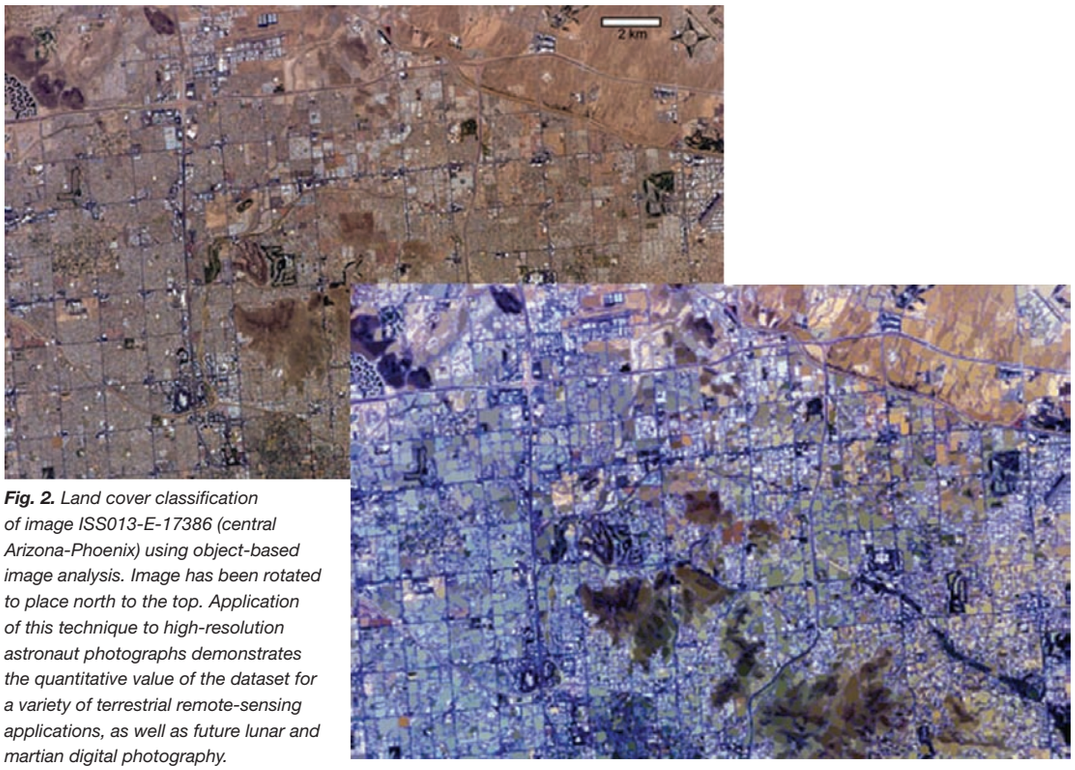

Fig. 2. *Land cover classification of image ISS013-E-17386 (central Arizona-Phoenix) using object-based image analysis. Image has been rotated to place north to the top. Application of this technique to high-resolution astronaut photographs demonstrates the quantitative value of the dataset for a variety of terrestrial remote-sensing applications, as well as future lunar and martian digital photography.*