Identifying Stressed and Potentially Unstable Trees by Aerial Photography on Ohio's Highways

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Stressed and declining trees pose a potential hazard in man dominated situations such as along highways. To reduce the risk of compromising public safety it is highly desirable to monitor the health of trees at regular time intervals. Identified declining trees can be pruned or removed.

The purpose of this study was to investigate remote sensing techniques to monitor trees automatically. The spectral signature of vegetation is a good health indicator. For example the leaf moisture content can be measured from the reflectance values at wavelengths of 0.8, 1.6, and 2.2 micrometers. The chlorophyll concentration in foliage is another discriminating factor to distinguish between healthy and stressed vegetation. The distinct increase in reflectance in the near infrared region of healthy vegetation, the so-called red-edge, disappears with increasing degree of senescence.

To explore the feasibility of monitoring trees with remote sensing, the Shade Tree Evaluation Project (STEP) on the Agricultural Research and Development Center served as a test site. The site contains over 1000 trees with more than 100 species and cultivars. The tree condition was evaluated in the field at three occasions, the last one a week prior to the flight. The National Geodetic Survey (NGS) has flown several lines with the Daedalus Multispectral Scanner 1260 MSS on board. This scanner records reflectance in 12 different spectral bands, ranging from ultra violet to thermal infrared. NGS converted the recorded data to a more suitable format for further processing. NGS also made available its VI2 program for visualizing the data. Subsequent processing was performed on ERDAS Imaging. The flying height of 3000 feet above ground leads to a ground pixel size of approximately 1.2 m by 1.2 m. Hence an average size tree is covered by 30 to 40 pixels, just enough to perform meaningful classification. The Normalized Difference Vegetation Index (NDVI) is extensively used to monitor vegetation. The multispectral ratios between infrared and visible bands enhance the difference in radiance and can be used to assess the health of vegetation. In order to reduce the effect of low ground cover, the soil-adjusted vegetation index was also used.

Generally, the comparison of the automatically obtained assessment of tree health agreed well with the field measurements and proved the feasibility of the proposed approach. The study also revealed a number of areas that require future research before a robust data acquisition and analyzing system can be employed to monitor trees along highways on a routine basis. It is particularly recommended to increase the geometric resolution so that trees are covered with hundred pixels or more. Also, it would be very advantageous to increase the radiometric resolution, for example by using a hyperspectral scanner. The results also confirmed that the data must be radiometrically calibrated by using a field spectrometer at the time of flight.