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EVALUATION OF IMAGE REGISTRATION ACCURACY IN THE LARGE AREA CROP INVENTORY EXPERIMENT

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ABSTRACT

The Large Area Crop Inventory Experiment (LACIE) was created to demonstrate the capability of forecasting the wide area annual production of major crops, such as wheat and corn, from multispectral LANDSAT imagery and meteorological data. The current classification algorithm utilizes multi-temporal imagery from different biological phases which are spatially aligned or registered. It is of paramount importance to investigate and evaluate the accuracy of the registration process, because the number of pixels and the area classified are directly affected. A new technique has been developed at the NASA Johnson Space Center to evaluate image registration accuracy.

The first step in the registration of an image with a previously acquired reference image is to extract a 234 scan line by 354 pixel area from a full frame LANDSAT image based upon the best estimate of the LANDSAT position. The second step is to find a best match position by correlating two images on a digital computer. This is being performed at NASA Goddard Space Flight Center, and the current scheme uses binary edge images derived from the original gray level images for correlation. Our task was to evaluate the registration accuracy in a set of LACIE image pairs which were registered with the above process. It was found that they are registered very closely and it suffices to search for a best match within a small range, say plus and minus five pixels.

The approach used involves two steps: the first is to register small subimage pairs extracted from the two LACIE images. For each subimage pair a best match is determined solely by shifting along the x and y coordinates because the dominant transform for small subimages (say 27 by 27) is the x and/or y shift only. The second step is to calculate a six parameter linear transform from the (x, y) coordinate system to a new coordinate system (p, q) using the local shift pairs (Δx_i, Δy_i). The six coefficients can be determined by the least square criteria. The LACIE images are small and notation and scale changes cannot be estimated reliably thus, only the shifts Δx and Δy are computed. With this approach there is need for a technique which will rapidly correlate two small subimages. It was found that methods using edges did not perform well on the small subimages being used. We chose instead to work directly with gray level images rather than edge images by employing a modified sequential similarity detection algorithm. Experiments were carried out for 44 LACIE sample segments, each of which had four acquisitions. By using channel 2 images registration accuracy was evaluated on all the six possible combinations per sample segment. It was observed that the range of Δx and Δy are restricted within plus and minus 2 pixels and 1 pixel, respectively. One reason for the observation that the distribution of Δx is wider than that of Δy is that the LANDSAT images are less sharp and edges are less reliable along the x axis. The root mean square of registration error is .99 pixels which satisfies the accuracy objective of the current registration procedure.