HPEC 2002 abstract

Real-Time Geo-Registration on High-Performance Computers -

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Format: preferred as a poster presentation

Topic Areas:

- Algorithm Mapping to High Performance Architectures
- Embedded Computing for Global Sensors and Information Dominance
- Case Study Example of High Performance Embedded Computing

The Global Hawk and Predator surveillance platforms have been extremely successful in collecting vast amounts of vital imagery data in hostile regions. Extraction of significant information for the military from this imagery data requires stitching the images together and registering them with geographical databases. The function of an *image geo-registration algorithm* is to find the accurate spatial correspondence between a collected image and an image tied to a geographical reference. Image geo-registration is a pre-requisite for comparing and fusing information across images. Pixel-level image correspondence is required for detecting pixel-level changes in the surveyed region, correlating and fusing pixel-level target information, enabling the use of contextual geographical features for target identification, and mosaicking a sequence of local images to construct a global image of the surveyed region. Real-time and accurate geo-registration algorithms will enable the war fighter to rapidly respond to military threats based on currently available surveillance platforms.

An image-registration algorithm estimates the sensor-collection parameters that optimize the correspondence of the image data with a reference. An initial solution is given by the measured sensor-collection parameters. Due to errors in the measured sensor position and orientation, there will be significant translation and rotation errors. The registration process then uses the image-content information to optimize the correspondence between the collected image and the reference. Image content information can be extracted at either the pixel-level or at an abstracted feature-level. The mutual information approach for registering two images uses pixel-level data to accurately find the correspondence between two images. It computes a match metric based on the joint distribution of pixel intensities of the two images, and it represents a generalization of pixel-intensity correlation algorithm. This generalization allows registration of images from dissimilar sensors. The throughput requirement of the mutual information algorithm is a function of the size of the image and the desired registration accuracy. For typical image sizes, the processing requirements range from 10 -100 Gflops. Real-time registration of streaming sensor imagery data (e.g., Global Hawk SAR or Predator video) would therefore require a computer with multiple processors.

This presentation will show that the mutual, information-based registration algorithm is highly data parallel. Based on this feature, the processing is partitioned into parallel tasks, where each task computes the match metric for a different registration hypothesis. This parallel registration algorithm has been implemented on a high-performance, embedded computer and exercised for registering a SAR test image with an ortho-photo reference image of the same region. The system shows close-to-linear reduction of processing latency as the number of processors used for the registration increases.