Preprocessing of Data for Testing if Image Registration Algorithms

Lisa Johansen
Computer Science
University of San Diego

Mentors
- *Dr. Jacqueline Le Moigne*
  Applied Information Sciences Branch
  NASA Goddard Space Flight Center
- *Dr. Ilya Zavorin*
  Goddard Earth Sciences Technology Center
  NASA Goddard Space Flight Center

Project Objective
The objective of this work was to do preprocessing on raw satellite data for the use of image registration techniques. Different images of the same area were extracted and down sampled in order to be registered. Image registration is also a preprocess for other sciences that may want to use registered images instead of raw imagery data in their research.

Significance
This research was conducted to register images as close to real time as possible and with as much consistency and as little error as possible. Most current image registration techniques are done manually, which takes much time and leaves a large margin for error. Image registration algorithms are being tested on the preprocessed data generated in this project. Image registration is used to align different images which is a necessary step in change detection. It is also necessary for image fusion, which creates an image that will provide more information about a location or object than a single image would provide. The registration of images is a very necessary part of the study of the earth and its changes. However, image registration is also very beneficial to many other areas of scientific visualization.

Approach
Image registration begins with a preprocessing of data. This includes taking raw satellite data, extracting the part that is being registered, and preparing it for registration. Cloud detection and region of interest masking are part of that preparation.
After the preprocessing, the main features in the images must be extracted. This is done with the use of wavelets. The preprocessed data is run through algorithms which use wavelets to make the detection of features easier.
Once the main features are extracted, the various registration algorithms can be tested with these images. The algorithms attempt to match features in different satellite images. This research was done in order to find which of the algorithms matches features most accurately depending on the features of the images. They will then create a toolbox of image registration algorithms that will be able to accurately register many various types of images. Once the images have been registered, they can be fused, resampled, or indexed for various scientific purposes.

My Contribution
I extracted images from four different satellites with four different resolutions (SeaWiFS – 1000m, MODIS – 500m, Landsat7 – 30m, Ikonos – 4m). Because these images were being registered together, the data extracted from a satellite's raw data had to be a subset of the data if the satellite against which its image would be contrasted. Normally, the lower resolution image is the larger image, so the image captured in the higher resolution image is a subset of the data in the low resolution image. I then masked out any obvious clouds and found the main region of interest so that only the relevant parts of the images would be registered.
In this project, I down sampled the images with algorithms that made use of wavelets. There are two kinds of down sampling. The first type compresses and reduces noise in the images. The second type brings out the strong features so that they can easily be compared and aligned. These decompositions are used for the alignment of the images. First, the higher resolution image had to be decomposed so that its resolution was as close to that of the low resolution image as possible. Once the two image had nearly the same resolution, the registration process could begin.
Second, the two images had to be down sampled further for registration techniques. The smaller the images were, the quicker the algorithms could register them. The small image also had the benefit of increasing accuracy. The larger images were used to fine tune the results acquired using the smaller images. Once the extraction and decompositions of the images were done, the tests of the registration techniques could begin.