Remote Sensing & GIS - Spring Semester 2010
Lab 1 - Preprocessing

1. General
- each student should work at one and the same computer, for Lab 1. Go to disk F: under rsgis and then rsgis2008. Then go to preprocessing, exec where the programs and the panchromatic image data are. The full data incl. metadata are under rsgis2008/data. Please do not delete or rename these files.
- some programs do not work or do not work correctly. The ones we will use should not have a problem.
- in program noire, filtering options 5, 7, 8 and 9 do not work. For option 3, the mask size is fixed as 5 x 5 pixels
- some programs, like noire, overwrite existing files, so be careful with the output filenames.
- use as output image format, normal TIFF (not tiled or compressed).
- note down at each processing step what parameters you used. This is necessary for your written final report (see also 7. below).
- you will start working with 2 panchromatic images, about 10,400 (H) x 20,700 (V) pixels.
  Ground pixel size is 1m, all are 11-bit (although stored as 16-bit). Read in the metadata file at least the acquisition date and time and sensor and sun azimuth and elevation. The images have at some places a background with value 0 (this is requested in some preprocessing programs).
- import one image, e.g. pan_000.tif in Photoshop. The image appears black because as many programs Photoshop can not display directly images with more than 8-bit. Also the histogram is totally wrong. Apply automatic contrast and then you can see the image. The histogram although closer to reality is also not the histogram of the original image. So, never use Photoshop for histograms of images with more than 8-bit, use program histo.exe. It generates a TIFF image with the histogram and a text file with the histogram values. Check in the text file the cumulative histogram. If we assume that the bottom and top e.g. 0.05% of the cumulative histogram have very few values, then find out how many significant grey values exist, compared to the theoretical 11-bit. Navigate in the visible image to get a feeling of how the Ikonos images look like and what objects can be detected. Try to find some homogeneous regions, to be used for noise level estimation later. They should be very homogeneous and as large as possible. See some examples at x/y pixel coordinates: 1750/19500, 6200/16100, 3570/16640, 190/17590. Some of these regions are suboptimal or should not be used, tell in the report why. Note it is better to have regions both with dark and light grey values, and the regions should not be saturated! You can check the homogeneity also by looking the standard deviation of the histogram of the homogeneous region(s). After selecting the regions, write down the coordinates of the upper left pixel and x/y size of the region. Input these to the program cut16.exe to cut-out these regions. They will be used later in program noicom.exe
- apply to pan_000.tif a strong contrast enhancement with Wallis.exe. The main parameters are 20 x 20 block size, 1023 target mean, 370 target standard deviation, 1 as brightness enforcing constant and 1 as contrast enforcing constant. View this image in Photoshop with automatic contrast. Navigate in the image and check the amount of noise in homogeneous areas (shown often as chess pattern noise; random noise) and for other artifacts, e.g. vertical stripes. This gives you an impression of the amount of random noise and possible artifacts.
- the aim of the whole preprocessing here is to optimize the images for matching and DSM generation.
- for each preprocessing step, please read first the delivered material to understand what you are doing the meaning of the parameters. You will find in this text several questions. You should briefly respond to these in your written report.
2. Estimation of noise in homogeneous regions (one dark and one light region suffice)
   Use program noicom.exe and import each previously cut-out region. Use the option homogeneous
   region, and do not request a cut-out within this program. Use a mask size of 3 x 3 and 5x5. Use a
   step of 1 x 1. Use as percentage of standard deviations 70%, 80% and 90%. Check the results in a
   text file and tabulate the results for the various mask sizes, percentages and regions. Comment the
   results.

3. Noise reduction
   Use a cut-out of 6,000 (V) x 10,000 (H) size from the bottom part of image pan_000.tif. Apply
   noise reduction using noire.exe and options 0-4. For Gaussian filter sigma refers to the standard
   deviation of the Gaussian in pixels (you may use 1, or use two very varying values and compare
   the results). For option 4, use 10 and 15 or 20 for T and compare the results. Zoom in the results
   300%-500% at the same regions and compare the filtering results with respect to: reduction of
   noise in homogeneous areas, preservation or even sharpening of sharp edges, preservation of small
   objects and thin lines, preservation of the geometry/position of edges. Mention
   advantages/disadvantages of the filters regarding these 4 aspects and select one optimal one. For
   the optimal one, cut-out with cut16.exe the same regions as in 1. And compute noise statistics with
   noicom.exe as in 2. Then compare quantitatively noise before and after filtering (in a table) and
   comment the results.

4. Wallis filtering
   Use the whole pan_000.tif image and use Wallis. With starting values, 20x20 block size, 1023
   target mean, 370 target standard deviation, 1 as brightness enforcing constant and 1 as contrast
   enforcing constant. After a check, target mean, target standard deviation and contrast enforcing
   constant may have to be changed. To do the check, after each Wallis filtering you should generate a
   histogram with histo.exe and aim at getting a histogram with little and equal saturation at both dark
   and light sides of the histogram. For equal saturation, you change the target mean. For not too
   much saturation you change target standard deviation and contrast enforcing constant. Note the
   latter is more important and for images with notable noise should be kept between 0.9 and 0.96.
   How much saturation is acceptable is subjective but it should not be too much, otherwise objects
   disappear.
   The images look horrible, but this preprocessing is for matching not visual appeal. Check for
   example what happens in shadow areas, before/after Wallis and how it can influence matching.
   Comment on the latter, i.e. what are the advantages of Wallis for matching? What is better, do first
   noise reduction and then Wallis or the opposite and why?
   To have the door open for Wallis for various applications, e.g. matching and orthoimage
   generation, with less computations, one could perform step 4 after 5, with 2 Wallis parameter
   selection, one optimized for matching, one for orthoimage generation.

5. Reduction of 11- to 8-bit
   Reduce image pan_000.tif after Wallis to 8-bit using program optimal_mapdown.exe.
   Use options: a) linear map-down, b) Gaussian map-down, or c) none of the above which should
   correspond to a histogram equalization. For Gaussian you can use a standard deviation of 30-50.
   Compare the results visually and also the image histograms in Photoshop. Comment on the results.

6. Final stage
   After finalizing the optimal methods and parameters in steps 2-5 above, then you should process
   both whole panchromatic images with the same methods and parameters.
   For the multispectral images, only steps 3 and 5 make some sense. Martin will advise you on how
   to proceed with these.

7. Final written report
   The report for the whole Lab 1 should be delivered at one date. However, we strongly advise you
to prepare the report for Lab 1 at each stage, directly writing-down results of each stage in a draft
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