

## Summer 2003 IPAM Research in Industrial Projects for Students

Industrial Partner: Los Alamos National Laboratory

Industrial Advisers: Kevin R. Vixie

Nicolas W. Hengartner

Brendt E. Wohlberg

Andrew M. Fraser

Allon Percus

### Proposal: Image Fusion

-----

A team of 4 undergraduates under the mentoring of Martin Burger (UCLA) will conduct research aimed at generating automatic algorithms for either or all the following image problem:

1. merging the information from the color channels of a 35 mm scanner with the information from the infrared channel of the same scanner to find and remove dust/defect artifacts (using inpainting),
2. merging several pictures into one panoramic mosaic, and
3. merging several pictures of the same scene, each measuring a different part of the dynamic range of the intensity field into one picture with a bigger dynamic range.

We suggest that the students start with the first problem before attacking the other two problems. The students are strongly encouraged to encode the algorithms into open source software and to maintain a project based web page for its distribution.

#### (1) Image correction for scanners.

-----

In this task, the infrared channel of the scanner is used to detect dust and small defects which are then "corrected" (in the color images generated by the scanner) with inpainting.

#### (2) Panoramic Gluing.

-----

Several digital pictures are to be coherently glued together. The images from different angles are also possibly at different resolutions and magnification (we suggest that the case of identical resolution and magnification be considered first). This problem can be decomposed into several sub-problems, each having its own challenges:

- i) Determine what is a good common reference frame for the mosaic.
- ii) Consider both the case in which a rough layout of the different pictures in the mosaic is known and the case where the pictures are 'pele-mele'. In both cases, one needs to register (align) the pictures.
- iii) In the regions of overlap, use the duplicated information to improve the resolution and dynamic range of the picture.
- iv) Consider using inpainting for filling (small) no-data regions within the mosaic, if applicable.

#### (3) Image merging.

-----

In this task, we expect that slides will be scanned at several different intensities and the results will be combined to obtain a digital image with a larger dynamic range.

We suggest that the Nikon scanner LS40 ED be used with the software driver found at <http://www.mostang.com/sane/> ...

In this case one is trying to estimate a broad dynamic range from several (in the case of the LS40 ED, four ) measurements of this range. The need for this arises from the nonlinear nature of the characteristic functions relating the intensity of incident light and the CCD measurement that the scanner produces.

#### Equipment needed for the project

-----

- 1) a digital camera and tripod to generate a sequence of overlapping images to "glue" into a panoramic mosaic.
- 2) a film scanner such as the Nikon LS 40 ED which can scan the film at several different intensity levels and has an infrared channel.
- 3) computational facilities. While Matlab might be used in development, we would encourage that the algorithms be implemented (for the final product) in something which is open source ... octave can often be used to replace Matlab and it is open source. A final product in C/C++/python etc. would be optimal.

#### Expected product

-----

As mentioned above:

- 1) software implementing solutions
- 2) website documenting the project and the solutions ... this is also the point of distribution for the software.