COMP 558: Assignment 2
Available: Monday, November 11th, 2013
Due Date: Monday, December 2nd, 2013 (before midnight) via mycourses

Notes: As with assignment 1 you are encouraged to use Matlab for this assignment. I EXPECT EVERYONE TO SUBMIT ORIGINAL WORK FOR THIS ASSIGMENT. This means that if you have consulted anyone or any sources (including source code), you must disclose this explicitly and that anything you submit reflects your own work. Your submission should be in the form of an electronic report (PDF), which includes a summary of what you did, answers to the specific questions, and a presentation and discussion of your results. Submit code that you have written to generate your results as a separate .zip file.

For this assignment you will use the sequences that are present on Morteza's COMP 558 page. These sequences are from the Middlebury Optical Flow Database and the advantage of using them is that the ground truth flows are available. This will allow you to assess the performance of your methods. As with assignment 1 there is no single correct result and I am looking at your ability to organize your work and discuss it, along with figures and explanations.

Question 1: Algorithm Improved Algorithm CONSTANT_FLOW (45%)

1) Implement the Improved Optical Flow Algorithm $CONSTANT\_FLOW$ on page 197 of the Trucco-Verri text, which is in the course pack. This is basically the direct least squares formulation of the problem that we discussed in class, but with the modification that points closer to the center of each patch are given more weight. The inputs are a series of time-varying images and the output is the optical flow. Test the algorithm on the sequences provided on Morteza's web page. Visualize your results as a (2D) flow field using suitable Matlab functions

2) Given that the ground truth flows are available, comment on the accuracy and consistency of your results depending on parameters such as the spatial window size, the size of the Gaussian filters in space and in time, or other factors which influence the performance of the algorithm, such as the nature of the underlying image sequence.

Question 2: Horn and Schunck Optical Flow Method (45%)

In class we also discussed a regularization approach to solving the optical flow equation under the constant brightness assumption. The basic idea was to invent an energy that is comprised of two terms - a term from the brigthness equation and a term that imposes smoothness on the resulting optical flow vectors. In continuous form the resulting Euler-Lagrange equations turn out to be:

$$E_x^2 u + E_x E_y v = \alpha^2 \nabla^2 u - E_x E_t$$

and

$$E_y^2 v + E_x E_y u = \alpha^2 \nabla^2 v - E_y E_t.$$

The discretized form of these equations is presented in the optical flow paper by Horn and Schunck, a copy of which is in the course pack. For this assignment use the equations in Section 12 of that paper. In other words, use:

$$u^{n+1} = \overline{u}^n - E_x[E_x \overline{u}^n + E_y \overline{v}^n + E_t]/(\alpha^2 + E_x^2 + E_y^2)$$
$$v^{n+1} = \overline{v}^n - E_y[E_x \overline{u}^n + E_y \overline{v}^n + E_t]/(\alpha^2 + E_x^2 + E_y^2)$$

1) Implement the above iterative equations to recover u and v, but as with question 1 employ Gaussian smoothing in space and time first, prior to computing the partial derivatives. Test your implementation on the same image sequences used in question 1, visualizing the results once again as a flow field.

2) Comment on the accuracy and consistency of your results depending on the assumed initial conditions to the Euler Lagrange equations the size of the Gaussian filters in space and time, or other factors influencing the performance of the algorithm, such as the nature of the underlying image sequence.

Question 3: Comparison of Results (10%)

Provide a discussion comparing the two sets of results obtained above and explaining the advantages and limitations of each of the two optical flow algorithms.