ECSE-415 Introduction to Computer Vision

Assignment #5: Motion Estimation

Due: Friday, April 15, 2016, 11:59pm

Please submit your assignment solutions electronically via the myCourses assignment dropbox. The solutions should be in PDF format. Attempt all parts of this assignment. Associated code files should be commented and submitted, so that they can be run for testing.

This assignment is out of a total of **100 points**. It is designed to familiarize the students with motion estimation using optical flow. The assignment requires the students to use Matlab to estimate the motion field of a given sequence of video frames using the Lucas-Kanade and the Horn-Schunck methods.

The student is expected to write his/her own code. To submit your code, submit all the required .m files. Assignments received up to 24 hours late will be penalized by 30%. Assignments received more than 24 hours late will not be marked.

Overview

In this assignment, the student is asked to estimate the motion field of a given video frames. The video sequence contains four moving synthetic patterns. A sample frame of this sequence is shown in Fig 1. The student is asked to compute and display the optical flow-based estimation of the motion field using two approaches: Lucas-Kanade and Horn-Schunck. You can use the Matlab's built-in implementations of these methods in your code.

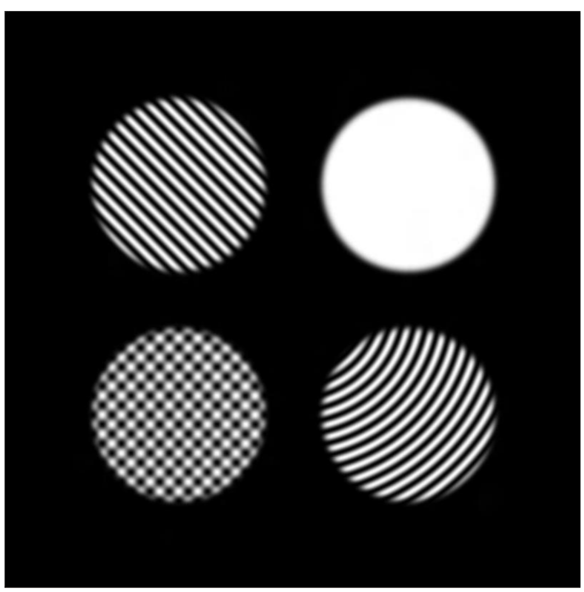

Fig 1: Synthetic patterns of the image sequence.

Code (55 pts)

Please use the code template in Table 1 for writing your code. The script loads the input video file (flow.avi) using Matlab's `VideoReader` class. Please note that the video frames are also available as an image sequence via the imageSequence.zip archive. If you want to use them instead of working with the video, please change the template code accordingly.

You need to create a LK and a HS optical flow object, before the main loop. The `VideoReader` class makes it possible to read in all the video frames included in the video file via the `while hasFrame(.)` structure. Inside the loop, you can read consecutive video frames using Matlab's `readFrame` method.

After computing the motion fields, proceed by displaying the LK-based and the HS-based optical flow overlaid on top the current video frame, as shown in Fig 2. Note that you need to amplify the magnitude of optical flow vectors for visualization. In Fig 2, the scale factors of LK and the HS is set to 10 and 25, respectively.

Table 1: Code template for Assignment 5

```
%% Load the input video
vidReader = VideoReader('flow.avi');

%% Create optical flow objects

%% do for each video frame
while hasFrame(vidReader)
    % read a video frame

    % estimate the LK-based motion field

    % estimate the HS-based motion field

    % display the LK optical flow
    subplot(1,2,1);

    % display the HS optical flow
    subplot(1,2,2);

    % pause execution (helps in updating the subplots)
    pause(0)
end
```

On your report, answer the following questions:

i. Assuming small motion, write the optical flow equation given by the brightness constancy constraint (5 pts). Define each term in the equation (2 pts). Explain whether this equation can be used to recover image motion at each pixel. (3 pts)

ii. Briefly describe how spatial coherence constraint could be used in solving the optical flow equation in Question i. (10 pts)

iii. Based on the results, describe for which synthetic pattern the motion is estimated correctly (answer this for the Lucas-Kanade optical flow only). (10 pts)

iv. Compare the performance of Lucas-Kanade and Horn-Schunck approaches in estimating the true motion fields. In your comparison, display three overlaid images, one from pure horizontal, one from pure vertical and one from combined motion. (15 pts)

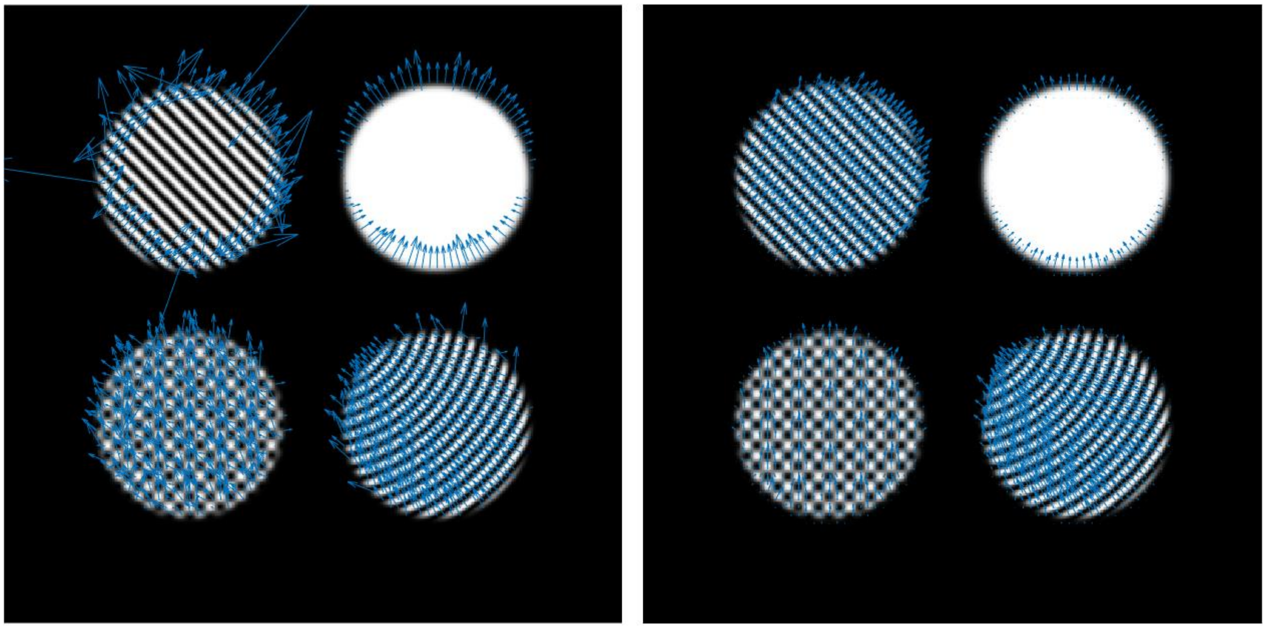

Fig 2: Optical flow estimation of the motion vectors for four synthetic patterns, overlaid on top of the original video frame. (Left) Lucas-Kanade, (right) Horn-Schunck.