Summer Design Project 2016
Week 1 & 2

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1 Week 1

1.1 Topics

Optical Flow :

Optical flow mainly focuses on computing the vectors of movement between two images (or two consecutive frames of a video). It helps to determine the general apparent movement of the object in the image by tracking the direction of movement of pixels in the image.

Horn and Schunck :

Horn and Schunck proposed an approach for calculating Optical flow based on constraints of Brightness Constancy and Image Smoothness and formulated an iterative way of achieving it. We implemented Horn and Schunck's iterative method in Octave over two images with small movement of pixels. We also implemented Gauss-Jordan elimination method for solving systems of linear equations in u and v as derived by Horn and Schunck. In general, this method consumed a lot of memory and time as numerous operations involving huge but sparse matrices were included. Both these methods yielded the vectors of movement of pixels showing very similar movements. Though this method is successful in computing optical flow for simple movements, it fails badly when complex objects and movements are involved. We have uploaded the source code of both the implementations on the shared Drive folder.

Software used :

Octave 3.4.3

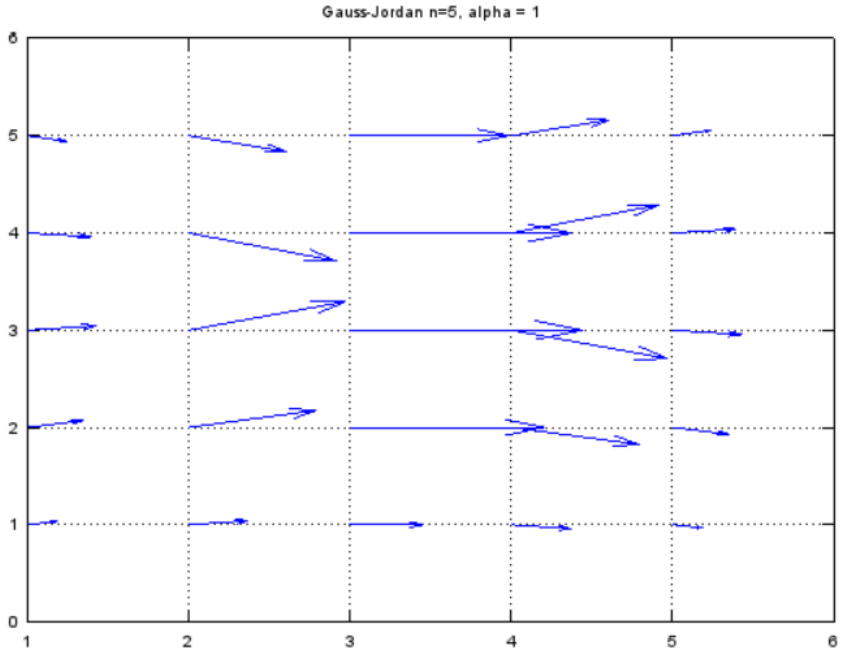
References :

B.K.P Horn, B.G. Schunck, Determine Optical Flow (1984)
Dr. Mubarak Shah, Lecture 7 - Optical Flow, Youtube: https://www.youtube.com/watch?v=kJouUVZ0QqU
A. Greenbaum, Chapter 10, Iterative Methods for Solving Linear Systems

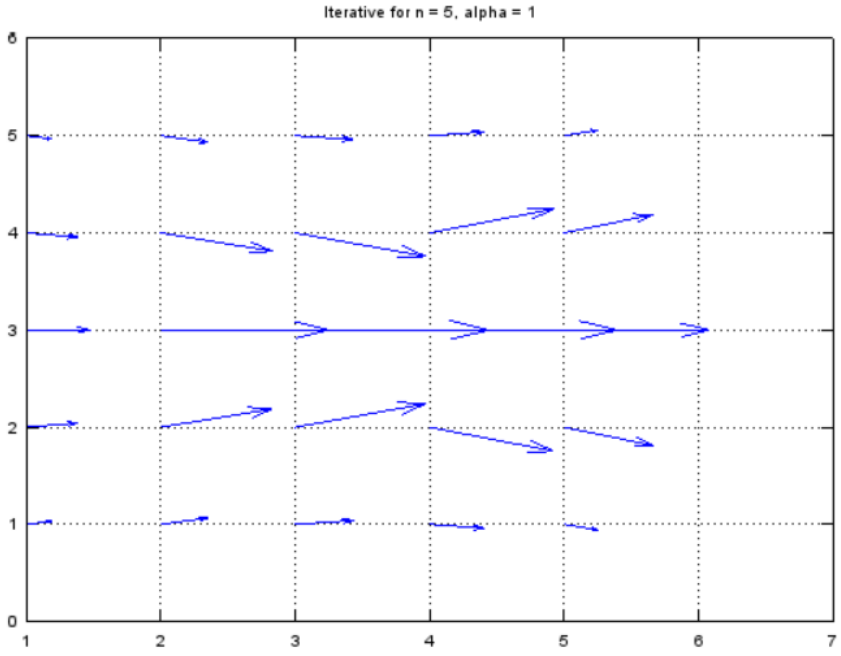
Results :

Optical Fows using:

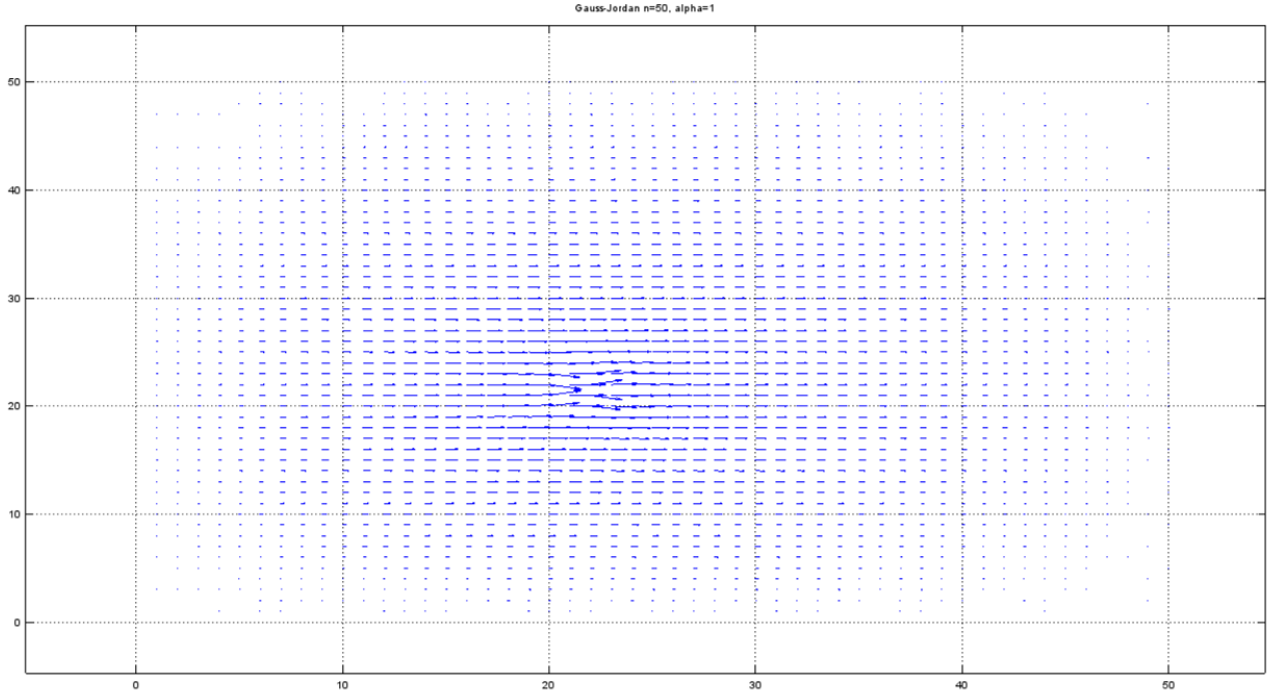
i. Gauss Jordan Elimination for image of size 5x5



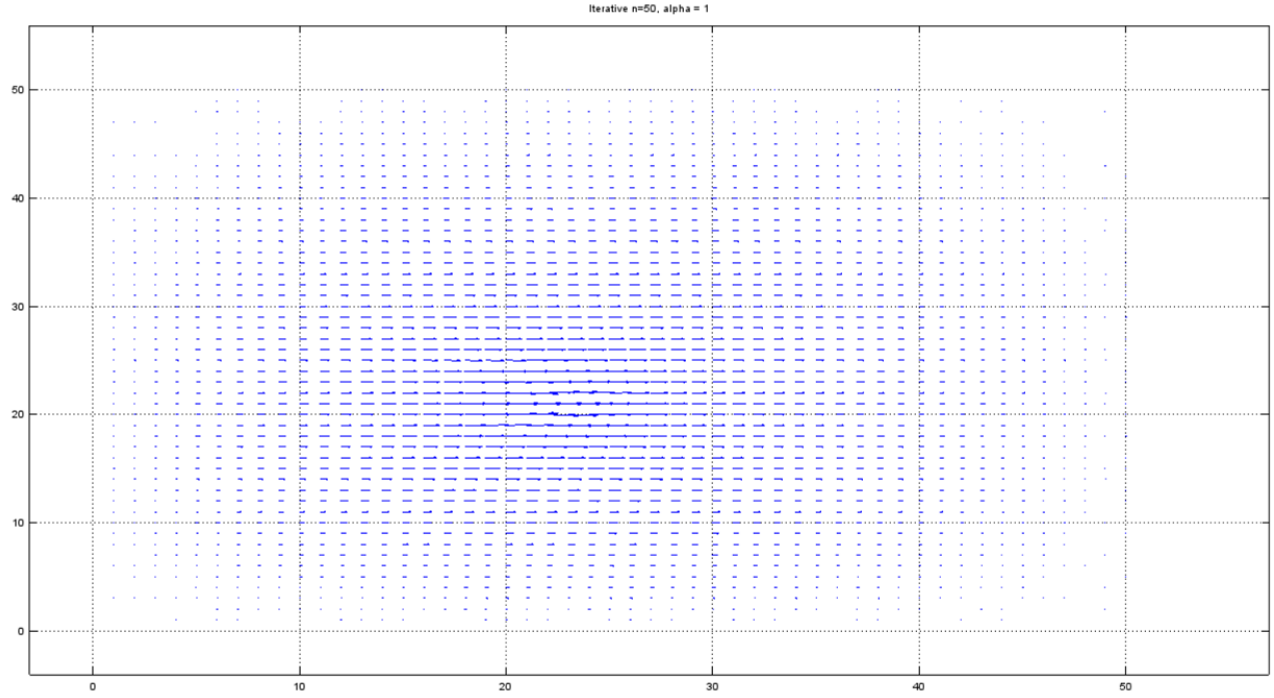
ii. Horn & Schunck for image of size 5x5



iii. Gauss Jordan Elimination for image of size 50x50



ii. Horn & Schunck for image of size 50x50



2 Week 2

2.1 Topics :

Lucas Kanade Optical Flow Method :

B. Lucas and T. Kanade published a paper *An Iterative Image Registration Technique*, the method described in which has been adopted for an Optical Flow algorithm. It considers the neighbors of a pixel to belong to the same surface and hence have similar velocities and uses Least Square approximation to determine the velocities. We implemented the same in Octave for two images. As the method is purely local it does not provide any information about the optical flow in the uniform interior region of an object in the image. Hence we see dense vectors along the edges of the moving objects while very small or none in the interior.

Michael Black :

We also read a thesis paper *A Quantitative Analysis of Current Practices in Optical Flow Estimation* by Michael Black which described many optical flow algorithms and the assumptions they have considered. He quantitatively judges the necessities of these assumptions. He, along with P. Anandan also proposed a weighting function to resolve the issue of outliers.

Installations :

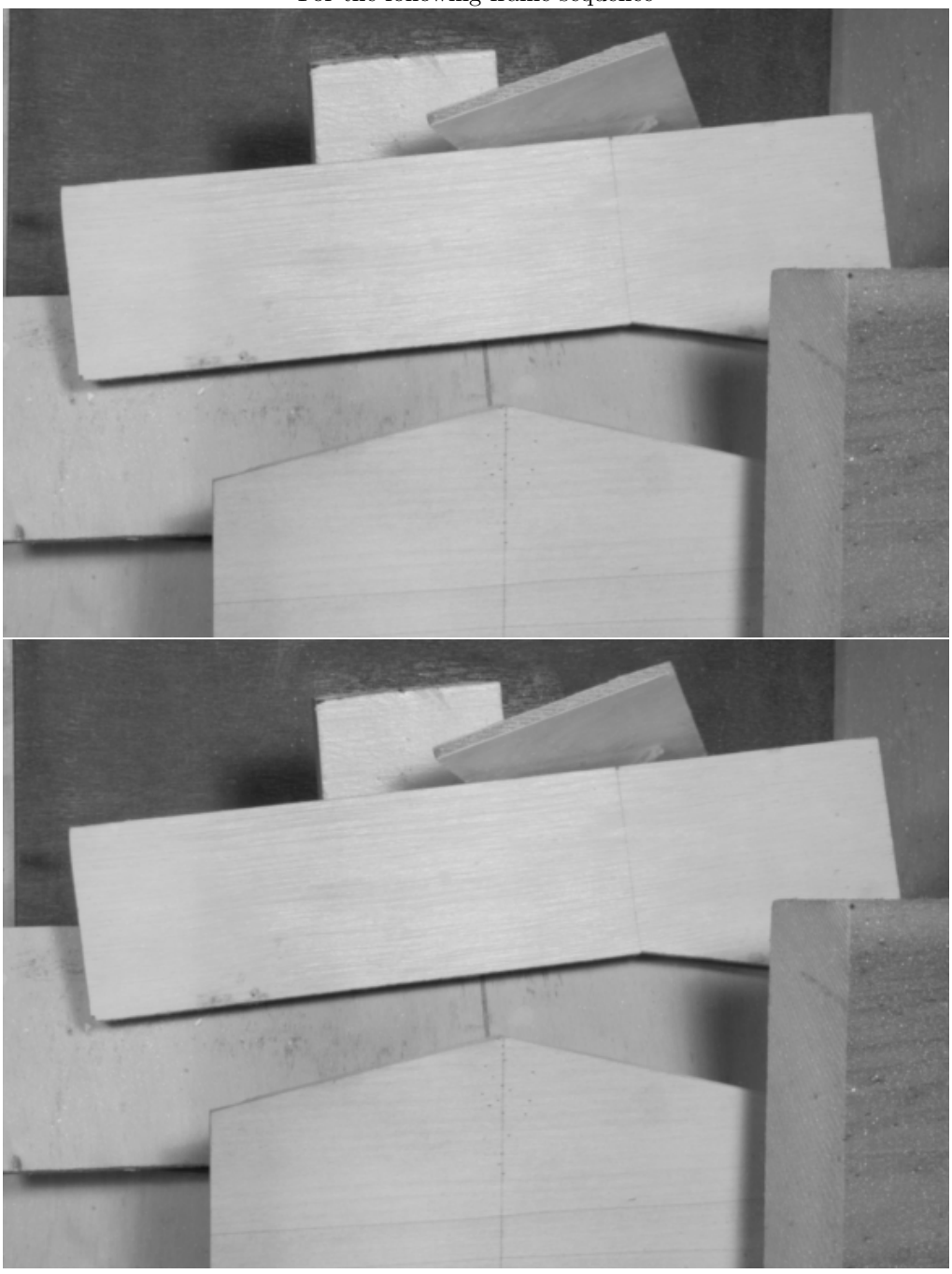
We installed the following dependancies : CMake, QT5-GUI, Media and Video I/O, Linear Algebra Libs (http://milq.github.io/install-opencv-ubuntu-debian/). Following which we installed Python 3.4, numPy 3.0 library and OpenCV 3.0. Using some sample codes and built-in functions of OpenCV to compute optical flow of a video in run-time. We read and tried to understand these built-in functions that compute the optical flow and the algorithm that it implies. We then tried to find out the differences between the optical flows of our implementation and this method. It so turned out that the built-in functions are very much efficient and accurate and also that they first point out the good features in the image to be tracked and then compute optical flow over these pixels only.

References :

Deqing Sun, Stefan Roth , J.P. Lewis, and Michael J. Black, Learning Optical Flow
Deqing Sun, Stefan Roth and Michael J. Black, A Quantitative Analysis of Current Practices in Optical Flow Estimation and the Principles Behind Them
B. Lucas, T. Kanade, An Iterative Image Registration Technique
M. Black, P. Anandan, Robust Estimation of Multiple Motions:Parametric and Piecewise-Smooth flow fields
Optical Flow, Michael Black, Youtube: https://www.youtube.com/watch?v=tIwpDuqJqcE
OpenCV Source Code

Results :

For the following frame sequence



The Optical flow is: