How to Conduct a Literature Review and Discover the Context of an Idea

Secrets of Optical Flow Estimation and Their Principles

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1 Introduction

This is one of the courses in the international computer vision summer school 2010 (ICVSS).

1.1 Goal

Good ideas have deep roots. Understanding such roots is the key to being able to generate new ideas moving forward. The goal of the Reading Group is to practice ways in which exploration of these roots can be performed.

It is important to trace back an idea to its root not only to give proper credit to its originators, but also to avoid re-discovering the same concept over and over, which slows down progress of the academic community as a whole (a small degree of rediscovery is unavoidable, and sometime healthy). [10]

1.2 Task

The student should choose at least one of the following topics:

- Multi-modal volume registration by maximization of mutual information
- Secrets of Optical Flow Estimation and Their Principles
- Towards high-resolution large-scale multi-view stereo,

research the literature and trace the roots of the ideas contained in these presentations as far back as possible.

2 The paper

I have chosen to do literature study of the paper "Secrets of Optical Flow Estimation and Their Principles". [11]

2.1 Main concept

The authors of the paper have seen that even though optical flow algorithms are getting better, many of them still share the base formulation from the work of Horn and Schunck. They analyse different parts of the optical flow algorithm to see where improvement can be made.

2.2 Baseline algorithm

In the paper the authors describe a "baseline" algorithm of what they think consists of standard components. By changing one component at a time, they can see of how big importance that component is, and how the algorithm improves.

In their creation of the baseline algorithm they make use of a few components from the paper "An Improved Algorithm for $TV - L^1$ Optical Flow" [13], mainly robustness against lightning changes, computation of derivatives, and a 5×5 median filtering of the flow field. They also make use of Rudin-Osher-Fatemi structure texture decomposition [9], and a "standard multi-resolution technique" where they choose to cite [2] and [3] together with [12] for the choice of downsampling factor. Methods from [12] is also used for their graduated non-convexity scheme (GNC).

2.2.1 Median filtering

In the analysis, the authors came to the conclusion that median filtering, to denoise the flow field, is the most important component.

The flow fields obtained after median filtering have however higher energy than non-median filtered ones. The objective function which is minimised, should be another one compared to the classical one.

3 Literature tree

The tree can be very big exploring all branches, and I have focused on what I found most important, which is the base optical flow algorithm.

Horn and Schunck's paper "Determining optical flow" [5] is one of the most cited papers on optical flow and also provides an algorithm for calculating it. Lucas and Kanade's paper "An Iterative Image Registration Technique with an Application to Stereo Vision" [7] from the same year also presents a method for calculate the optical flow, by using a spatial intensity gradient search which minimises the Euclidean distance between the corresponding patches in the consecutive frames.

Some prior work to [5] is Fennemat and Thompson's "Velocity determination in scenes containing several moving objects" [4] where they quantifies the speed and direction of objects that are moving in a sequence with Gradient-Intensity Transform Method (GITM), and Netravali and Robbins' "Motion-compensated television coding, 1" [8] which describe a method for estimating the displacement of moving objects between frames for television coding.

An earlier work I have come across is "A Class of Algorithms for Fast Digital Image Registration" by Barnea and Silverman [1] where they introduced a new approach for image registration, "Sequential Similarity Detection Algorithms" (SSDAs), which was fast for that time.

"Estimating the velocity of moving images in television signals" [6] by Limb and Murphy is one of the first papers I have found which is a nonmatching method and [4] extends this approach.

It seems as all other earlier work I have found is local based methods, and since Horn and Schunck's method is global I decided not to include all of them. It seems that many methods were based on matching and speeding up cross correlation during this time period. Except from papers that focus only on matching and image differences, there are quite a few in the television area, and also many similarities with the motion field in the optics area.

Please see figure 1 for a graphical presentation.

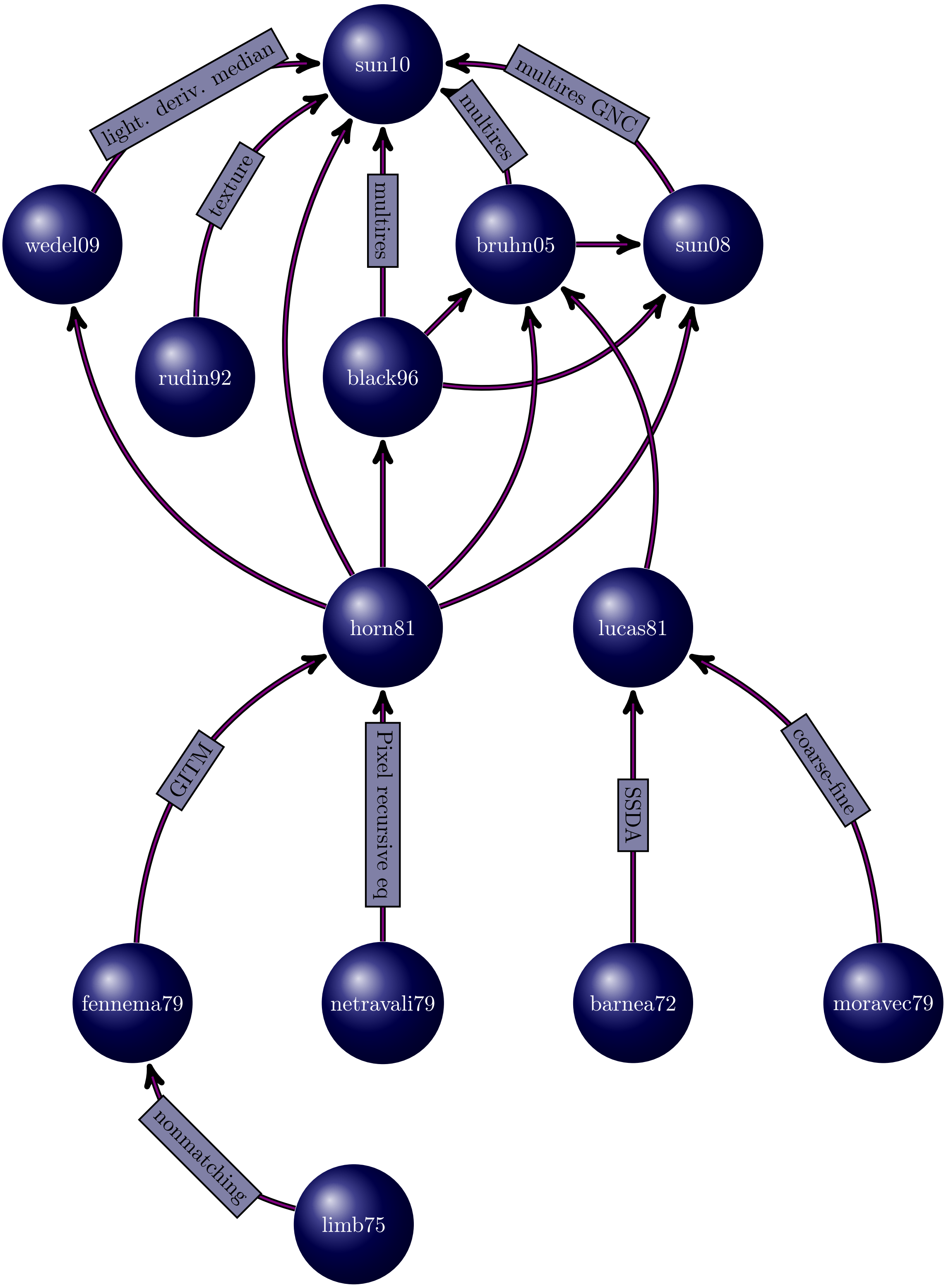

Figure 1: Graphical tree

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