Secrets of Optical Flow Estimation and Their Principles

Guido Maria Re
Dep. Mechanical Engineering
Politecnico di Milano
Italy

Since I have worked alone for this homework, I preferred to focus my efforts on tracing the roots of the ideas than create a wide net of “citation connection”.
I am a student of Mechanical Engineering, so all the three topics of the Reading Group are not well known for me. Consequently, I did not have a starting point for my exercise, like well-known books, articles or some advises from colleagues which have some experience in this field.
For this reason I have decided to start my research from a wide point of view and then to tighten it.

I started searching what Optical Flow is on Wikipedia, that gave me few informations, but definitely useful. There I discovered a reference, “Performance of optical flow techniques” written by John L. Barron, David J. Fleet, and Steven Beauchemin in 1994, that is a good survey and it is cited by 1331 articles since 1996 (information found on SCOPUS).
The article describes different techniques that can be divided in four groups:

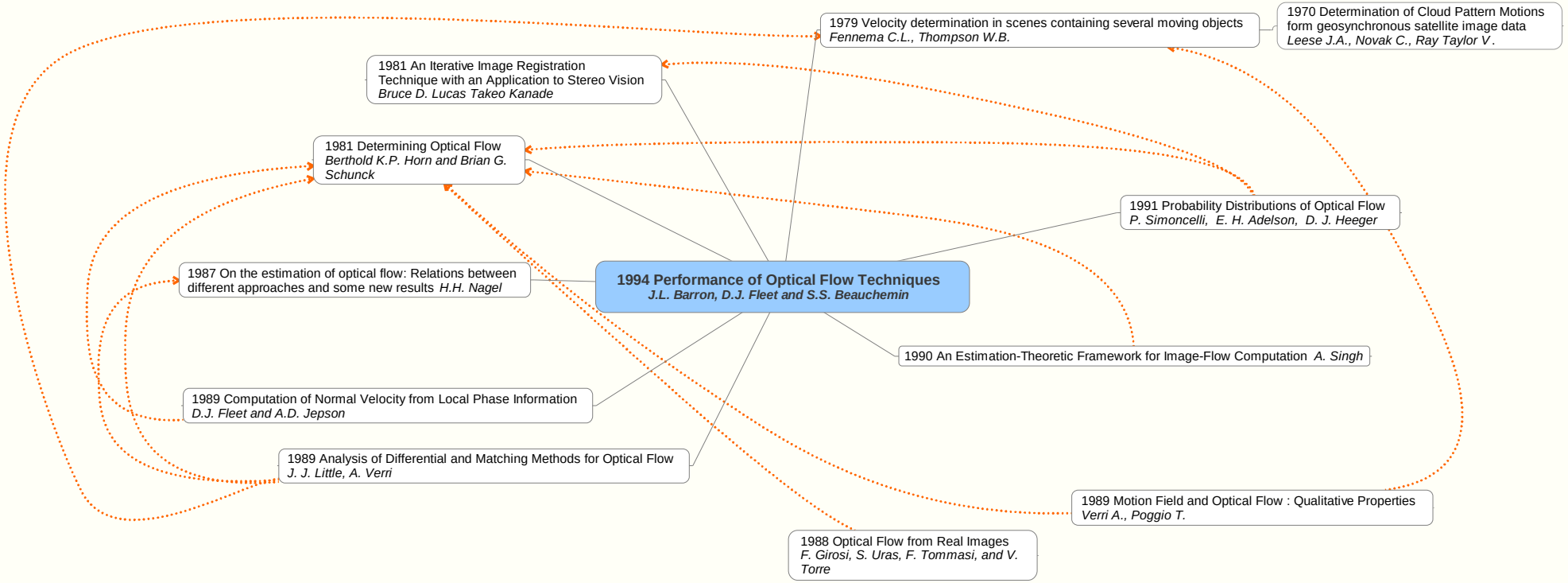
- Differential Techniques,
- Region-Based Matching Techniques,
- Energy-based Methods,
- Phase-based Techniques.

Then, starting from these groups, I have extended my exploration, trying to find the related articles cited in the survey. Unfortunately, some articles were impossible to find: some of them are not available as electronic resource or not physically held by Politecnico di Milano. So, for some of them I have looked for related articles written by the same authors in those years, while it has been impossible to find anything for others.

It is interesting to notice that there are many connections between these articles. In particular the work of Horn and Schunck, “Determining optical flow” is cited many times. I found some articles and books in the reference of this paper that are not strictly related to the optical flow estimation and to computer science in general. These are the works of Gibson in the '50 and '60, that was a psychologist interested to the perception systems. I did not read anything about his works, but I can suppose that he could have influenced the first researchers involved in the optical flow estimation.
Another very cited article is “Velocity determination in scenes containing several moving objects”, written by Fennema and Thompson. One of the reference of this article is “Detection of cloud patterns motions form geosynchronous satellite image data”, written by Leese, Novakcs and Taylor in 1970. This is the earliest article that I found about optical flow. Actually, the article does not deal with the optical estimation from a theoretical point of view, but a method for a precise problem that uses optical flow is proposed. This article is impossible to find on the web, I have fortunately discovered it in the main library of Politecnico di Milano.

Here the list of the articles that I found

Year	**Title**	*Autors*
1970	**Determination of Cloud Pattern Motions form geosynchronous satellite image data**	*Leese J.A., Novak C., Ray Taylor V.*
1979	**Velocity determination in scenes containing several moving objects**	*Fennema C.L., Thompson W.B.*
1981	**An Iterative Image Registration Technique with an Application to Stereo Vision**	*Bruce D. Lucas Takeo Kanade*
1981	**Determining Optical Flow**	*Berthold K.P. Horn and Brian G. Schunck*
1987	**On the estimation of optical flow: Relations between different approaches and some new results**	*H.H. Nagel*
1988	**Optical Flow from Real Images**	*F. Girosi, S. Uras, F. Tommasi, and V. Torre*
1989	**Computation of Normal Velocity from Local Phase Information**	*D.J. Fleet and A.D. Jepson*
1989	**Analysis of Differential and Matching Methods for Optical Flow**	*J. J. Little, A. Verri*
1989	**Motion Field and Optical Flow : Qualitative Properties**	*Verri A., Poggio T.*
1990	**An Estimation-Theoretic Framework for Image-Flow Computation**	*A. Singh*
1991	**Probability Distributions of Optical Flow**	*P. Simoncelli, E. H. Adelson, D. J. Heeger*
1994	**Performance of Optical Flow Techniques**	*J.L. Barron, D.J. Fleet and S.S. Beauchemin*


1979 Velocity determination in scenes containing several moving objects
Fennema C.L., Thompson W.B.
1970 Determination of Cloud Pattern Motions form geosynchronous satellite image data
Leese J.A., Novak C., Ray Taylor V.
1981 An Iterative Image Registration Technique with an Application to Stereo Vision
Bruce D. Lucas Takeo Kanade
1981 Determining Optical Flow
Berthold K.P. Horn and Brian G. Schunck
1991 Probability Distributions of Optical Flow
P. Simoncelli, E. H. Adelson, D. J. Heeger
1987 On the estimation of optical flow: Relations between different approaches and some new results H.H. Nagel
1994 Performance of Optical Flow Techniques
J.L. Barron, D.J. Fleet and S.S. Beauchemin
1990 An Estimation-Theoretic Framework for Image-Flow Computation A. Singh
1989 Computation of Normal Velocity from Local Phase Information
D.J. Fleet and A.D. Jepson
1989 Analysis of Differential and Matching Methods for Optical Flow
J. J. Little, A. Verri
1989 Motion Field and Optical Flow : Qualitative Properties
Verri A., Poggio T.
1988 Optical Flow from Real Images
F. Girosi, S. Uras, F. Tommasi, and V. Torre