DETERMINING DISPLACEMENT FIELDS ALONG CONTOURS FROM IMAGE SEQUENCES

Patrick BOUTHEMY

IRISA / INRIA
Campus de Beaulieu
35042 RENNES, France

ABSTRACT

We propose a framework for image flow analysis consisting of three major stages; i.e.:

- determine moving edges by some local process;
- integrate motion information along linked contours;
- propagate motion estimation through homogeneous regions obtained inside these contours.

This paper is concerned with the two first stages. A procedure, based on some local modeling and maximum likelihood scheme, bas been designed to perform the first step. After some linking process, constraints provided by the measurements gained from the first stage can be combined to compute the velocity field along contours, by minimizing some simple functional. To this end, a gradient algorithm is used with a recursive estimation from one point to its successor in the chain.

RESUME

Nous proposons un schéma d'obtention du champ des vitesses dans une séquence d'images s'articulant en trois étapes, à savoir :

- déterminer localement les éléments de contour en mouvement;
- intégrer l'information de mouvement le long des lignes contours chaînées;
- propager l'estimation du mouvement à l'intérieur des zones homogènes délimitées par ces lignes contours.

Le papier traite des deux premières étapes. Une procédure, basée sur une modélisation locale et un critère de maximum de vraisemblance, a été conçue afin de réaliser le premier point. Après chaînage, les mesures issues du premier niveau peuvent être combinées afin de calculer le champ des vitesses complet le long des lignes contours via la minimisation d'une fonctionnelle simple. A cette fin, un algorithme de gradient est mis en oeuvre avec une récurrence de point en point le long de la chaîne contour.

KEYWORDS: image sequence, moving edge determination, motion estimation, local modeling, maximum likelihood test, stochastic gradient.

I INTRODUCTION

Image sequence analysis has received more and more attention since 70's. In particular substantial studies have been concerned with motion estimation accross changing two-dimensional images. Two main motivations have subtented there research efforts. First, motion computation represents an attractive challenge in order to design some robust, tractable and general-purpose method. On the other hand, application areas never stop broadening, |1|.

Meteorological applications (determining wind fields owing to cloud motion estimation, |2|), military domain (target tracking) were among pioneer ones. Then came interframe image coding for broadcast television or videoconferencing purpose |3,4|. For a few years, other potential applications have appeared: biomedical (e.g., angiocardiography |5|,) robotics (mobile robot, |6|), traffic monitoring, graphics ... These new domains are not only interested in two-dimensional motion as it is, but as intrinsic features conveying information about the depicted 3D-scene. Indeed motion in the imaging plane provides primary cues to relative depth, structure and 3D-movements of objects in space |7,8|.

The motion in the imaging plane is usually referred to as the "optic flow". Optic flow can be represented as a vector field: the field of apparent velocities of brightness patterns in the image due to relative motion of camera and objects in space. (As one's uses a dicrete representation of an image sequence, displacement vector fields and velocity vector fields are usually confused, although mathematically of different nature).

Discriminating discontinuities in the velocity field is a key problem in motion estimation schemes whatever they are. Indeed, feature-based methods require cooperative matching procedures |9|, and gradient-based methods involve some smoothing constraint |10,11|. Thus, we have designed a method whose first task is to cope with these discontinuities, which are tied to contours in the image, such as occluding contours, joint ones ...

We propose a framework for image flow analysis consisting of three major stages; i.e.:
determine moving edges by some local process;
link these eges and integrate motion information along contours;
propagate motion estimation through homogeneous re-