Optical Flow based Active Contour Model for 2d+t Object Segmentation

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keywords: Optical Flow, Active Contour, Tracking, Image and Video Segmentation

Abstract : A fundamental step for video/image retrieval by content is the calculation of the visual features. In contexts the most relevant content consists in represented subjects rather than the whole scene. The distinction between focused objects and background permits to calculate the visual features of each object alone, making more effective the retrieval task. Segmentation of moving objects from a video sequence is an important task whose applications cover domains such like video compression, video surveillance or object recognition. Image segmentation, widely employed in medical imaging, computer vision, production quality control, etc , is the process to extract meaningful regions from an image. However, the definition of meaningful region is dependent from the applicative context. Generally, an image segmentation process should capture image parts that are perceptually relevant. The definition of what is perceptual relevant characterizes any segmentation method. In this work, the meaningful regions are these related to the focused objects which are in motion. Many image segmentation techniques can be found in literature. They can be roughly classified in region-based and contour-based approaches. More recently [1-3], it was suggested that it should be possible to follow edges in images by suggesting a curve in an image, and then letting the curve itself move to a suitable shape and position. This curve should have physical properties like elasticity and rigidity, and also be attracted by edges in the image. For the contour to be attracted to edges in the image an energy image is created, which has high values where the original image has edges and low values otherwise. The attractor image gives the contour a potential energy by summing the energy in the points the contour passes. The contour itself has an internal energy level determined by its shape and by minimizing the total energy one aims at a smooth contour that follows the original image's edges well.

Since we can distinguish moving objects from static elements of a scene by analyzing norm of the optical flow vectors, this one is incorporated in a region-based active contour model in order to attract the evolving contour to moving objects contours. Optical flow aims to measure motion field from the apparent motion of the brightness pattern. Computation of the optical flow can be achieved by many different methods, among a large literature [4-6]. Recently, 3D tensor techniques have shown their superiority in producing dense and accurate optical flow fields [7-8]. They provides a powerful and closed representation of the local brightness structure. Our objective is to construct a segmentation method able to identify what properties characterize objects and distinguish them from other objects and from the background. The use of optical flow procedures together with other segmentation techniques has been already exploited in other works [9], but to the end to get a more accurate estimation of the motion field. In this work we have used a modified Active Contour Model, where derivative of the optical flow field is used as a component of the energy function to be minimized, to segment out the three dimensional objects from video sequence. In 3D the image force is defined in the same way as in 2D, but the internal energy has to be calculated in a slightly different way,

which also leads to a modification of the Euler-Lagrange-equation. To improve the detection stage, we extended the energy formulation of active contour by including an additional force resulting from the calculation of the optical flow. We propose a robust and fast algorithm of active surface model, which is a 3D extension of the active contour model. The energy criterion and the evolution equation are defined in n-dimension and combines active contours with an implementation of optical flow. We extend methods mentioned above to fit contours to shapes in 3D images. This includes finding good ways of representing the active contour as well as how to iterate and control the contour. The operator must suggest an initial contour, which is quite close to the intended shape. The proposed method has been developed as a pre-processing stage to be used in methodologies and tools for video/image indexing and retrieval by content. The first task of the algorithm exploits the cues from motion analysis for moving area detection. The developed method has been applied to a variety of scenes where objects of different type and shape are represented on variously textured background. Contour based segmentation is a difficult task if we use the optical flow as an input of our video segmentation. Such a function is more related to a region information as consequence the idea to incorporate region information from the inside and outside seems more natural than using this function as boundary potential. The paper presents a segmentation approach that combines optical flows and active models to characterize objects and follow them in video sequences. The approach is based on a minimization of a functional of energy (E) which uses perceptual information in ROI in an image, in conjunction with a mixture of Gaussian to model voxels of the background image and those of the visual objects. The active model part minimizes a functional over each component of the colour image, and is fast and robust with respect to noise. Experiments with a number of test sequences are promising and extend the numerous works on this subject.

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