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Research Article

Deformable Contour-Based Maneuvering Flying Vehicle Tracking in Color Video Sequences

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This paper presents a new method for the tracking of maneuvering flying vehicles using a deformable contour model in color video sequences. The proposed approach concentrates on targets with maneuvering motion in sky, which involves fundamental aspect change stemmed from 3D rotation of the target or video camera. In order to segment and track the aircraft in a video, at first, the target contour is initialized manually in a key frame, and then it is matched and tracked automatically in the subsequent frames. Generally active contour models employ a set of energy functions based on edge, texture, color, and shape features. Afterwards, objective function is minimized iteratively to track the target contour. In the proposed algorithm, we employ game of life cellular automaton to manage snake pixels' (snaxels') deformation in each epoch of minimization procedure. Furthermore, to cope with the large aspect change of aircraft, a Gaussian model has been taken into account to represent the target color in RGB space. To compensate for changes in luminance and chrominance ingredients of the target, the prior distribution function is dynamically updated during tracking. The proposed algorithm is evaluated using the collected dataset, and the expected probability of tracking error is calculated. Experimental results show positive results for the proposed algorithm.

1. Introduction

The video-based locating and tracking of flying vehicles is an interesting issue in the visual control of aerial systems, which may be employed in aerial surveillance, the navigation of flying robot, missile, microflying, unmanned aircraft, and so forth. In order to localize, track, and recognize flying vehicles, some approaches have been presented recently. In this context, four main state-of-the-art methodologies are well known and applicable including (1) invisible spectrum-based methods like radio detection and ranging (RADAR) or light detection and ranging (LIDAR); (2) visible spectrum-based approaches [1–8] such as existing algorithms in infrared and thermal imaging systems in the wavelength range of 380 nm to 780 nm and even more in far infrared case; (3) global positioning system (GPS-) based methods; and (4) combination of visible and invisible spectrum-based methods. Feasibility of these categories is mostly dependent upon the distance of the imaging system to the target of interest. Furthermore, each flying vehicle has a set of flight specifications such as the minimum and maximum speed, maneuvering capability, flight board, and so on, whose data may help to estimate the position of the target accurately.

Irrespective of available information, the paper emphasizes on flying vehicle tracking (FVT) in color video sequences. In this domain, we concentrate especially on maneuvering aircraft with large aspect change, which is considered to be a challenging issue. Considering the high deformation of target contour in this application, utilizing deformable surfaces such as active contour [9–11] and active mesh [1, 12] models seems to be a proper choice.

1.1. Related Work. In [1], a method for flying vehicle tracking was introduced in monochrome video sequences. In this method, the incipient location of the target was determined manually; then, the target was tracked automatically by optimizing the mesh energy functions. In [2], a vision-based scheme for automatic locating of a flying vehicle was