J Real-Time Image Proc
DOI 10.1007/s11554-013-0368-8

ORIGINAL RESEARCH PAPER

Performance of dynamic texture segmentation using GPU

Francisco Gómez Fernández · María Elena Buemi · Juan Manuel Rodríguez · Julio C. Jacobo-Berlles

Received: 8 January 2013 / Accepted: 15 July 2013

Abstract This work is focused on the assessment of the use of GPU computation in dynamic texture segmentation under the mixture of dynamic textures (MDT) model. In this generative video model, the observed texture is a time-varying process commanded by a hidden state process. The use of mixtures in this model allows simultaneously handling of different visual processes. Nowadays, the use of GPU computing is growing in high-performance applications, but the adaptation of existing algorithms in such a way as to obtain a benefit from its use is not an easy task. In this paper, we made two implementations, one in CPU and the other in GPU, of a known segmentation algorithm based on MDT. In the MDT algorithm, there is a matrix inversion process that is highly demanding in terms of computing power. We make a comparison between the gain in performance obtained by porting to GPU this matrix inversion process and the gain obtained by porting to GPU the whole MDT segmentation process. We also study real-time motion segmentation performance by separating the learning part of the algorithm from the segmentation part, leaving the learning stage as an off-line process and keeping the segmentation as an online process. The results of performance analyses allow us to decide the cases in which the full GPU implementation of the motion segmentation process is worthwhile.

F. Gómez Fernández (✉) · M. E. Buemi · J. M. Rodríguez · J. C. Jacobo-Berlles
Departamento de Computación, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires, Argentina
e-mail: fgomez@dc.uba.ar

Keywords GPU · Dynamic textures · Expectation maximization · Video segmentation · Graphical model

1 Introduction

Dynamic visual processes present in videos are closely related to motion phenomena. Understanding and analyzing motion in videos has been a challenging task in computer vision for decades. Videos containing water, fire, smoke and crowds, among others, are well characterized as visual processes and can be modeled with dynamic textures (DTs).

DTs model textures that vary in time. They can be viewed as 2D time-varying stochastic processes. These stochastic processes can be modeled using generative models. DTs are characterized by their statistical parameters for these models. These parameters can be learned form video samples, and their estimation can be used to perform video segmentation [3].

Alternatively, it is possible to use methods based on optical flow [1, 2] for motion segmentation. This approach presents difficulties such as aperture and noise problems. They can be dealt with using regularization, but this produces unwanted effects in motion, smoothing edges or regions where the movement is smooth (for example, vegetation in outdoor scenes).

In video segmentation using DTs, the problem of having various DTs on the same video has to be addressed. A possible solution is to use a mixture of dynamic textures (MDT) [4] model. In it, the possibility of a video sequence to belong to one of several DTs is explicitly modeled. This allows us to use an expectation maximization (EM) algorithm to classify a given set of video sequences into

Published online: 10 August 2013