Physical simulation for real-time image/video retargeting

Roberto Gallea, Edoardo Ardizzone, Roberto Pirrone.
DICGIM - Universita' degli studi di Palermo*

Figure 1: *We retarget media by considering them as viscous objects whose local stiffness is related to local visual saliency. Object particles are modeled as mass-points connected by springs. Stiffer springs correspond to high-content regions which are preserved, while deformations are spread across pliable ones. Time consistency for videos is assured using strong connections between correspondent nodes in consequent frames planes. The whole method is implemented as an ODE system implemented on a GPU-based lattice providing real-time performances.*

1 Introduction

Retargeting methods present content on arbitrary aspect ratio media displays limiting distortions in relevant objects. This is done by means of applying non-homogeneous resizing operators across the whole media, constraining it to fit into the required size. Several succesful systems have been proposed to achieve image retargeting, while video retargeting is still challenging due to time consistency and computational complexity requirements. Two important contributes were proposed: non-homogeneous retargeting [Wolf et al. 2007] and improved seam-carving [Rubinstein et al. 2008]. The first one claims to achieve real-time performance but considers spatial coordinates separately. The latter do preserve media structure, but sometimes introduces artifacts and does not provide real-time performance. In addition it is not designed for streaming purposes. We show how a physical simulation solves the retargeting problem and the relative issues, such as time consistence, reporting how this is feasible in real-time. Moreover, at each step the system considers only two consequent frames, being able to deal with streaming media.

2 Proposed model and implementation

In a nutshell, the proposed method models the media as a viscous physical object (on an xyt coordinate system) composed by particles. Relations between particles are modelled as springs with variable stiffness. By stretching or compressing the media, elastic forces arise and it gets deformed properly until an equilibrium is reached. The result is a retargeted media. Content preservation is realized by relating content saliency proportionally to local stiffness. Just few constraints are required: 1) After the deformation, pixels are forced to remain on the original frame, 2) Frames border pixels in original media should remain border pixels in the retargeted version too (optional). Saliency is extracted using a contrast-based method [Cheng et al. 2011]. For the retargeting purpose, a grid consisting of $16x16$ nodes is used. However, $8x8$ or $12x12$ nodes are often sufficient.

In order to retarget streaming media, when considering the i-th frame, the result of the (i-1)-th is taken as a starting point and high-stiffness springs are connected between two corresponding nodes of the two frames. This constrains any deformation taking place after the normal dynamic of individual frames to be similar between neighboring frames.

The method is implemented as a parallel ODE system, solved explicitly using a 4th order Runge-Kutta integration method, taking advantage of gpGPU parallelism.

*e-mail: roberto.gallea@unipa.it

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