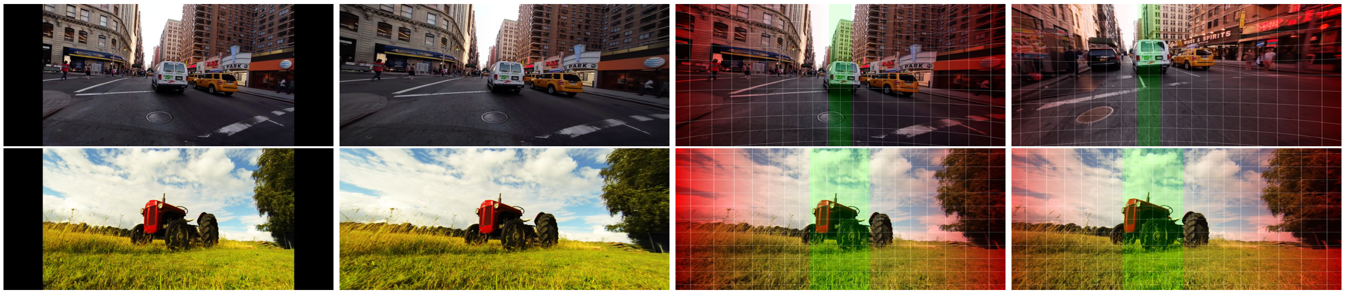
Atomic Stretch: Optimally bounded real-time stretching and beyond

Rasmus Ramsbøl Jensen Jannik Boll Nielsen
Technical University of Denmark



(a) *Original* **(b)** *Stretched* **(c)** *Stretched w. overlay* **(d)** *Tracking of object in focus*

Figure 1: *16:9 footage stretched to 21:9, while fully preserving the target of attention (white van / tractor).* ***a****: Original 16:9 footage.* ***b****: Footage stretched to 21:9, preserving center-pixels.* ***c****: Stretched footage with overlay, indicating protected region (green), and stretch magnitude (red).* ***d****: Stretching using tracking information to keep the white van preserved.*

Abstract

Atomic Stretch is a plugin for your preferred Adobe video editing tool, allowing real-time smooth and optimally bounded retargetting from and to any aspect ratio. The plugin allows preserving of high interest pixels through a protected region, attention redirection through color-modification, countering barrelling effects through vertical stretching, and tracking of targets of interest.

Keywords: Stretching, remapping, retargeting, real-time, video-processing
Concepts: •**Computing methodologies** → **Image processing;** *Video summarization;*

Introduction

Resizing video footage to a desired aspect ratio, also known as retargeting, is a task exercised constantly by photographers, video-editors, and the like. Footage from different sensors with ratios 4:3, 16:9 or 21:9 (from anamorphic lenses) has to be matched with different output devices, where the most common ratios are 16:9 (widescreen) and 21:9 (cinamascope). If web pages and billboards are included, any ratio can be encountered. Many cameras simply achieve 16:9 by cropping a 4:3 sensor.

In practice, to match footage with the output aspect, the video-editor has to decide between cropping and stretching. Cropping effectively increases the focal length, decreases the total light sensitivity and might introduce the need to upscale. Stretching can be performed linearly in its most naive sense such that pixels simply become wider. Finally, a smooth, non-uniform, stretching may be achieved by manually defining a warp-field based on e.g. Bézier-curves or B-splines.

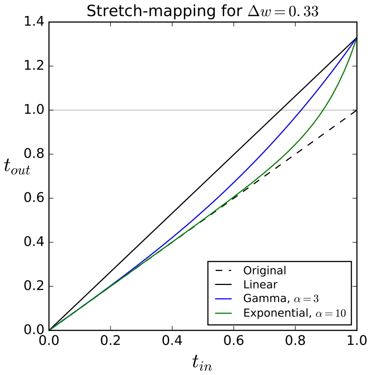


Figure 2: *Examples of mappings from normalized input columns, t_{in}, to normalized output columns, t_{out}. The non-linear, smooth, mappings 'Gamma' and 'Exponential' are shown bounded by the trivial 'Original' and 'Linear' mapping. The smooth mappings preserves pixels that are close to the origin of the stretch.*

While advanced retargeting methods do exist [Wang et al. 2009; Hu et al. 2014], practical tools for video editing are scarce. We here present an automatic yet customizable real-time tool, which minimizes vertical compression effects, allows a protected region of interest supporting tracking, and attention redirection using desaturation and darkening. The stretching is within optimal bounds and the addition of vertical stretch towards the edges minimizes the resulting vertical compression effect. Fig. 1 shows the application of our tool on a 16:9 frame stretched to 21:9. The tool is named Atomic Stretch and acts as a plugin to the industry standard video editing tools, Adobe After Effects and Premiere. The plugin will provide more wiggle-room in choice of camera, optics and editing.

Method

We wish to stretch a given frame from the protected area (on each side) to the frame edge. Let $t_{in} \in [0, 1]$ denote the normalized x-coordinate in the original frame part, and let $t_{out} \in [0, 1 + \Delta w]$ be the normalized x-coordinate in the stretched part, where Δw is the fractional width increase. The stretching operation can now be defined as follows:

$$t_{out} = g(t_{in}) = t_{in} + \Delta w \cdot f(t_{in}) \quad \text{for} \quad f(t_{in}) \in [0, 1] \quad (1)$$

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s). © 2016 Copyright held by the owner/author(s).
SA '16, December 05-08, 2016, , Macao
ISBN: 978-1-4503-4540-8/16/12
DOI: http://dx.doi.org/10.1145/3005274.3005279

where $f(t_{in})$ controls the added stretch. The function has an unstretched lower bound, $f(t_{in}) = 0$ (dashed line, Fig. 2), and an upper bound for $f(t_{in}) = t_{in}$ corresponding to a linear stretch (solid black line, Fig. 2). To be continuous in the intersection between protected and stretched area, the gradient should ideally have the limit $\frac{dt_{out}}{dt_{in}} \to 1$ for $t \to 0$, i.e. be tangent to the dashed line in Fig. 2 at $t_{in} = t_{out} = 0$. Fulfilling these requirements, we propose two easing-functions that are commonly used for animation: The Gamma and an Exponential functions. They are defined respectively as:

$$f_{\texttt{Gamma}}(t_{in}) = t_{in}^{\alpha} \quad \text{and} \quad f_{\texttt{Exp}}(t_{in}) = \frac{\mathrm{e}^{\alpha \cdot t_{in}} - 1}{\mathrm{e}^{\alpha} - 1} \tag{2}$$

and behave slightly different. The functions are depicted in Fig. 2, using curvature parameters, $\alpha = 3$ and $\alpha = 10$ respectively.

Although the mapping from original to output coordinates is well defined (Eq. 1), in practice we need the inverse, $t_{in} = g^{-1}(t_{out})$, to allow pixel-interpolation. Unfortunately, there is no closed form solution of the inverse and we use Newton's method to approximate this. Since initial and final values of t_{in} are known, each pixel-column, t_i, can be computed in succession using a single Newton iteration, with the former column as initial starting guess. This allows for real-time computation and is considerably faster than e.g. using a B-spline warpfield.

In addition to widening the footage we also add an adjustable vertical stretch as a function of horizontal stretch in order to counter the widening of objects in stretched regions (Fig. 1c). We also allow the interpolation function to affect the hue, saturation, and luminance color-space using userdefined weights. This allows e.g desaturation, which draws focus away from the stretch and towards the protected region of interest. Animating the curvature parameter allows for a subtle dolly zoom effect and defining the protected center based on tracking data allows a moving region of interest to be protected (Fig. 1d).

Acknowledgements

We would like to thank our beta-testers for valuable testing and constructive feedback.

References

HU, W., LUO, Z., AND FAN, X. 2014. Image retargeting via adaptive scaling with geometry preservation. *IEEE Journal on Emerging and Selected Topics in Circuits and Systems 4*, 1, 70–81.

WANG, Y.-S., FU, H., SORKINE, O., LEE, T.-Y., AND SEIDEL, H.-P. 2009. Motion-aware temporal coherence for video resizing. *ACM Transactions on Graphics 28*, 5, 1.