Algorithms for film digital restoration: unsupervised approaches for film frames enhancement

Alessandro Rizzi and Alice Plutino

Since the beginning of this Century we are assisting to a crucial step in the domain of cinema: the transition from analogic to digital. The computed generated imagery substituted the early developed special effects on film and the use of smartphones and digital devices took the place of old Super8 formats. In this context, film restoration passes quite often by the digitization and the use of software for image enhancement and restoration are widely diffused and used also by non-pro users. The digital restoration of colour has widely spread, and digital techniques allow to easier removal of colour casts, frames histograms equalization, dynamic range expansion and saturation adjustment. Despite this easy applicability, when adjusting the colour of a film of historical value, constant supervision by qualified personnel is still required.

In our contribution we show and resume our results from the works and projects we have conducted in digital film restoration and we describe our method based on the idea of recovering the original appearance of colours instead of the original colour signal. This approach is based on the application of Spatial Colour Algorithms (SCAs), a family of algorithms inspired by the capabilities of Human Visual System (HSV) of autonomously adjust the variation of lightness and colours in a scene.

SCAs are based on the idea that colour sensation does not depend on the pointwise value of the stimulus, but on the spatial arrangement of the stimuli in the scene. In fact, identical levels of radiance at a point can originate completely different colour sensations according to the values in the rest of the image. To reproduce this behaviour SCAs performs spatial comparisons among the pixels in the input image and for this reason SCAs are characterized by a high computational cost and a local and global behaviour. All the SCAs present a common structure: a first step in which each pixel is recomputed according to the spatial distribution of the other pixels in the image, in the second step an adjustment can be added according to the SCA goal. Due to this characteristic, SCAs can be suitable for analog-to-digital dynamic range adjustment or colour enhancement when the fading occurred on a film.

Thanks to the SCAs algorithms is possible to conduct a semi-automatic and unsupervised colour restoration on faded frames, with a technique that permit also to non-pro users to operate on film restoration without the need of expensive and complex software. This solution could be an interesting alternative to classical restoration approach in the domain of little archives or institution that aim to valorise and diffuse their collections and records without the need of a complex and long process of restoration. In addition those new methods could open an interesting discussion in how evaluate the quality of a restored film, and how to proceed in a restoration when there are no references.

Biographies

Alessandro Rizzi
Alessandro Rizzi is full professor, Department of Computer Science, University of Milano. He has been one of the founders of the Italian Color Group, secretary of CIE Division 8, an IS&T Fellow and a past Vice-President. He is topical editor for Applied Color Science of Journal of Optical Society of America A and associate editor of Journal of Electronic Imaging. In 2015, he received the Davies medal from the Royal Photographic Society.

Alice Plutino
Alice Plutino is a PhD student in Computer Science at the University of Milan. She received her Bachelor and her Master degree in Conservation and Diagnostic of Cultural Heritage. Her current field of research is colorimetry for cultural heritage and digital movie restoration. She's also interested in image quality metrics, digital color and algorithms for image enhancement.