

## Restoration of Color Images

Is it possible to mathematically estimate the original colors of an image when only limited color information and gray levels are present? How faithful is this estimate?

The answer is yes, it is possible — and with striking accuracy.

A new algorithm has been developed to restore color images when only a limited amount of the color data and the gray levels are available. Although previous experiments produced similar results, this new algorithmic method tends to more accurately reproduce the luminosity of the image. While the quality of the reconstruction increases with more correct color information, the way the color information is distributed is even more important. Using the new method, very limited but well distributed color information is sufficient to re-color the entire image. Even having as little as 3% of the original information distributed randomly over an image will produce a good quality reconstruction of the original color image.

The work was inspired by Andrea Mantegna's frescoes at Ovetari Chapel, Eremitani Church in Padua, Italy, which were partially destroyed by an Allied bomb in World War II. Black and white photos of the full frescoes taken before the war were available. Fragments of the frescoes with original colors remain, although the largest is no bigger than a packet of cigarettes and the smallest is about the size of a postage stamp.<sup>1</sup> However, the surface covered by the original fragments is only 77 m<sup>2</sup>, while the original area spanned several hundred square meters. With the new algorithmic method, this invaluable artwork can be reconstructed from only about 8% of the original information.

To restore the color to the original image, the colored fragments were matched to the black and white photos using computer-based pattern-matching techniques. The original colors were then extended from the original fragments into the gray regions by employing the new algorithm, which is based on minimization of a function that depends on discrepancy in the data and on the constraints. The result is a good quality reconstruction of the original color images.

This new method has had a significant impact on other applications, including old black and white image and video restoration, the extreme compression of color images and the recovery of multi-channel signals affected by nonlinear distortion.

To find out more about the Mantegna Project and this new technology, visit <http://www.pd.infn.it/~labmante/Sottopagine/EngLab.htm>.

Source:  
*Restoration of Color Images by Vector Valued  
BV Functions and Variational Calculus*  
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<sup>1</sup> Morris, Roderick Conway. 2006. "An ancient modernist." *Spectator*, 14 Oct.  
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