

Cornsweet Surfaces for Selective Contrast Enhancement

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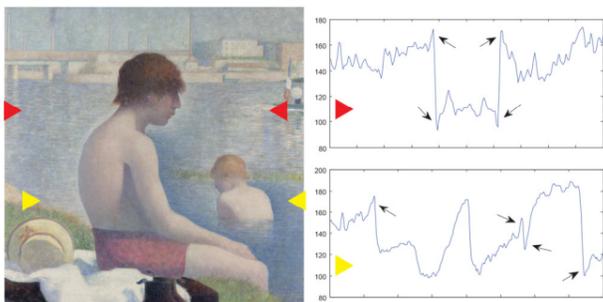
with Tania Pouli, Erik Reinhard & Hans-Peter Seidel



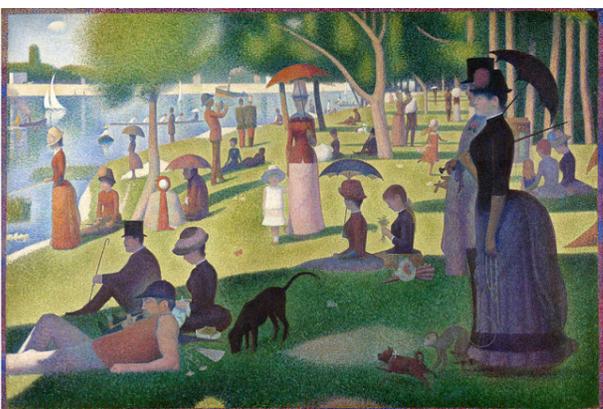
The contrast of photographs or rendered images is commonly enhanced to increase the image's visual appeal. Normal computer science approaches take no account of image content. In artwork, spatial configurations are used to increase apparent contrast. We have a spatially aware contrast enhancement algorithm, which uses image structure to hide the countershading profiles. We can achieve enhancements that better match the countershading used by artists, with no loss of contrast compared to traditional contrast enhancement techniques.

Countershading in art

Artists like Seurat make effective use of countershading, embedding shading variations such that they give the impression of increased contrast.



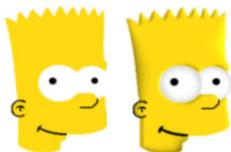
The graphs show two shading profiles, between the corresponding triangles on the image. Black arrows indicate where the artist produces profiles similar to those in the Cornsweet effect.



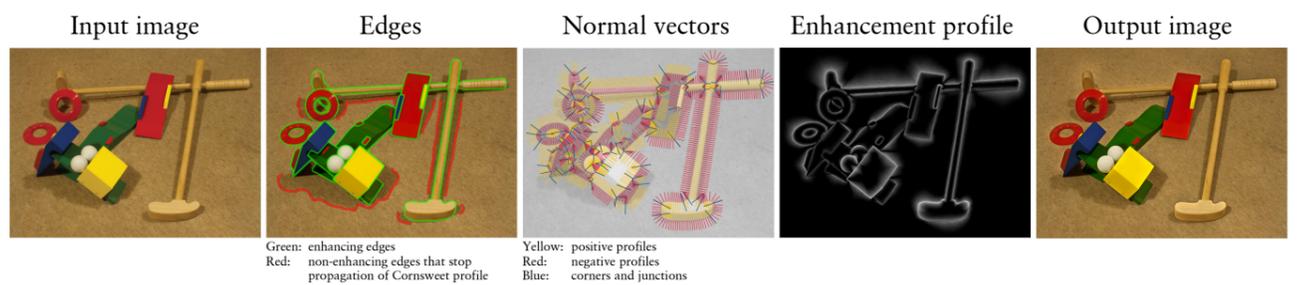
The strength of the enhancement can be related to the width of the countershading profile so that the result is an image with no objectionable artifacts and with increased contrast. Artists often apply shading in their paintings that resembles countershading. However, they vary the extent of their countershading to coincide with content elsewhere in the painting, thus embedding countershading into the image that is less obvious but still produces high edge contrasts.

Other applications

As well as improving images, countershading may be an appropriate alternative to existing methods of adding 3D-like effects to cartoons.



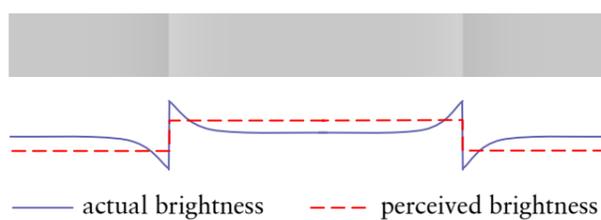
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From artistic inspiration to implementation

Implementation needs high-level image processing that is difficult to achieve with filter-based approaches or with previous image-based techniques. We therefore investigated vectorising the image, allowing us to produce spline-based countershading profiles that can be applied to the image. Adaptively extending the profiles, as far as the image content allows, means we can maximise the embedding of the profiles and thereby improve local contrast while avoiding the introduction of artefacts.

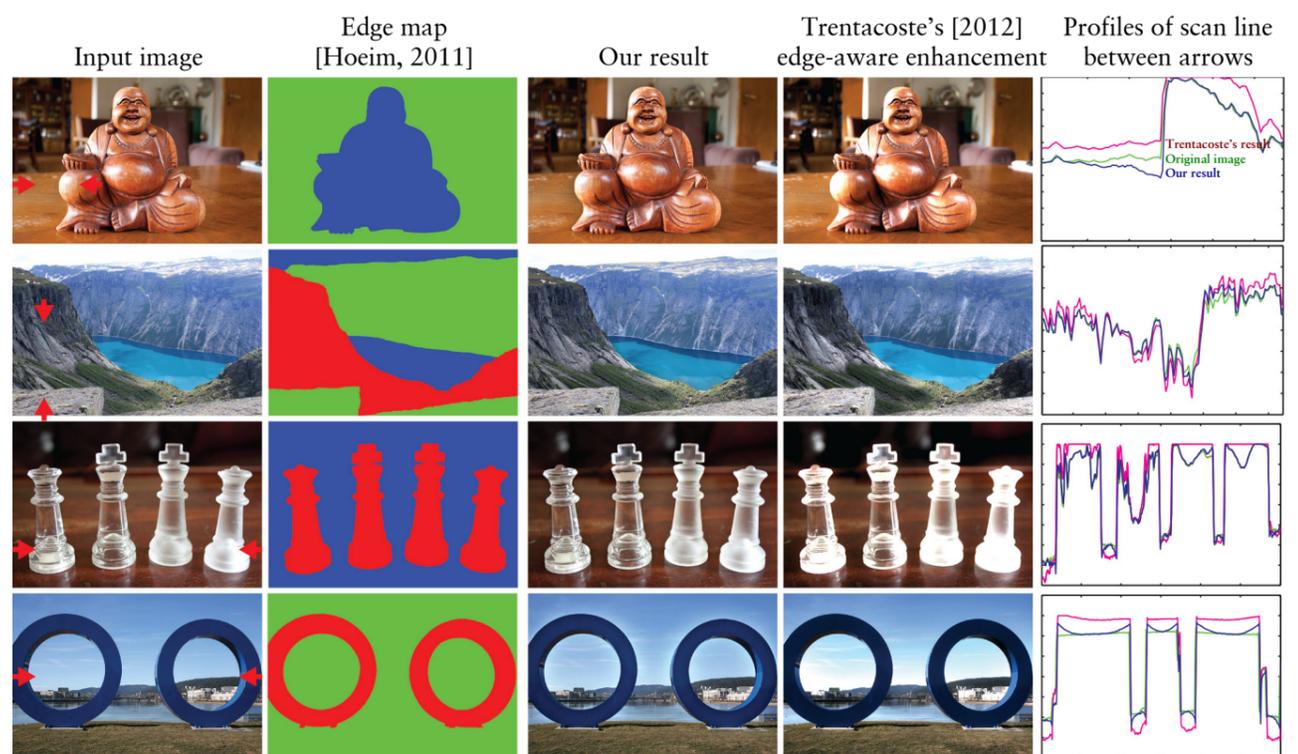
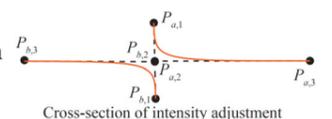
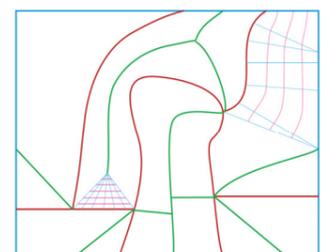
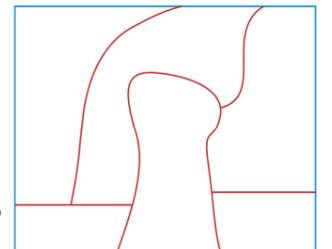
Cornsweet profiles



Cornsweet demonstrated that an appropriate increase or decrease in actual brightness immediately next to an edge dramatically increases a human's perception of the edge. We take advantage of this psychophysical effect in our countershading profiles. In the above example the centre of the bright bar is the same actual intensity as the outside ends of the dark bars.

Algorithm

1. Find the key edges in the image, either manually or by an automatic edge-finder.
2. Convert these edges to cubic B-spline curves.
3. Segment the image into a collection of non-overlapping regions bounded by cubic B-spline curves (red and green lines). Produce B-spline patches in each region (two example patches shown with cyan and magenta parameter lines).
4. Determine an appropriate countershading profile in each region, using B-spline patches to encode the intensity adjustments.
5. Apply the countershading to the image, using a measure of the texture density to further enhance contrast in regions of heavy texture.



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