Sharpness detection module

Overview

A software module for automatically estimating the level of sharpness of video and assessing whether video has been upscaled. The detector measures the actual sharpness of the content, relative to the nominal video/movie resolution.

It can be used for example to

- detect production insufficiencies, e.g. un-sharp video/film content due to lens out of focus,
- detect if content has been up-scaled from standard definition to high definition video,
- monitor the film scanning process for out of focus quality control.

In depth description

Sharpness is a measure of how well in focus an image appears. No-reference sharpness metrics are required for applications such as the detection of production insufficiencies, e.g. un-sharp video/film content due to lens out of focus, the decision if content can be up-scaled from low to high resolution with certain quality demands in high resolution, e.g. does SD video contain sufficient resolution to be up-scaled for HD broadcast, or to determine if video has been up-scaled from SD to HD.

The sharpness/up-scale detector uses as basic feature the spread of edges detected by a Sobel filter for both derivatives. Thus, all significant edges that are spread approximately horizontally or vertically, covering a tolerance angle, are extracted.

For each pixel the image gradient magnitude is calculated and an adaptive threshold is applied. The adaptive threshold leads to a focus on edges with high gradient magnitude (in relation to the magnitude mean). Then a thinning process is performed in order to get a binary edge image, in which the measuring points for our metric are set. At every measuring point the edge width is defined by the pixels between the local minimum and maximum along the gradient, perpendicular to the edge.

In order to enhance the precision of the local extrema estimation, we add a sub-pixel accurate approximation of the local extrema by an interpolated polynomial. Motivated by the observation that the human visual system (HVS) perceives edges with high contrast as sharper, we refine our metric by decreasing the measured edge width in proportion to the slope. In a next step, the image is divided into blocks in order to deduce local sharpness values. For each block a representative edge width is calculated by averaging all measured edge widths within this block.

Finally, the overall image sharpness is calculated statistically from the block sharpness values, where only the most significant blocks are taken into account. Figure 4a illustrates the local block-wise sharpness estimation, and shows the sharpness of the most significant blocks in shades of red. Focusing on the sharpest blocks is helpful for images with e.g. out-of-focus regions. The measure expresses to which extent the actual video resolution exploits the nominal video resolution, or in other words how sharp the video content is.

This approach is characterized by its simplicity and low computational complexity, enabling real-time performance for SD resolution. Simultaneously it makes sharpness and blur estimation feasible. Our sharpness metric shows significantly less variation due to image content than state of the art work.

Figure 6. Localised block-based sharpness estimation, the intensities of the red blocks in the left image correspond to the measured sharpness of the underlying image block

Potential fields of Application

Visual quality analysis for production, playout and archiving/preservation.

Possibilities for exploitation

The software module is available to end users as part of the VidiCert video quality analysis software.

Further Information

TOSCA-MP public deliverable D2.3 Metadata Extraction, Enrichment and Linking V3 (March 2014)

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