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SPATIO-TEMPORAL MASKING IN HUMAN VISION AND ITS APPLICATION TO IMAGE CODING

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12a. DISTRIBUTION / AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Before an image is stored or transmitted, we have access to the original and the distorted versions. The enhanced codec is compared to the original block by block to determine which blocks have been improved by the enhancement. These blocks are then flagged for post-processing in a way that is compliant with the JPEG standard and adds nothing to the compressed image's bandwidth. The end result is a compressed image that can be decompressed on any standard JPEG decompressor, but that can be enhanced by a sophisticated decompressor.

For the comparison of the original and enhanced images, we have been developing a new vision model that is specifically tailored to the detection of errors that occur within or between two JPEG codec blocks. Previous filter models have been restricted from using a large number of filters due to computational constraints which we avoid by focusing the model on a tiny spatial area of 8x16 pixels. Further, features of human vision that have been included in previous models (color, temporal, stereo etc.) are not needed for this more focused problem. Issues that have not been completely addressed by previous models, such as masking effects, are tractable and the model is more applicable to JPEG compression.

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Final Progress Report

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2. Objectives

As previously described

3. Status of the effort

We have developed a system for compressing and restoring images that is compatible with the JPEG picture compression standard. Direct application of traditional image enhancing techniques fails to utilize a unique feature that can be exploited when working with digital compression: before a JPEG image is stored or transmitted, we have access to the original (figure A) and the distorted versions (figure C). Enhancement can be selectively applied and assessed, and successful enhancement instructions can be included with the image file. Image blocks are flagged for post-processing with a parity adjusting system that is compliant with the JPEG standard and adds nothing to the compressed images' bandwidth. The end result is a compressed image that can be decompressed on any standard JPEG decompressor (figure D), but that can be enhanced by a sophisticated decompressor (figure B) that makes use of the "hidden flags".

To assess the success of the enhancement instructions, we have developed a new model of human vision. Our model is particularly well suited to detecting errors inside and between JPEG image blocks. Previous filter models have been restricted from using a large number of filters due to computational constraints, which we have avoided by focusing the model on a tiny spatial area of 8x16 pixels.

4. Accomplishments / New Findings

The Regents of the University of California have applied for a U.S. Patent on the invention and are seeking licensees to commercialize this methodology. The model has broad applications in image quality assessment as well.
In addition to the research, we developed computer software for psychophysical testing and vision model development that will be useful for other researchers. Amnon Silverstein is presently preparing this software for distribution to other laboratories.

5. Personnel Supported

Amnon Silverstein

6. Publications

D. A. Silverstein, S. A. Klein "Precomputing and encoding compressed image enhancement instructions" [In review for IEEE transactions on image processing]

D. A. Silverstein, "A DCT image fidelity metric and its application to a text-based scheme for image display" SPIE Human Vision, Visual Processing, and Digital Display III, Ed, Rogowitz & Allebach Vol.1913, pp.229-239,1993

D. A. Silverstein, S. A. Klein "Restoration of compressed images" SPIE Image and Video Compression Vol. 2186, 56-64, 1994

S. A. Klein, D. A. Silverstein & T. Carney "Relevance of human vision to JPEG-DCT compression" SPIE Human Vision, Visual Processing, and Digital Display III, Ed, Rogowitz & Allebach Vol. 1666, 200-215, 1992

7. Interactions/Transitions

Our new vision model was presented at the ARVO conference in Sarasota, May 17 1995. Abstract 2142-109, "Can an Oriented-Filter Model Predict the Detectability of Spatially Local Stimuli?"

Our image compression and enhancement work was presented at the SPIE conference in San Jose, 1994 "Restoration of compressed images"

Both of these topics were presented at a talk in Hewlett Packard Laboratories in Palo Alto, July 1995 to Dr. Joyce Farrell's Photographic Image Quality group and the Image Technology research group.

Amnon Silverstein became an employee at Hewlett Packard Labs in Palo Alto August 1, 1995. He has been incorporating the knowledge and techniques developed from his work in this project to picture quality and printing issues. He is further developing the vision model for application to halftone design and assessment. He is also designing new methods for utilizing JPEG image compression for printed images.

8. Patent Disclosure

We have filed a disclosure for a patent through the University Office of Technology Licensing, Attorny's Docket No. 028726-009 "Precomputing and encoding compressed image enhancement instructions"