

ERCIM “Alain Bensoussan” Fellowship Scientific Report

Fellow: Zhenzhong Chen
Visited Location : Institut National de Recherche en Informatique et en Automatique
(INRIA), Rennes, France.
Duration of Visit: 10/09/2007-09/09/2008

I - Scientific activity

During my ERCIM fellowship program at INRIA TEMICS group, my research is mainly in the area of perceptually-friendly video coding. This work aims to model the relationship between the visibility threshold and the human visual system and exploit its application in video compression.

In addition to the redundancy of the visual signal statistical correlation, the perceptual redundancy should be exploited to provide perceptual-friendly visual signal representation. Due to the spatial and temporal masking effects, the human visual system has the limitation on the perceptibility of certain levels of noise. Since the human visual system is space-invariant where the fovea has the highest density of sensor cells on the retina, the visual acuity decreases with increased eccentricity relative to the fovea. Together with Dr. Christine Guillemot, we investigate a foveated just-noticeable-distortion (JND) model. The traditional JND methods exploit the visibility of the minimally perceptible distortion but assume the visual acuity is consistent over the image. A foveation model is incorporated with the spatial and temporal JND profiles. A foveated JND model is developed by combining the spatial JND as a function of luminance contrast and spatial masking effect, the temporal JND to model the temporal masking effect, and a foveation model to describe the relationship between the visibility threshold and eccentricity relative to the fovea. Associated with the proposed foveated JND model, more imperceptible distortion can be tolerated in the contaminated image.

We apply the foveated JND model for H.264/AVC video coding. The macroblock bit allocation and rate-distortion optimization are proposed according to the foveated JND profile. The regions with higher visibility thresholds are coded with larger quantizers since these regions can tolerate higher distortion. The saved bit rate can be used to improve the quality of the regions which cannot tolerate high distortion. Therefore, the subjective quality of the whole image is improved. The performance of the foveated JND model is demonstrated with the subjective tests which follow the corresponding protocols in Rec. ITU-R BT.500.

This work was done in cooperation with the scientific contact at INRIA, Dr. Christine Guillemot. Several papers are in preparation. Future collaborations will be extended.

II- Publication(s) during your fellowship

Journal Paper:

1. Zhenzhong Chen and Christine Guillemot, "Foveated just-noticeable-distortion profile and its applications in video coding," in preparation.

Abstract

N.A.

Conference Paper:

1. Zhenzhong Chen, "A rate and distortion analysis for H.264/AVC video coding," IEEE International Symposium on Circuit and Systems, Seattle, WA, US, May 18-21, 2008.

Abstract

This paper addresses the rate and distortion analysis problem in H.264/AVC video coding. It is well known that such an analysis is important in video coding. Exploring the relationship between the quantization and rate-distortion information of video signal can assist with the control strategies in the coding process. A novel algorithm of the rate and distortion analysis for H.264/AVC video coding is presented. The rate and distortion characteristics of video signal are approximated and estimated using statistical learning. When compared to traditional methods, the proposed method provides better approximation and estimation accuracy for the rate and distortion analysis in H.264/AVC video coding.

2. Zhenzhong Chen and Christine Guillemot, "Perceptually-friendly H.264/AVC video coding," to be submitted.

Abstract

This paper presents a perceptual H.264/AVC video coding method based a foveated just-noticeable-distortion (JND) model. Since the perceptual acuity decreases with the increased eccentricity, a foveation model is developed to further explore the perceptual redundancy in addition to the spatial and temporal just-noticeable-distortion profiles. Bit allocation and rate-distortion algorithms based on the foveated JND model are proposed. The performance of the foveated JND model is assessed with subjective visual tests. Applying the proposed model in H.264/AVC video coding can achieve better visual quality.

III -Attended Seminars, Workshops, and Conferences

Seminar:

I was invited to present my research working in following seminars:

1. "Visual attention based video object coding", Oct. 10, 2007, INRIA/IRISA, jointly with Thomson R&D, Rennes, France.
2. "Saliency based video coding," Jan. 11, 2008, University of Nantes, Nantes, France.
3. "Visual attention based video coding," July 10, 2008, Université catholique de Louvain (UCL), Louvain, Belgium.

I also attended following seminars at INRIA/IRISA, Rennes, France:

1. "Error Correction and Encryption: Can they be combined?" Oct. 4, 2007, by Prof. K.P. Subbalakshmi from Stevens Institute of Technology, USA.
2. "Fast greedy algorithms for sparse approximation," Nov. 29, 2007, by Dr. Mike Davies from University of Edimburgh, UK.

3. “Provably efficient algorithms for Compressed Sensing, ” June 26, 2008, by Dr. Thomas Blumensath, from University of Edimburgh, UK.

4. Mini-Workshop on Images, databases, randomness and sparse representations, May 29, 2008.

1) Joint Image Compression and Description Using Sparse Decompositions

Authors: Joaquin Zepeda, Ewa Kijak and Patrick Gros

2) On finding approximate nearest neighbours in a set of compressible signals

Authors: Philippe Jost and Pirre Vandergheynst (From EPFL, Swithlands.)

3) NV-tree: An Efficient Disk-Based Index for Approximate Search in Very Large High-Dimensional Collections

Authors: Herwig Lejsek, Friðrik Heiðar Ásmundsson, Björn Þór Jónsson, and Laurent Amsaleg

Conference:

I attended following conferences to present my research work during the fellowship program:

1. IEEE International Symposium on Circuit and Systems, Seattle, WA, US, May 18-21, 2008.

2. Picture Coding Symposium, Lisbon, Portugal, Nov. 6-9, 2007.

IV – Research Exchange Programme (12 month scheme)

Thanks to ERCIM fellowship exchange programme, I visited Prof. Christophe Devleeschouwer (UCL, FNRS, Belgium) during July 7-11, 2008. I was invited to give a seminar, had meetings with researchers and students in Prof. Christophe’s group, exchanged ideas with them and discussed future collaborations.