**Guest editorial: Image/Video Quality and System Performance**

Dr. Mohamed-Chaker Larabi

Université de Poitiers, XLIM Signal Image and Communication dept.

France

chaker.larabi@univ-poitiers.fr

Dr. Sophie Triantaphillidou

University of Westminster, Faculty of Media, Arts and Design

UK

[triants@wmin.ac.uk](mailto:triants@wmin.ac.uk)

Dr. Andrew B. Watson

NASA Ames Research Center,

USA

andrew.b.watson@nasa.gov

Swift developments in display technologies, digital printing, imaging sensors, image processing and transmittance are enabling new possibilities for creating and conveying visual content. In an age where images and video are overwhelmingly present and where mobile, satellite and 3D imaging have become ordinary experiences, the quantification of the performance of modern imaging systems requires adapted approaches. At the end of the imaging chain, it is most often a human observer who decides whether images and video are of a satisfactory visual quality. The perceived quality contemporary imaging conveys, its measurement and modelling is hence of crucial importance, not only in visual arts and commercial applications, but also in scientific and entertaining environments. Advances in our understanding of the Human Visual System workings offers new possibilities for creating visually superior imaging systems and the potential for more accurate modelling of the produced image quality. As a result, there is a wealth of research around imaging performance and perceived quality.

During the last decade, an important research effort has been produced in order to understand and model the human’s visual attention. This resulted in several computational saliency models trying to find the most attractive objects thanks to image/video characteristics. The existing models are either low-level features oriented (bottom-up) or task oriented (top-down). However, most of the models belong to the former approach and only few tentatives have been done following the latter one. The interest for such models can be explained by the potential optimization that can obtained when the salient area are known. This undoubtedly help for preserving the quality of some of the scene objects when applying some processings like compression, watermarking, transmission and so on. Moreover, the performance of image processing algorithms and the quality of experience linked to them, are fundamentally associated with the salient information. Impairments falling in the salient areas will have a more important impact on the QoE than on un-salient ones.

Quality assessment has been a challenge in the last decade and many issues are still open in this field. To date, an impressive number of full reference metrics dedicated to images have been developed. Many of them are well correlated to human judgment in the framework of multimedia applications. However, only few tentatives have tackled the blind (no reference) or semi-blind (reduced reference) image quality assessment. First, because these type of metrics are highly dependent upon the impairment type. Then, it is always difficult to select side information that are both reduced and efficient in gathering the reference information of the pristine image. These problems are tenfold when dealing with video content, where the temporal variation of both content and quality makes the scope very different from the image one. Furthermore, with the advent of new technologies like 3D or multiview, quality is facing new challenges since the intervention of the visual perception is exacerbated. Moreover, depth has not be considered as only an additional dimension but as a feature changing the full interpretation of a scene. Therefore, the research community has to improve its understanding of the binocular vision mechanisms such as the binocular rivalry, suppression and fusion, in order to be able to predict the perceptual impact of the various impairments.

High dynamic range is foreseen to be the next stage of multimedia imaging. It allows to outstrip the problems caused by tone mapping operators and other processings. However, as a new technology, there are no clues about how to assess the quality of images/video having this wide dynamic. An important research effort is expected in the next few year to understand and develop tools and quality metrics fulfilling the challenges of the quality of experience.

This special section presents some of the recent advances in image and video quality assessment and system performance with applications to multimedia, consumer camera, image and video coding, and other related topics. The papers of this special section can be grouped into four categories, according to the addressed subject.

# The first category addresses image and video quality metrics. First, (061106) a psychometric study evaluates a number of no-reference image quality metrics, based on natural scene statistics, which were previously shown to predict successfully the subjective quality of digital image processing algorithms. The best performing metrics, BIQI and NIQE, are shown to perform equally well on two tests with four printed images and different graded papers, whilst NIQE is also robust to scene content variations. (061114) In the second study concerned with the metrication of image quality, a no-reference image quality metric that uses image features derived from the image’s contourlet transform to obtain structural image information and singular-value decomposition is proposed. The advantage of the metric is that it does not require training or learning and is shown to deliver predictions that correlate highly with human observations. Finally, multimodal quality assessment is very important since it corresponds to the real-life experience with visual content. Despite, the relevance of this field, few approaches have been proposed in the literature. One contribution (061108) of this special section is addressing this problem by running psychophysical experiments to help in understanding the interaction existing between audio and video. Based on their subjective findings, authors propose objective metrics combining in various ways audio and video quality.

# The category of visual saliency and attention is tackled by three papers in the issue. In the first (061113), the problem of saliency detection was approached by selecting image features from multiple image views with different contributions. A multimanifold ranking algorithm determining final saliency is presented and tested using qualitative and quantitative comparisons and different image databases. In the second (061107), a number of full-reference video quality metrics were assessed with and without the incorporation of visual saliency models. It is shown that, overall, computational models of attention benefit all selected metrics, but predominantly those designed to predict spatial degradations. Finally, authors of the third paper (061103) explored two different visual tasks related to quality i.e. quality estimation and difference estimation. Eye-tracking results showed a different strategy for each of the tasks. Visual characteristics (e.g. fixations) are different in position, duration and role, leading to the conclusion that instructions may might have a noticeable influence on the used strategy.

# 

The third category related to image and video coding is the focus of attention of an important research effort. In **(061110)**, authors propose an optimized parallel implementation of the DCT transform using OpenCL (open computing language). The results show interesting speed-up factors in heterogeneous environments. Authors of **(061112)** propose a Wyner-Ziv video coding scheme with low bit-rate fluctuations based on a symmetric coding structure. The bit-rate stability is seen as a great advantage for many applications with constrained communication bandwidth. Recently, a joint effort between ITU and ISO allowed the development of a new video coding standard called HEVC (high efficiency video coding) based on a quadtree structure to provide variable transform sizes in the transform coding process. Authors of **(061105)** propose a similarity-check scheme to efficiently reduce the Transform Unit (TU) candidate modes. The proposed optimisation allowed an important saving of the TU encoding time for almost invisible impairments. Finally (061114), the effect of coding and transmission is evaluated on the performance of a state-of-the-art pedestrian detection algorithm. “quality aware” spatial image statistics are used to blindly categorize distorted video frames by distortion type and level in a blind way.

**(061111)** In a paper concerned with feature subsets that predict image quality of consumer cameras,the authors have used the new CID2013 large database with consumer camera photographs, to classify images using principal component analysis. Images were classified in terms of sharpness and noise energy, with the sharpness dimension including lightness, resolution and contrast. A feature subset model is proposed that predicts successfully human observations. (061102) The second paper proposes a benchmark in order to solve the problem of quality and speed metrics combination for mobile phone camera evaluation.

Vergence-accommodation conflict has been studied for 3D in order to understand the accumulation of visual fatigue. Authors of **(061109)** investigated this conflict for Holographic stereograms showing that improved full-parallax holographic stereogram can control the focusing depths of points and guarantee consistency between the vergence and accommodation distances.

Several people deserve to be acknowledged for the success of this special section. We would like to thank authors for submitting their high quality papers, and reviewers, for dedicating their time and expertise to selecting the best papers for publication. Special thanks go to the Editor-in-Chief, Dr. Gaurav Sharma, and the editorial staff for their full support throughout the process of this special section.

Biographies

Mohamed-Chaker Larabi received his PhD from the University of Poitiers (2002). He is currently the associate professor in charge of the perception, color and quality activity at the same university. His actual scientific interests deal with image and video coding and optimization, 2D and 3D image and video quality assessment, and user experience. Chaker Larabi is a member MPEG and JPEG committee (since 2000), and chair of the Advanced Image Coding group and, the Test and Quality SubGroup. He serves as a member of divisions 1 and 8 of CIE, is a member of IS&T, and a senior member of IEEE. He is involved in many local, regional, national and international projects.

Sophie Triantaphillidou is an Associate Professor in Imaging Science and the Director of the Imaging Technology Research Group of the University of Westminster, UK. She received her PhD from the University of Westminster in Imaging Science in 2002. She has published over 40 papers relating to imaging system performance, image quality and human vision and is the co-editor and a main contributor of the 10th edition of Manual of Photography, published by Focal Press in 2010. She has been the co-chair of the SPIE/IS&T Electronic Imaging: Image Quality and System Performance conference since 2012 and has been involved in several national and international programme committees relating to Imaging. She was the recipient of the Davis Medal of the Royal Photographic Society in 2012, awarded for her contributions to digital imaging science.

Andrew B. Watson is the Senior Scientist for Vision Research at NASA Ames Research Center in California. He was an undergraduate at Columbia University, received his PhD in Psychology from the University of Pennsylvania, and did postdoctoral work at the University of Cambridge in England. He is the author of over 100 papers and seven patents on topics in vision science and imaging technology. In 2001, he founded the Journal of Vision (http://journalofvision.org) where he served as Editor-in-Chief. Dr. Watson is a Fellow of the Optical Society of America, of the Association for Research in Vision and Ophthalmology, and of the Society for Information Display. He is Vice Chair for Vision Science and Human Factors of the International Committee on Display Measurement. In 2007 he received the Otto Schade Award from the Society for Information Display, and in 2008 the Special Recognition Award from the Association for Research in Vision and Ophthalmology. In 2011, he received the Presidential Rank Award from the President of the United States.