

**Proposal for a Half Day Tutorial
at the 15th IEEE International Symposium on Signal Processing and
Information Technology**

ISSPIT 2015

December 7-10, 2015, Abu Dhabi, UAE

Half day tutorial:

Presenters:

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Affiliations:

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Topic overview

Title: Design and Implementation of Advanced Video imaging systems

This tutorial will focus on the design and implementation of imaging systems on field programmable gate arrays (FPGAs). We will address different software and hardware issues related to the implementation of algorithms used in applications such as biometrics, medical imaging and video coding. Hardware compilation, partial dynamic reconfiguration and design partitioning for reconfigurable hardware will be also covered, looking at different aspects of: optimisation, code generation and configuration. The tutorial will review the latest FPGA technologies and development methods for imaging systems, including the Zynq System on Chip (SoC) platform, and will conclude with comprehensive case studies demonstrating the deployment of low power reconfigurable architectures for algorithms acceleration and performance evaluation methods for embedded imaging systems. Emphasis will be also on the latest video coding techniques. Different main blocks of H.265/MPEG-HEVC, referred to as High Efficiency Video Coding (HEVC) along with their complexities will be detailed. The potential of parallelism and complexities reduction methodologies will be explained. In addition, the video quality enhancement techniques will be explained in the context of Quality of experience.

Target audience

- What prior knowledge?
image processing, computer hardware and C programming
- What will the participants learn?
Design, implementation and evaluation techniques and tools, video and imaging algorithms and applications, reconfigurable computing
- How many participants do you expect?
Approximately 30 - 40

Content details

❑ Introduction to Imaging Systems

- Theory and Concepts
- Algorithms and Applications

❑ Video Coding

- Video coding standards
- Main blocks of latest standards
- Complexity analysis and reductions
- Potential Parallelism
- Quality enhancement

❑ Reconfigurable Computing for Imaging Systems

- FPGA Technology and Architectures
- FPGA programming tools
- FPGA platforms for DSP and Imaging

❑ FPGA Design Methodologies and Optimization Techniques

- FPGA Programming Tools
- Hardware/Software Co-Design
- Partial Dynamic Reconfiguration
- Architectures using Distributed Arithmetic and Systolic Design
- FPGA Implementation, Power Optimization, and Performance Evaluation

❑ Examples and Demos

- Medical Imaging: De-noising and segmentation
- Biometrics
- Video Processing

❑ Conclusions, Q&A

Format

Power point (PPT) slides, videos and demos will be presented in this tutorial to illustrate different steps for the design and implementation of imaging systems on reconfigurable hardware.

Presenters' expertise

Prof. Abbas Amira received his Ph.D. in the area of Computer Engineering from Queen's University Belfast in 2001, United Kingdom, developing a coprocessor for matrix algorithms using reconfigurable computing for image and signal processing applications. Prof. Amira took academic and consultancy positions in the United Kingdom and overseas, including his current positions as a Professor in Computer Engineering at Qatar University, Qatar and a full professor in visual communications and leader of the Visual Communication Cluster at the University of the West of Scotland (UWS), UK. He took other academic positions at the University of Ulster-UK, Qatar University-Qatar, Brunel University-UK and Queen's University Belfast-UK.

He has been awarded a number of grants from government and industry and has published more than 200 publications in the area of reconfigurable computing, image and signal processing during his career to date. He has successfully supervised 13 PhD students under his supervision in the area of image processing and reconfigurable computing.

He has been invited to give talks, short courses and tutorials at universities and international conferences and being chair, program committee for a number of conferences. He was one of the tutorials presenters at IEEE International Conference on Image Processing ICIP 2009, Chair of ECVW 2011, Program Chair of ECVW2010, Program Co-Chair of ICM12, DELTA 2008, IMVIP 2005. He is the general conference Co-Chair for ICM 2014. He contributed as program committee member to many conferences in the areas of image and signal processing, reconfigurable computing, embedded systems and connected health. He a member of the IEEE Technical Committee for Biomedical Circuits and Systems.

He is also one of the 2008 VARIAN prize recipients. He has been a PhD external examiner for Trinity College Dublin, Edinburgh, Southampton and many other Universities in UK,

Hong Kong, Australia and Finland. Prof. Amira was one of the guest editors for the Special Issue in the Pattern Recognition Journal, titled "Feature Generation and Machine Learning for Robust Multimodal Biometrics", March 2008.

He took consultancy positions with many companies in UK, and he holds a visiting professor position at University of Tun Hussein Onn, Malaysia. Previously, he was visiting Professor with the University of Nancy, Henri Poincare, France. He is a regular referee for many national and international funding bodies, including (EPSRC and QNRF) and he sits on the international advisory boards for some international research centers. He is a Fellow of IET, Fellow of the Higher Education Academy, Senior member of the IEEE, and Senior member of ACM. His research interests include: embedded systems, high performance reconfigurable computing, image and video processing, multi-resolution analysis, biometrics and connected health applications.

Dr. Naeem Ramzan (S'04-M'08-SM'13) has over 10 years of experiences in the field of video processing and communications. Before joining University of West of Scotland (UWS), he was senior fellow researcher and Lecturer (Assistant Prof.) at Queen Mary University of London. He is currently a Reader in Visual Communication in UWS. He has investigated/co-investigated/participated several projects funded by EU and UK research councils. Dr Ramzan received his M.Sc. in telecommunication from University of Brest, France and PhD in electronic engineering from Queen Mary University of London in 2004 and 2008 respectively. He has authored or co-authored of over 80 research publications including journals, book chapters and standardised contributions. He edited the book on "Social Media Retrieval" in Springer, 2013. He is Co-Editor-in-Chief of the VQEG E-letter. I served as Guest Editor in Signal Processing Image Communication Journal and IEEE COMSOC MMTC E-letter.

He organised and co-chaired of three ACM Multimedia workshops and served as session chair/co-chair in number of conferences including IEEE ICM, IEEE ICECS and ACM Multimedia. He has been invited to give talks and tutorial in different UK universities. He has served the programme committee member of number of conferences including ICIP from last five years.

He has been part of standardisation bodies like MPEG, and VQEG. He is a Co-chair of MPEG High Efficiency Video Coding (HEVC/H265) Verification Group (AHG5), Co-chair of VQEG Ultra High Definition group and a member of British Standard Institution (BSI). He is Senior Member of IEEE, fellow of Higher Education Academy, UK, member of IET, member of IEEE Comsoc and IEEE signal processing society. His research interest includes Image/Video Processing, 2D/3D Video Transmission, Social Media Distribution,

Quality of Experience of 2D/3D videos with sensory devices, Health monitoring environment, and Surveillance centric processing.

Recent related publications (Selected)

1. H. Rabah, A. Amira, B.K. Mohanti, S. Almadeed, P.K. Meher "FPGA implementation of orthogonal matching pursuit algorithm for compressive sensing reconstruction", IEEE Transactions on VLSI, Issue 99, 2014.
2. N. Almaadeed, A.Amira, A. Aggoun "Speaker Identification using Multimodal Neural Networks and Wavelet Analysis" IET Biometrics pp 18 – 28, March 2015.
3. B. K. Mohanty, P. K. Meher, S. Al-Maadeed, and A. Amira "Memory Footprint Reduction for Power-Efficient Realization of 2-D Finite Impulse Response Filters", IEEE Transactions on Circuits and Systems—I: REGULAR PAPERS, VOL. 61, No. 1, January 2014.
4. J.S.S.Kutty, F.Boussaid, A.Amira "A High Speed Configurable FPGA Architecture For Bilateral Filtering" The International Conference on Image Processing (ICIP), 27-30 October 2014, Paris, France.
5. A. Ahmad, A. Amira, H. Rabah and Y. Berviller, "Medical Image Denoising on FPGA using Finite Radon Transform", *IET Image Processing – Volume 6, Issue 9*, pp. 862 – 870, December 2012.
6. T. Jaber, A.Amira and P. Milligan, "An Enhanced Approach for Latent Semantic Indexing Using Multiresolution Analysis" IET Image Processing, Volume. 6, Issue. 9, pp. 1236–1245, December 2012.
7. B. Krill, A. Ahmad, A. Amira, H. Rabah, "An efficient FPGA-based dynamic partial reconfiguration design flow and environment for image and signal processing IP cores", *Signal Processing: Image Communication*, Volume 25, Issue 5, 2010, Pages 377-387, ISSN 0923-5965
8. A. Ahmad, B. Krill, A. Amira, H. Rabah, "Efficient architectures for 3D HWT using dynamic partial reconfiguration", *Journal of Systems Architecture*, Volume 56, Issue 8, 2010, Pages 305-316, ISSN 1383-7621
9. M. Guarisco, H. Rabah, A. Amira, "Dynamically reconfigurable architecture for real time adaptation of H264/AVC-SVC video streams," *Computer Vision and Pattern Recognition Workshops (CVPRW)*, 2010 IEEE Computer Society Conference on , vol., no., pp.39-44, 13-18 June 2010 doi: 10.1109/CVPRW.2010.5543764
10. A. Ahmad, A. Amira, P. Nicholl, and B. Krill "FPGA-based Implementation of Constructing Feature Vectors for Face Recognition using DWT", *Springer Journal of*

- Real-time Image Processing – Special Issue Real Time Biometrics and Secure Media, September 2011.
11. P. Nicholl, A. Ahmad, A. Amira "A Novel Feature Vectors Construction Approach for Face Recognition" Transactions on Computational Sciences, Special Issue on Security in Computing, LNCS 6480, pp.223-248, 2010.
 12. S. Chandrasekaran, A. Amira, A. Bermak and M. Shi "An Efficient VLSI Architecture and FPGA Implementation of the Finite Ridglet Transform" Journal of Real-Time Image Processing, Vol 3, No 3, pp 183-193, September 2008.
 13. M. Shi, A. Bermak, S. Chandrasekaran, A. Amira and S. Brahim-Belhouari, "A Committee Machine Gas Identification System Based on Dynamically Reconfigurable FPGA" the IEEE Sensors Journal, Vol. 8, No. 4, April 2008.
 14. D. Bouchaffra and A. Amira, "Structural Hidden Markov Models for Biometrics: Fusion of Face and Fingerprint" Pattern Recognition Vol. 41, No. 3, pp 852– 867, March 2008
 15. P. Meher, S. Chandrasekaran and A. Amira "FPGA Realization of FIR Filters by Efficient and Flexible Systolization Using Distributed Arithmetic" IEEE Transactions on Signal Processing, Vol. 56, No. 7, pp. 3009-3012, July 2008.
 16. T. K. Tan, R. Weerakkody, M. Mrak, Naeem Ramzan, V. Baroncini, G. J. Sullivan, J.-R. Ohm and K. D. McCann, "Video Quality Evaluation Methodology and Verification Testing of HEVC Compression Performance", To appear in IEEE Trans. Of Circuit and System for Video Technology.
 17. Ahmad Alzubi, Abbas Amira, and Naeem Ramzan, "Semantic Content-Based Image Retrieval: A Comprehensive Study", Journal of Visual Communication and Image Representation, Vol. 32, pp. 20–54, Oct. 2015.
 18. T. K. Tan, M. Mrak, R. Weerakkody, Naeem Ramzan, V. Baroncini, G. J. Sullivan, J.-R. Ohm and K. D. McCann, "HEVC Subjective Video Quality Test Results", IET Journal the Best of IET and IBC, Vol. 6, pp. 59-64, 2014.
 19. M Pinson and Naeem Ramzan, "Best Practices for Multimedia Quality Evaluation Training Sessions" VQEG eLetter, Vol. 1, Issue 1, Pages 2-5, 2014.
 20. Naeem Ramzan, Hyunggon Park, Ebroul Izquierdo, "Video Streaming over P2P Networks: Challenges and Opportunities", in ELSEVIER Journal of Signal Processing: Image Communication, Vol. 27, Issue 5, pp. 401-411, May 2012.
 21. Jong-Seok Lee, Francesca De Simone, Naeem Ramzan, Ebroul Izquierdo, and Touradj Ebrahimi, "Quality assessment of multidimensional video scalability", in IEEE Communication Magazine, Vol. 50, No. 4, pp. 38-46, 2012.

22. Stefano Asioli, Naeem Ramzan, Ebroul Izquierdo, "A Game Theoretic Approach to Minimum-Delay Scalable Video Transmission over P2P" in *ELSEVIER Journal of Signal Processing: Image Communication*, Vol. 27, Issue 5, pp. 513-521, May 2012.
23. Naeem Ramzan, Emanuele Quacchio, Toni Zgaljic, Stefano Asioli, Luca Celetto, Ebroul Izquierdo, Fabrizio Rovati, "Peer-to-peer Streaming of Scalable Video in Future Internet Applications", *IEEE Communication Magazine*, vol. 49, Issue 3, pages 128–135, March 2011.
24. Naeem Ramzan, "Scalable and Adaptable Media Coding Techniques for Social/P2P Networks" in *IEEE COMSOC MMTC E-Letter*, July 2011.
25. Naeem Ramzan, Toni Zgaljic, and Ebroul Izquierdo, "An Efficient Optimisation Scheme For Scalable Surveillance Centric Video Communications", *ELSEVIER Journal of Signal Processing: Image Communication*, vol. 24, issue 6, pages 510-523, 2009.
26. Naeem Ramzan, Shuai Wan, and Ebroul Izquierdo, "Joint Source-Channel Coding for Wavelet-Based Scalable Video Transmission Using an Adaptive Turbo Code," *EURASIP Journal on Image and Video Processing*, vol. 2007, Article ID 47517, 12 pages, 2007.
27. Shuai Wan, Marta Mark, Naeem Ramzan and Ebroul Izquierdo, "Perceptually Adaptive Joint Deranging-Deblocking Filtering for Scalable Video Multicast over Wireless Networks," *ELSEVIER Journal of Signal Processing: Image Communication*, vol. 22, issue 3, pages 235-346, March 2007.
28. Naeem Ramzan, Zeeshan Pervez, Abbas Amira, "Quality of Experience Evaluation of H.265/MPEG-HEVC And VP9 Compression Efficiency", Accepted in 26th IEEE International Conference on Microelectronics (IEEE ICM), Doha, Qatar, Dec. 2014.
29. T. K. Tan, M. Mrak, R. Weerakkody, Naeem Ramzan, V. Baroncini, G. J. Sullivan, J.-R. Ohm and K. D. McCann, "HEVC Subjective Video Quality Test Results", *International Broadcasting Convention (IBC)*, Amsterdam, Netherlands, Sept. 2014.
30. Philippe Hanhart, Naeem Ramzan, Vittorio Baroncini, and Touradj Ebrahimi, "Cross-lab Subjective Evaluation of the MVC+D and 3D-AVC 3D Video Coding Standards", 6th *International Workshop on Quality of Multimedia Experience (QoMEX)*, Singapore, Sept. 2014.
31. Naeem Ramzan, Abbas Amira, Christos Grecos, "Evaluation of SVC in adaptive P2P streaming" in the *Proc of 20th IEEE International Conference on Electronics, Circuits and Systems (ICECS)*, Abu Dhabi, UAE, Dec. 2013.
32. Naeem Ramzan, Abbas Amira, Christos Grecos, "Efficient transmission of multiview video over unreliable channels" in the *Proc of 20th IEEE International Conference on Image Processing (ICIP)*, Melbourne, Australia, Sept. 2013.
33. Stefano Asioli, Naeem Ramzan, Ebroul Izquierdo, "Exploiting social relationships for free-riders detection in Minimum-delay p2p scalable video streaming", in the *Proc of 19th IEEE International Conference on Image Processing (ICIP)*, Orlando, Florida, USA, Oct. 2012.

34. Stefano Asoli, Naeem Ramzan, Ebroul Izquierdo, "A game theoretic framework for optimal resource allocation in p2p scalable video streaming", in the Proc. of 37th IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Japan, 2012.

Previous Tutorials (Delivered by Prof. Abbas Amira)

- Invited Tutorial on "Design and Implementation of Imaging and Biomedical Systems on Reconfigurable Hardware", the 7th IEEE GCC Conference, 17-20 November 2013, Doha, Qatar.
- Invited Tutorial on "Programming the Cell Processor", Tun Hussein Onn Malaysia (UHTM), 24th October 2013, Batu Pahat, Johore, Malaysia.
- Tutorial on "Reconfigurable Biomedical Systems" the IEEE Design and Test Symposium (IDT 2012), 15-17 December 2012, Doha, Qatar.
- Tutorial on "Reconfigurable Computing for DSP and Imaging: from Algorithm to Low Power Design" the IEEE International Conference on Information Science, Signal Processing and Their Applications (ISSPA2012), 3-5 July, 2012, Montreal, Canada.
- Short Course on "Rapid Prototyping of Embedded Systems", Qatar University, 26th March, 2012, Doha, Qatar.
- Short Course on "C for Rapid Prototyping of Embedded Systems", NIBEC, University of Ulster, 30th June-1st July, 2011. Northern Ireland,
- Short Course on "Software Tools for Embedded Computing on FPGAs", CDTA, 23rd May 2011, Algiers.
- Tutorial on "Embedded Encryption and Security Systems" The 1st Algerian Winter School on Smart Cards, organized by CDTA, December 2010, Algiers.
- Tutorial on "Real-Time Embedded Biometric Systems" The 1st Algerian Summer School on Biometrics (ASSB 2010), organized by CDTA, 23-27 May 2010, Algiers.
- Two days short course on "DSP for Communications", A.T.E.I, Department of Electronics, A.T.E.I of Thessaloniki, 22-23 January 2010, Greece.
- Half day tutorial on "Multiresolution Analysis for Imaging on Reconfigurable Hardware" at the IEEE Conference on Image Processing (ICIP 2009), 7-11 November 2009, Cairo, Egypt.
- Three days short course on "DSP for Communications", A.T.E.I, Department of Electronics, A.T.E.I of Thessaloniki, 28-30 November 2008, Greece.
- Half day tutorial on "Accelerating Matrix Algorithms on Reconfigurable Hardware for Image and Signal Processing Applications" at the Irish Machine Vision and Image Processing Conference (IMVIP2004), 1-3 September 2004, Dublin, Ireland.
- Three days short course on "Software, Hardware Tools and Solutions for Image and Signal Video, 3D Graphics and scientific Applications", University of Jijel, 01-03 March 2004, Jijel, Algeria.

Previous Tutorials/Seminars (Delivered by Dr Naeem Ramzan)

- "Adaptive Streaming of UHD video", VQEG meeting, Intel Head Quarter, Santa Clara, USA, Feb. 2015.
- "Ultra HD performance evaluation", ACERO, Stockholm, Sweden, July 2014.
- "Scalable and adaptable video over P2P network", presented at the Future Media Network Cluster Meeting, organized by the EC, Brussels, Belgium, Nov. 2010.
- "Scalable video coding as basis for networked media internet", presented at NEM Summit "Towards Future Media Internet", Saint-Malo, France, Sept. 2009.
- "Optimal joint source channel coding for scalable video transmission over wireless channels," presented in 5th Streaming Day Conference, Genoa, Italy, Sept. 2009.
- "Two- dimensional error protection scheme for efficient scalable video transmission," presented in 4th Streaming Day Conference (STDay 08), Parma, Italy, Sept. 2008.

What is new in this proposal?

The proposal for ISSPIT 2015 tutorial is innovative and contains new and advanced topics which were not covered the previous tutorials. The new topics include some optimization techniques for the mapping of image and video processing algorithms on reconfigurable hardware and SoC platforms using software hardware co-design approaches. The tutorial will focus also on the design and implementation of high efficiency video coding and its Quality evaluation methods. There will also new demos and programming tools / techniques used for the implementation.