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PROCEEDINGS

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Electronic Imaging

SCIENCE AND TECHNOLOGY

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Media Watermarking, Security, and Forensics 2018

Editors: **Adnan M. Alattar,** Digimarc Corp. (United States),
Nasir D. Memon, Tandon School of Engineering, New York Univ. (United States),
Gaurav Sharma, University of Rochester (United States)

These papers represent the program of Electronic Imaging 2018,
held 28 January – 1 February 2018, at the Hyatt Regency San Francisco Airport in Burlingame, CA.

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Media Watermarking, Security, and Forensics 2018

Chairs' Welcome to Media Watermarking, Security, and Forensics 2018

Welcome to Media Watermarking, Security, and Forensics (MWSF) 2018, which marks the 20th year of the conference within the Electronic Imaging Symposium (with minor variations in the conference title). As usual, this year's conference features a strong technical program building on the long history of the conference as the premier venue for original new ideas in its fields. The papers from the technical program are featured in the accompanying proceedings. Additionally, would like to highlight several key events from this year's program. This year's MWSF conference featured three keynote talks:

1. Digital watermarking from inflated expectation to mainstream adoption, **Tony Rodriguez,** Digimarc Corporation (US)
2. Content protection: Beyond conditional access and digital rights management, **Mehmet Celik,** NexGuard Labs (Netherlands)
3. Scaling media forensics, **David Doermann,** DARPA (US)

These memorable and engaging talks highlighted new developments, emerging industry and academic research directions, and summarized key historical developments in our fields. This year's conference also featured a though provoking panel discussion:

Panel: Deep Learning, Shallow Understanding?
Panelists: **Matt Cragun** (NVIDIA), **Ed Delp** (Purdue U.), **Jessica Fridrich** (Binghamton U.), **Jonathon Shlens** (Google)

We thank the keynote speakers, panelists, reviewers, session chairs, and all authors and presenters for their contributions to MWSF 2018. Also, to the Society of Imaging Science and Technology, which sponsors the symposium, our sincere vote of appreciation for all their assistance with the conference.

Adnan M. Alattar, Nasir D. Memon, Gaurav Sharma
MWSF 2018 Conference Chairs

Media Watermarking, Security, and Forensics 2018

Monday, January 29, 2018

Keynote: Digital Watermarking from Inflated Expectation to Mainstream Adoption
Session Chair: Gaurav Sharma, University of Rochester (United States)
9:00 – 10:00 am
Cypress C

MWSF-113
Digital watermarking from inflated expectation to mainstream adoption, *Tony Rodriguez, Digimarc Corporation (United States)*

Tony Rodriguez has been an integral leader of innovation efforts at Digimarc since 1996 and currently serves as chief technology officer for Digimarc. He has 25 years' experience in computer science and image processing research and development. At Digimarc, he has held senior software engineering and research positions, focused on the development and application of digital watermarking and other content identification technologies. Before joining Digimarc, he worked at Intel Architecture Labs as a senior software engineer focused on video segmentation and streaming technologies. Rodriguez is a named inventor of numerous patents and the author of several published papers on the topic of Digital Watermarking and a chapter in the book, Multimedia Security Handbook, published in 2005.

10:00 – 10:30 am Coffee Break

Forensics and Steganalysis

Session Chair: Patrick Bas, CNRS (France)

10:30 am – 12:10 pm
Cypress C

10:30 MWSF-118
Boosting image forgery detection using resampling features and copy-move analysis, *Tajuddin Manhar Mohammed[1], Jason Bunk[1], Lakshmanan Nataraj[1], Jawadul Bappy[2], Arjuna Flenner[3], B.S. Manjunath[4], Shivkumar Chandrasekaran[4], Amit Roy-Chowdhury[2], and Lawrence Peterson[3]; [1]Mayachitra, Inc., [2]University of California, Riverside, [3]NAVAIR, and [4]University of California, Santa Barbara (United States)*

10:55 MWSF-119
Image manipulation detection using sensor linear pattern, *Miroslav Goljan, Jessica Fridrich, and Matthias Kirchner, Binghamton University (United States)*

11:20 MWSF-120
Privacy preserving forensics for JPEG images, *Huajian Liu, Martin Steinebach, Richard Stein, and Felix Mayer, Fraunhofer SIT (Germany)*

11:45 MWSF-121
Steganalyzing images of arbitrary size with CNNs, *Clement Fuji Tsang and Jessica Fridrich, Binghamton University (United States)*

12:10 – 2:00 pm Lunch

Plenary Session

2:00 – 3:00 pm
Grand Peninsula Ballroom D

Overview of Modern Machine Learning and Deep Neural Networks - Impact on Imaging and the Field of Computer Vision, *Greg Corrado, Google, Inc. (United States)*

Dr. Greg Corrado, co-founder of Google Brain, principal scientist, and director of augmented intelligence research at Google, provides an overview of modern machine learning and deep neural networks, with particular attention to its impact on imaging and the field of computer vision.

Dr. Corrado is a senior research scientist interested in biological neuroscience, artificial intelligence, and scalable machine learning. He has published in fields ranging across behavioral economics, neuromorphic device physics, systems neuroscience, and deep learning. At Google he has worked for some time on brain inspired computing, and most recently has served as one of the founding members and the co-technical lead of Google's large scale deep neural networks project. Prior to joining Google, Dr. Corrado was a staff research scientist at IBM. He received his MS in computer science and PhD in neuroscience from Stanford University.

3:00 – 3:30 pm Coffee Break

Watermarking and Steganalysis

Session Chair: Mehmet Celik, NexGuard Labs (Netherlands)

3:30 – 4:45 pm
Cypress C

3:30 MWSF-158
Blind detection of image rotation and angle estimation, *Miroslav Goljan, Binghamton University (United States)*

3:55 MWSF-159
Display image-barcodes using blue/red channel embedding, *Karthik Dinesh and Gaurav Sharma, University of Rochester (United States)*

4:20 MWSF-160
Deep learning regressors for quantitative steganalysis, *Mo Chen, Mehdi Boroumand, and Jessica Fridrich, Binghamton University (United States)*

5:00 – 6:00 pm All-Conference Welcome Reception

Tuesday, January 30, 2018

7:15 – 8:45 am Women in Electronic Imaging Breakfast

Keynote: Content Protection, Beyond Conditional Access and Digital Rights
9:00 – 10:00 am
Cypress C

MWSF-197
Content protection: Beyond conditional access and digital rights management, *Mehmet Celik, NexGuard Labs (Netherlands)*

Dr. Mehmet Celik is a principle scientist and the director of research at NexGuard Labs in Kudelski Group. After receiving his PhD from University of Rochester (2004), he joined Philips Research. He was part of the Content-Identification group which spun-off as Civolution in 2008. He led the research team at Civolution, where he helped develop renowned solutions based on watermarking and fingerprinting algorithms. Audience measurement solution based on audio watermarking was acquired by Kantar Media in 2014 and is now deployed in various countries. Broadcast monitoring and TV analytics solution based on video watermarking and audio/video fingerprinting was acquired by 4C-Insights in 2015 and is now tracking over 2100 channels in 76 countries. Forensic tracking solutions based on audio/video watermarking was acquired by Kudelski Group in 2016 and is now used by all major studios and deployed on over 100,000 movie screens. These solutions have been recognized by the National Academy of Television Arts & Sciences with Technology & Engineering Emmy® Awards in 2016 and 2018. Dr. Celik is now focusing on challenges around forensic tracking of live sports & premium content when distributed via broadcast or over-the-top.

10:00 AM – 7:30 pm Industry Exhibition

10:00 – 10:30 am Coffee Break

Deep Learning Forensics

Session Chair: Miroslav Goljan, Binghamton University (United States)

10:30 am – 12:10 pm
Cypress C

10:30 MWSF-211
Towards order of processing operations detection in JPEG-compressed images with convolutional neural networks, *Belhassen Bayar and Matthew Stamm, Drexel University (United States)*

10:55 MWSF-212
Resampling forgery detection using deep learning and a-contrario analysis, *Arjuna Flenner[1], Lawrence Peterson[1], Jason Bunk[2], Tajuddin Manhar Mohammed[2], Lakshmanan Nataraj[2], and B.S. Manjunath[2]; [1]NAVAIR and [2]Mayachitra, Inc. (United States)*

11:20 MWSF-213
Deep learning for detecting processing history of images, *Mehdi Boroumand and Jessica Fridrich, Binghamton University (United States)*

11:45 MWSF-214
Satellite image forgery detection and localization using GAN and one-class classifier, *Sri Kalyan Yarlagadda[1], David Güera Cobo[1], Paolo Bestagini[2], Fengqing Zhu[1], Stefano Tubaro[2], and Edward Delp[1]; [1]Purdue University (United States) and [2]Politecnico di Milano (Italy)*

12:10 – 2:00 pm Lunch

Plenary Session

2:00 – 3:00 pm
Grand Peninsula Ballroom D

Fast, Automated 3D Modeling of Buildings and Other GPS Denied Environments, *Avideh Zakhor, University of California, Berkeley (United States)*

Professor Avideh Zahkor discusses fast, automated 3D modeling of buildings and other GPS denied environments with examples from her work in 3D reality capture, and visual and metric documentation of building interiors. Dr. Zakhor is a serial entrepreneur with startups in outdoor mapping, indoor mapping, and micro-lithography, currently CEO and founder of Indoor Reality, a Silicon Valley startup with products in 3D reality capture, and visual and metric documentation of building interiors.

Dr. Zakhor has been faculty member at University of California, Berkeley since 1994 where she holds the Qualcomm Chair in the electrical engineering and computer science department. She co-founded OPC technology in 1996, which was acquired by Mentor Graphics in 1998, and UrbanScan Inc. in 2005, acquired by Google in 2007. UrbanScan created the first fully automated 3D outdoor mapping system for 3D exterior models of buildings in urban environments. She has received a number of best paper awards in 3D computer vision, image processing, signal processing, is an IEEE fellow, and received the presidential young investigator award in 1992. Dr. Zakhor received her BSc in electrical engineering, from the California Institute of Technology (1983), and her MS (1985) and PhD (1987) in electrical engineering and computer science from MIT.

3:00 – 3:30 pm Coffee Break

Panel: Deep Learning, Shallow Understanding?
Panelists: Matt Cragun, NVIDIA Corporation (United States); Edward Delp, Purdue University (United States); Jessica Fridrich, Binghamton University (United States); and Jonathon Shlens, Google Inc. (United States)

Panel Moderator: Nasir Memon, New York University (United States)
3:30 – 5:00 pm
Cypress C

Symposium Demonstration Session

5:30 – 7:30 pm
Grand Peninsula Ballroom E

Wednesday, January 31, 2018

Keynote: DARPA MediFor Progress and Challenges
Session Chair: Adnan Alattar, Digimarc Corporation (United States)
9:00 – 10:00 am
Cypress C

MWSF-309
Scaling media forensics, *David Doermann, DARPA (United States)*

Dr. David Doermann joined DARPA in April 2014. His areas of technical interest span language and media processing and exploitation, vision and mobile technologies. He comes to DARPA with a vision of increasing capabilities through joint vision/language interaction for triage and forensics applications. Dr. Doermann holds a Doctor of Philosophy in computer science and a Master of Science in computer science from the University of Maryland, College Park. He has authored more than 250 peer-reviewed journal and conference papers and book chapters and is the co-editor of the Handbook of Document Image Processing and Recognition. *In 2014, Dr. Doermann was elected a Fellow of the IEEE for contributions to research and development of automatic analysis and processing of document page imagery.*

10:00 AM – 4:00 pm Industry Exhibition

10:00 – 10:30 am Coffee Break

Steganography and Steganalysis

Session Chair: Jessica Fridrich, Binghamton University (United States)

10:30 am – 12:10 pm
Cypress C

10:30 MWSF-316
Natural steganography in JPEG compressed images, *Tomas Denemark[1], Patrick Bas[2], and Jessica Fridrich[1]; [1]Binghamton University (United States) and [2]CNRS (France)*

10:55 MWSF-317
How to augment a small learning set for improving the performances of a CNN-based steganalyzer?, *Mehdi Yedroudj[1,2], Marc Chaumont[1,3], and Frédéric Comby[1,2]; [1]LIRMM, [2]University of Montpellier, and [3]University of Nimes (France)*

11:20 MWSF-318
Steganalysis into the wild: How to define a source?, *Quentin Giboulot[1], Rémi Cogranne[1], and Patrick Bas[2]; [1]Troyes University of Technology and [2]University of Lille (France)*

11:45 MWSF-319
Domain adaptation in steganalysis for the spatial domain, *Li Lin[1], Jennifer Newman[1], Stephanie Reinders[1], Yong Guan[1], and Min Wu[2]; [1]Iowa State University and [2]University of Maryland, College Park (United States)*

12:10 – 2:00 pm Lunch

Plenary Session

2:00 – 3:00 pm
Grand Peninsula Ballroom D

Ubiquitous, Consumer AR Systems to Supplant Smartphones, *Ronald T. Azuma, Intel, Corp. (United States)*

Dr. Ronald T. Azuma, researcher and augmented reality pioneer, shares his vision for achieving ubiquitous, consumer AR systems. Recent large investments in augmented reality reflect the commercial interest in its inherent potential to replace current smartphone technology, but much remains to be done. In his talk, Dr. Azuma gives a vision for achieving this goal, which requires not just solving numerous technical challenges but also determining new, compelling AR experiences that will establish AR as a new platform and novel form of media.

Dr. Azuma leads a team in Intel Labs that designs and prototypes novel experiences and key enabling technologies to enable new forms of media. These technology areas include computational imaging and photography, computational displays, and head-worn displays. Dr. Azuma is recognized as a pioneer and innovator in augmented reality, and has held prominent leadership roles in that research area, including leading and implementing research projects and demonstrations in areas such as AR, visualization, and mobile applications. Dr. Azuma received his BSc (1988) in electrical engineering from University of California, Berkeley, and MS (1990) and PhD (1995) in computer science from University of North Carolina, Chapel Hill. Prior to joining Intel, he was a research leader at Nokia Research Center Hollywood, and a senior researcher at Hughes Research Laboratories.

3:00 – 3:30 pm Coffee Break

Biometrics and Encryption

Session Chair: Robert Ulichney, HP Labs, HP Inc. (United States)

3:30 – 4:50 pm
Cypress C

3:30 MWSF-369
Study on color space for the performance of degraded face image recognition, *Xinwei Liu[1,2], Christophe Charrier[1], Marius Pedersen[2], and Patrick Bours[2]; [1]Normandie University (France) and [2]Norwegian University of Science and Technology (Norway)*

3:55 MWSF-370
Image scramble algorithm with robustness under transcoding, *Chanyul Kim, In kwon Choi, Minwoo Park, Kwangpyo Choi, and Jeonghoon Park, Samsung Research (Republic of Korea)*

4:20 MWSF-371
Hybrid image encryption, *Martin Steinebach[1], Huajian Liu[1], Richard Stein[2], and Felix Mayer[1]; [1]Fraunhofer SIT and [2]Technische Universität Darmstadt (Germany)*

4:45
Conference Closing Remarks

Symposium Interactive Papers (Poster) Session

5:30 – 7:30 pm
The Grove

Meet the Future: A Showcase of Student and Young Professionals Research

5:30 – 7:30 pm
The Grove