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Dear Christina

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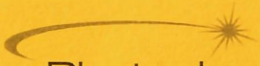
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Applications of Digital Image Processing XXXIII

Andrew G. Tescher
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Contents

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xi Conference Committee

SESSION 1 IMAGE SIGNAL PROCESSING I

- 7798 05 **Multi-scale edge detection with local noise estimate** [7798-04]
B. Jiang, Old Dominion Univ. (United States); Z. Rahman, NASA Langley Research Ctr. (United States)
- 7798 06 **Correlation filter design using a single cluttered training image for detecting a noisy target in a nonoverlapping scene** [7798-05]
P. M. Aguilar-González, V. Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada (Mexico)
- 7798 07 **Denoising point clouds using pulling-back method** [7798-06]
C. Shen, East China Normal Univ. (China); Y. Peng, Shanghai Univ. (China); G. Zhang, East China Normal Univ. (China)

SESSION 2 IMAGE SIGNAL PROCESSING II

- 7798 09 **Image restoration based on multiple PSF information with applications to phase-coded imaging system** [7798-08]
P.-C. Chen, Y.-L. Chen, H.-Y. Sung, Industrial Technology Research Institute (Taiwan)
- 7798 0A **Motion-compensated compressed sensing for dynamic imaging** [7798-09]
R. Sundaresan, Y. Kim, The Univ. of Arizona (United States); M. S. Nadar, Siemens Corporate Research (United States); A. Bilgin, The Univ. of Arizona (United States)
- 7798 0B **Using enhancement data to deinterlace 1080i HDTV** [7798-10]
A. L. Lin, Stanford Univ. (United States); J. S. Lim, Massachusetts Institute of Technology (United States)

SESSION 3 IMAGE SIGNAL PROCESSING III

- 7798 0C **Multispectral MRI-based virtual cystoscopy** [7798-11]
L. Li, City Univ. of New York (United States); H. Zhu, S. Wang, Stony Brook Univ. (United States); X. Wei, City Univ. of New York (United States); Z. Liang, Stony Brook Univ. (United States)
- 7798 0D **Computational architecture for image processing on a small unmanned ground vehicle** [7798-12]
S. Ho, H. Nguyen, U.S. Army Research Lab. (United States)
- 7798 0E **Automatic activity estimation based on object behaviour signature** [7798-13]
F. E. Martínez-Pérez, J. A. González-Fraga, M. Tentori, Univ. Autónoma de Baja California (Mexico)

iii

SESSION 4 DIGITAL CULTURAL HERITAGE

- 7798 OG **Signal processing and analyzing works of art** [7798-15]
D. H. Johnson, Rice Univ. (United States); C. R. Johnson, Jr., Cornell Univ. (United States);
E. Hendriks, Van Gogh Museum (Netherlands)
- 7798 OH **Texton-based analysis of paintings** [7798-16]
L. J. P. van der Maaten, Univ. of California, San Diego (United States) and Delft Univ. of
Technology (Netherlands); E. O. Postma, Tilburg Univ. (Netherlands)
- 7798 OI **Multispectral imaging for digital painting analysis: a Gauguin case study** [7798-17]
B. Cornelis, A. Doots, Vrije Univ. Brussel (Belgium); F. Leen, Royal Museums of Fine-Arts
(Belgium); A. Munteanu, P. Schelkens, Vrije Univ. Brussel (Belgium)
- 7798 OJ **Attenuating hue identification and color estimation for underpainting reconstruction from
x-ray synchrotron imaging data** [7798-18]
A. Anitha, S. M. Hughes, Univ. of Colorado at Boulder (United States)

SESSION 5 VISUAL SEARCH I

- 7798 OK **Keypoint clustering for robust image matching** [7798-19]
S. Vaddadi, O. Hamsici, Y. Reznik, J. Hong, C. Lee, Qualcomm Inc. (United States)
- 7798 OL **Fast quantization and matching of histogram-based image features** [7798-20]
Y. A. Reznik, Qualcomm Inc. (United States); V. Chandrasekhar, G. Takacs, D. M. Chen,
S. S. Tsai, B. Girod, Stanford Univ. (United States)
- 7798 OM **Permutable descriptors for orientation-invariant image matching** [7798-21]
G. Takacs, V. Chandrasekhar, H. Chen, D. Chen, S. Tsai, Stanford Univ. (United States);
R. Grzeszczuk, Nokia Research Ctr. (United States); B. Girod, Stanford Univ. (United States)
- 7798 OO **Object tracking in real environments** [7798-23]
A. M. Nelson, J. J. Neubert, The Univ. of North Dakota (United States)

SESSION 6 VISUAL SEARCH II

- 7798 OP **Three-dimensional target modeling with synthetic aperture radar** [7798-24]
J. R. Hupton, J. A. Saghi, California Polytechnic State Univ., San Luis Obispo (United States)
- 7798 OQ **A Bayesian network-based approach for identifying regions of interest utilizing global
image features** [7798-25]
M. Jaber, E. Saber, Rochester Institute of Technology (United States)
- 7798 OR **Low-cost asset tracking using location-aware camera phones** [7798-26]
D. Chen, S. Tsai, Stanford Univ. (United States); K.-H. Kim, C.-H. Hsu, J. P. Singh, Deutsche
Telekom Inc. (United States); B. Girod, Stanford Univ. (United States)
- 7798 OS **Propagation of geotags based on object duplicate detection** [7798-27]
P. Vajda, I. Ivanov, J.-S. Lee, L. Goldmann, T. Ebrahimi, Ecole Polytechnique Fédérale de
Lausanne (Switzerland)

SESSION 7 COMPRESSION AND TRANSFORMS FOR IMAGES AND VIDEO I

- 7798 0U **Design of high-performance fixed-point transforms using the common factor method** [7798-29]
A. T. Hinds, Ricoh InfoPrint Solutions Co. (United States)
- 7798 0V **Recent developments in standardization of high efficiency video coding (HEVC)** [7798-30]
G. J. Sullivan, Microsoft Corp. (United States); J.-R. Ohm, RWTH Aachen (Germany)
- 7798 0W **Efficient large size transforms for high-performance video coding** [7798-31]
R. Joshi, Y. A. Reznik, M. Karczewicz, Qualcomm Inc. (United States)

SESSION 8 COMPRESSION AND TRANSFORMS FOR IMAGES AND VIDEO II

- 7798 0X **Low-complexity lossless codes for image and video coding** [7798-32]
Y. A. Reznik, Qualcomm Inc. (United States)
- 7798 0Y **Embedded memory compression for video and graphics applications** [7798-33]
A. Teng, D. Gokce, M. Aleksic, Y. A. Reznik, Qualcomm Inc. (United States)
- 7798 0Z **Self-derivation of motion estimation techniques to improve video coding efficiency** [7798-34]
Y. Chiu, Intel Corp. (United States); L. Xu, W. Zhang, Intel Labs. China (China); H. Jiang, Intel Corp. (United States)
- 7798 10 **Variable length coding for binary sources and applications in video compression** [7798-35]
G. Korodi, D. He, P. Imthurn, Research In Motion Ltd. (Canada)
- 7798 11 **Subjective evaluation of next-generation video compression algorithms: a case study** [7798-36]
F. De Simone, L. Goldmann, J.-S. Lee, T. Ebrahimi, Ecole Polytechnique Fédérale de Lausanne (Switzerland); V. Baroncini, Fondazione Ugo Bordoni (Italy)

SESSION 9 COMPUTATIONAL IMAGING I: JOINT SESSION WITH CONFERENCE 7800

- 7798 12 **High dynamic range video with ghost removal** [7798-37]
S. Mangiat, J. Gibson, Univ. of California, Santa Barbara (United States)
- 7798 13 **ECME hard thresholding methods for image reconstruction from compressive samples** [7798-38]
K. Qiu, A. Dogandžić, Iowa State Univ. (United States)
- 7798 14 **A survey of image retargeting techniques** [7798-39]
D. Vaquero, M. Turk, Univ. of California, Santa Barbara (United States); K. Pulli, M. Tico, N. Gelfand, Nokia Research Ctr. (United States)
- 7798 15 **Objective and subjective measurement and modeling of image quality: a case study** [7798-40]
B. W. Keelan, Aptina, LLC (United States)

- 7798 16 **Computationally efficient deblurring of shift-variant highly defocused images** [7798-41]
S. B. Sastry, M. Subbarao, Stony Brook Univ. (United States)

SESSION 10 COMPUTATIONAL IMAGING II: JOINT SESSION WITH CONFERENCE 7800

- 7798 17 **The restoration of large blur image based on POCS algorithm** [7798-42]
J. Luo, Huazhong Univ. of Science and Technology (China) and Huazhong Agricultural Univ. (China); X. Zhang, C. Xie, T. Zhang, Huazhong Univ. of Science and Technology (China)
- 7798 18 **Generating highly realistic 3D animation video with depth-of-field and motion blur effects** [7798-43]
K. Sathyanarayana, M. Subbarao, Stony Brook Univ. (United States)

SESSION 11 PERCEPTUAL CODING OF STILL AND MOTION IMAGES I

- 7798 1C **Evaluation of MPEG4-SVC for QoE protection in the context of transmission errors** [7798-46]
Y. Pitrey, M. Barkowsky, P. Le Callet, R. P  pion, Univ. de Nantes (France)
- 7798 1D **Rate allocation as quality index performance test** [7798-47]
T. Richter, Univ. Stuttgart (Germany)
- 7798 1E **A compressive sensing approach to perceptual image coding** [7798-48]
M. R. Pickering, Univ. of New South Wales (Australia); J. You, Norwegian Univ. of Science and Technology (Norway); T. Ebrahimi, Norwegian Univ. of Science and Technology (Norway) and Ecole Polytechnique F  d  rale de Lausanne (Switzerland);
A. Perkis, Norwegian Univ. of Science and Technology (Norway)

SESSION 12 PERCEPTUAL CODING OF STILL AND MOTION IMAGES II

- 7798 1F **Perceptually optimized quantization tables for H.264/AVC** [7798-49]
H. Chen, G. Braeckman, J. Barbarien, A. Munteanu, P. Schelkens, Vrije Univ. Brussel (Belgium)
- 7798 1G **Open source database of images DEIMOS: high dynamic range images** [7798-50]
K. Fliegel, P. P  ta, M. Kl  ma, M. Bla  ek, J. Havl  n, Czech Technical Univ. in Prague (Czech Republic)
- 7798 1H **Research of color distribution index in CIE L*a*b* color space** [7798-51]
W.-D. Jeng, National Chiao Tung Univ. (Taiwan); T.-W. Huang, National Central Univ. (Taiwan); O.-Y. Mang, National Chiao Tung Univ. (Taiwan); T.-H. Lee, Wistron Corp. (Taiwan); Y.-F. Hsieh, National Central Univ. (Taiwan); Y.-T. Kuo, National Chiao Tung Univ. (Taiwan) and Jen-Teh Junior College of Medicine, Nursing and Management (Taiwan)

SESSION 13 MOBILE VIDEO: PROCESSING, COMMUNICATIONS, DISPLAY, AND APPLICATIONS I

- 7798 1I **Video quality management for mobile video application** [7798-52]
K.-C. Yang, K. El-Maleh, V. Bhaskaren, Qualcomm Inc. (United States)

- 7798 1K **Low-complexity H.264/AVC motion compensated prediction for mobile video applications** [7798-54]
S.-W. Lee, C.-C. J. Kuo, The Univ. of Southern California (United States)
- 7798 1L **Decoder friendly H.264/AVC deblocking filter design** [7798-55]
S.-W. Lee, C.-C. J. Kuo, The Univ. of Southern California (United States)

SESSION 14 MOBILE VIDEO: PROCESSING, COMMUNICATIONS, DISPLAY, AND APPLICATIONS II

- 7798 1M **Postprocessing and denoising of video using sparse multiresolutional transforms** [7798-56]
O. G. Sezer, Georgia Tech (United States); O. G. Guleryuz, DoCoMo Communications Labs. USA, Inc. (United States)
- 7798 1N **Image retargeting for small display devices** [7798-57]
C. Jung, C. Kim, Korea Advanced Institute of Science and Technology (Korea, Republic of)
- 7798 1P **Adaptive image backlight compensation for mobile phone users** [7798-59]
H. Kong, C. Jung, W. Kim, J. Lee, C. Kim, Korea Advanced Institute of Science and Technology (Korea, Republic of)
- 7798 1Q **Remote gaming on resource-constrained devices** [7798-60]
W. Reza, H. Kalva, R. Kaufman, Florida Atlantic Univ. (United States)

SESSION 15 OPTICS, PHOTONICS AND DIGITAL IMAGE PROCESSING

- 7798 1R **Multivariate image analysis of laser-induced photothermal imaging used for detection of caries tooth** [7798-61]
A. F. El-Sherif, W. M. Abdel Aziz, Y. H. El-Sharkawy, Egyptian Armed Forces (Egypt)
- 7798 1S **A multi-pedestrian detection and counting system using fusion of stereo camera and laser scanner** [7798-62]
B. Ling, S. Tiwari, Z. Li, Migma Systems, Inc. (United States); D. R. P. Gibson, Federal Highway Administration (United States)
- 7798 1T **Defect detection and classification of machined surfaces under multiple illuminant directions** [7798-63]
Y. Liao, X. Weng, Univ. of Michigan (United States); C. W. Swonger, Coherix Inc. (United States); J. Ni, Univ. of Michigan (United States)
- 7798 1U **Comparison between two different methods to obtain the wavefront aberration function** [7798-64]
A. S. Cruz Félix, J. Ibarra, E. López, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico); M. A. Rosales, Univ. de las Américas Puebla (Mexico); E. Tepichín, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico)
- 7798 1V **Refractive power maps of the anterior surface of the cornea according to different models** [7798-65]
L. Morales-Tellez, M. A. Rosales, Univ. de las Américas Puebla (Mexico); E. López-Olazagasti, G. Ramírez-Zavaleta, E. Tepichín, Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico)

- 7798 1W **Rapid ideal template creation for the inspection of MEMS based on self-similarity characteristics** [7798-66]
A. Burla, T. Haist, W. Lyda, A. Y. Michael, W. Osten, Univ. Stuttgart (Germany)
- 7798 1Y **Automatic alignment of multi-temporal images of planetary nebulae using local optimization** [7798-68]
F. Kazemzadeh, A. R. Hajian, Univ. of Waterloo (Canada)

POSTER SESSION

- 7798 20 **The development of an automatic scanning path generation method for the spinneret test** [7798-70]
C.-J. Chen, M.-W. Hung, W. Jywe, D. Chiang, Instrument Technology Research Ctr. (Taiwan)
- 7798 21 **Meteor automatic imager and analyzer: analysis of noise characteristics and possible noise suppression** [7798-71]
J. Švihlík, Institute of Chemical Technology (Czech Republic); K. Fliegel, P. Páta, S. Vitek, Czech Technical Univ. in Prague (Czech Republic); P. Koten, Academy of Sciences of the Czech Republic (Czech Republic)
- 7798 22 **Correlation-based nonlinear composite filters applied to image recognition** [7798-72]
S. Martínez-Díaz, Instituto Tecnológico de La Paz (Mexico)
- 7798 23 **Automated tracking of yeast cell lineages** [7798-73]
K. Kim, HRL Labs., LLC (United States); A. C. Rowat, Harvard Univ. (United States); A. E. Carpenter, Broad Institute of MIT and Harvard (United States)
- 7798 24 **Center location error correction of circular targets** [7798-74]
Y. Yin, Tianjin Univ. (China); X. Liu, A. Li, C. Zhang, D. He, Shenzhen Univ. (China); X. Peng, Tianjin Univ. (China) and Shenzhen Univ. (China)
- 7798 25 **Performance of visual tasks from contour information** [7798-75]
Y. Yitzhaky, L. Itan, Ben-Gurion Univ. of the Negev (Israel)
- 7798 26 **Augmented reality system** [7798-76]
C.-L. Lin, Y.-Z. Su, M.-W. Hung, K.-C. Huang, Instrument Technology Research Ctr. (Taiwan)
- 7798 27 **Image restoration with local adaptive methods** [7798-77]
C. A. Carranza, V. Kober, H. Hidalgo, Ctr. de Investigación Científica y de Educación Superior de Ensenada (Mexico)
- 7798 29 **Improvement of visual perception in cloudy environments** [7798-79]
F. J. Arias, V. H. Díaz-Ramírez, Ctr. de Investigación y Desarrollo de Tecnología Digital (Mexico)
- 7798 2A **Performance test of optical and electronic image stabilizer for digital imaging system** [7798-80]
Q. Li, Z. Xu, H. Feng, Y. Chen, Zhejiang Univ. (China)

- 7798 2B **Meteor automatic imager and analyzer: system design and its parameters** [7798-81]
K. Fliegel, P. Páta, S. Vítek, Czech Technical Univ. in Prague (Czech Republic); P. Koten, Academy of Sciences of the Czech Republic (Czech Republic)
- 7798 2C **Analysis of the selection of overlapping region of sectioned restoration for images with space-variant point spread function** [7798-82]
X. Tao, J. Zhao, H. Feng, Q. Li, Z. Xu, Y. Chen, Zhejiang Univ. (China)
- 7798 2D **Image restoration of nonuniformly illuminated images with camera microscanning** [7798-83]
J. L. López-Martínez, Ctr. de Investigación Científica y de Educación Superior de Ensenada (Mexico) and Univ. Autónoma de Yucatán (Mexico); V. Kober, Ctr. de Investigación Científica y de Educación Superior de Ensenada (Mexico)
- 7798 2E **Vertex-based marching algorithms for finding multidimensional geometric intersections** [7798-84]
L. T. Dechevsky, A. Lakså, B. Bang, J. Gundersen, A. R. Kristoffersen, P. Zanaty, Narvik Univ. College (Norway)
- 7798 2F **Calibration of a dual-PTZ camera system for stereo vision** [7798-85]
Y.-Z. Chang, J.-F. Hou, Y. H. Tsao, Chang Gung Univ. (Taiwan); S.-T. Lee, Chang Gung Memorial Hospital (Taiwan)
- 7798 2H **Utilization of consumer level digital cameras in astronomy** [7798-87]
P. Páta, K. Fliegel, M. Klíma, M. Blažek, M. Řeřábek, Czech Technical Univ. in Prague (Czech Republic)
- 7798 2I **Use of the EM algorithm in image registration in a scene captured by a moving camera** [7798-88]
N. M. Namazi, The Catholic Univ. of America (United States); W. Scharpf, U.S. Naval Research Lab. (United States); J. Obermark, DCS Corp. (United States); J. N. Caron, Research Support Instruments, Inc. (United States)
- 7798 2J **Scene kinetics mitigation using factor analysis with derivative factors** [7798-90]
D. K. Melgaard, A. J. Scholand, K. W. Larson, Sandia National Labs. (United States)
- 7798 2L **Novel gray coded pattern for unwrapping phase in fringe projection based 3D profiling** [7798-93]
M. Kondiparthi, A. Phani, Indian Institute of Science (India)
- 7798 2M **A comparison between intensity and depth images for extracting features related to wear labels in carpets** [7798-94]
S. A. Orjuela, E. Vansteenkiste, F. Rooms, S. De Meulemeester, R. de Keyser, W. Philips, Univ. Gent (Belgium)

Author Index

Low-Cost Asset Tracking using Location-Aware Camera Phones

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ABSTRACT

Maintaining an accurate and up-to-date inventory of one's assets is a labor-intensive, tedious, and costly operation. To ease this difficult but important task, we design and implement a mobile asset tracking system for automatically generating an inventory by snapping photos of the assets with a smartphone. Since smartphones are becoming ubiquitous, construction and deployment of our inventory management solution is simple and cost-effective. Automatic asset recognition is achieved by first segmenting individual assets out of the query photo and then performing bag-of-visual-features (BoVF) image matching on the segmented regions. The smartphone's sensor readings, such as digital compass and accelerometer measurements, can be used to determine the location of each asset, and this location information is stored in the inventory for each recognized asset.

As a special case study, we demonstrate a mobile book tracking system, where users snap photos of books stacked on bookshelves to generate a location-aware book inventory. It is shown that segmenting the book spines is very important for accurate feature-based image matching into a database of book spines. Segmentation also provides the exact orientation of each book spine, so more discriminative upright local features can be employed for improved recognition. This system's mobile client has been implemented for smartphones running the Symbian or Android operating systems. The client enables a user to snap a picture of a bookshelf and to subsequently view the recognized spines in the smartphone's viewfinder. Two different pose estimates, one from BoVF geometric matching and the other from segmentation boundaries, are both utilized to accurately draw the boundary of each spine in the viewfinder for easy visualization. The BoVF representation also allows matching each photo of a bookshelf rack against a photo of the entire bookshelf, and the resulting feature matches are used in conjunction with the smartphone's orientation sensors to determine the exact location of each book.

Keywords: Visual search, location sensing, inventory management

1. INTRODUCTION

Accurately tracking a large set of assets is a difficult, time-consuming task for many people and institutions. Asset inventories are typically maintained by manual updates or deployments of barcode or radio-frequency identification (RFID) technologies. Manual updates are costly in terms of human labor and error-prone. Expensive barcode or RFID systems, on the other hand, may only be affordable to large institutions and require physically attaching a marker to each asset. Given these disadvantages, a more efficient and affordable asset tracking system is desired.

Modern smartphones are equipped with auto-focus cameras, orientation sensors, and high-speed network access. These capabilities of smartphones make them an attractive choice for automated asset tracking. In our asset tracking system, the user simply snaps a few photos with a smartphone of the assets that should be indexed. The pictures are transmitted from the phone to a processing server. On the server, robust image-based features are extracted from the query photos and matched against a large visual database of previously indexed assets or products. Matching these robust features enables automatic identification of assets in the query photos. Subsequently, meta data such as the name, description, price, and manufacturer for each asset can be easily retrieved from the Internet and transferred into the user's inventory database. When the smartphone receives the response from the server, the recognized assets can also be highlighted in the phone's viewfinder. Suppose

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