Safwan Wshah, University of Vermont

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RESEARCH INTERESTS

My research interests lie at the intersection of machine-learning theory and its applications in the fields of medicine, transportation and energy. In my lab we research deep learning and deep reinforcement learning models to improve their adaptability and generalization to allow higher-quality applications to broader classes of real-life problems.

EDUCATION

State University of NewYork at Buffalo, Buffalo, NY USA
PhD, Department of Computer Science and Engineering, May 2008 to June 2012.

University of Cincinnati, Cincinnati, OH USA
PhD Student, Department of Electrical and Computer Engineering, Sep 2007 to May 2008.(Transfered to State University of NewYork at Buffalo)

The University of Jordan, Amman, Jordan
MSc. in Communication engineering, Department of Electrical Engineering, Sep 2002 to Jul 2005.

Princess Sumaya University, Amman, Jordan
BSc. in Electronics engineering, Department of Electronics Engineering, Oct. 1996 to Feb. 2001.

ACADEMIC EXPERIENCE

University of Vermont, Burlington, VT, USA **August 2017 to Present**
Assistant Professor, Director of Vermont Artificial Intelligence Lab VaiL

At the Vermont Artificial Intelligence Laboratory (VaiL) we work at the intersection of machine learning theory and application. Our mission is to improve the adaptability and generalization of machine learning methods, in order to allow higher-quality applications to broader classes of real-life problems. We research deep learning, deep reinforcement learning, and memory-augmented models. Our main application domain is the energy field, though we also collaborate with groups from the medical and transportation fields. For a complete list of recent projects: http://swshah.w3.uvm.edu/vail/research.php

RESEARCH EXPERIENCE

PARC - A Xerox Company, Webster, NY, USA **June 2014 to August 2017**
Research Scientist

Creating new machine learning and image processing algorithms in computer vision and document imaging fields for transportation, healthcare and education. I Implemented algorithms for object detection, tracking, image classification, and domain adaptation. Trained and tested deep learning models using Caffe, TensorFlow and MatConvNet under both Linux and Windows. Instructed internal course "Deep Learning in Computer Vision".

- **Vehicle Passenger Detection System**: Implemented scalable Deep Neural Networks algorithms for counting passengers in vehicles. Xerox Vehicle Passenger Detection System identifies the number of occupants in a vehicle with more than 95% accuracy, at speeds ranging from stop and go to 100 mph. I created scalable deep learning convolutional neural network algorithms to count the number of passengers inside

the car, for more information refer to Xerox-Vehicle-Passenger-Detection-System.

- **Digital Alternatives**: Implemented high advance image processing algorithms to analysis documents captured from different sources (mobile camera, electronic, scanned, etc) in order to fill them electronically on fly. The Xerox Digital Alternatives Tool maintain productivity and reduce document workflow complexity in an always-connected world. It is a workflow solution supporting today's increasingly mobile knowledge worker population, providing the ability to complete multiple workflows within a single application and without the need for paper.For more information refer to Xerox Digital Alternatives.

- **Xerox Ignite Educator Support System**: Implemented image processing and deep learning approaches based on auto-encoders and convolutional neural networks to recognize students handwriting from elementary schools. Ignite is a workflow and software solution that is using the power of data to transform K-12 education. Teacher would first scan students homework and/or exams into the Ignite system via a range of multifunctional input devices. Xerox Ignite reads, interprets, and analyzes the students work in minutes. For more information about the project refer to Ignite Educator Support System.

- **Human Video analytics**: In this on-going project we are building a set of algorithms for human activities recognition in surveillance cameras, algorithms include detection, tracking and action recognition.

- **Surgical Video Analytics**: This Project is a collaboration with University of Rochester Medical Center (URMC) in which we Implemented Deep Neural Networks and BoW algorithms for action quality assessment. Videos captured in-vivo during a surgical procedure are often post-analyzed in order to evaluate the quality of the procedure, identify errors that have taken place, assess the expertise and skill level of the surgeon, and to provide coaching and feedback to students of surgery. This analysis is currently done manually, requiring many hours of laborious inspection by expert surgeons.

Xerox Research Center, Webster, NY, USA **August 2012 to May 2014**
Research Scientist

Creating new machine learning and image processing algorithms in document imaging fields for transportation, healthcare and education. I Implemented image processing and machine learning, deep learning algorithms for handwriting recognition, form understanding, form registration, form data extraction and word spotting.

- **Form Registration**: Implemented image processing algorithms for independent global and local form registration for health care transaction processing.
- **Crowd Sourcing for Medical Forms**: Developed image processing modules to process different medical forms with emphasis on their crowdsourcability.
- **Statistical Toolkit**: Develop high level statistical toolkit (C/C++) that implements statistical analysis and machine learning functionalities such as Neural network, convolutional neural networks.
- **Expression Spotting System**: Implemented deep learning algorithms to perform a low level of information retrieval that detect and recognize specific information such as mail address, email address, phone number, dates, numerical tables, page number, etc...
- **Handwriting and Machine Printed Text Separation** : participated in implementing deep learning algorithms that separate handwritten from machine printed text in structured documents using auto-encoders.

Center for Unified Biometrics and Sensors, University at Buffalo, Buffalo, NY USA
Research Assistant **May 2008 to Sep. 2012**

- **Keyword spotting in off-line Handwritten Documents** : Proposed filler and background models for keyword spotting that combines local scores and global word hypotheses scores to learn a classifier for keywords and non-keywords based on statistical Markov models..

- **Arabic Handwritten Recognition**: Developed features and statistical approaches to recognize full Arabic handwritten documents without line segmentation. The method used n-gram language modeling for enhancing the results. In this project I developed advanced technique based on continuous probability-Connected Hidden Markov Models with robust features such as GSC (Gradient-Structural-Concavity) features to gain the best performance on full Arabic document. The developed algorithm alleviated the need for segmenting Arabic text prior to recognition. The algorithm performed concurrently both segmentation and recognition, the algorithm achieved 70% accuracy on the public AMA dataset.

Teaching Experience

Assistant Professor, University of Vermont, Computer Science Department (2017 until Present): Teaching machine learning and deep learning courses. These courses offered for both graduate and senior students. Courses are developed from scratch.

Adjunct Professor, University of Rochester, Electrical and Computer Engineering Department (Fall-2016): Teaching Digital Signal Processing course as primary instructor. The course had 45 students from graduate and undergraduate levels from Electrical and Biomedical Engineering Departments.

Industry Course, PARC (Fall-2015): Teaching *Deep Learning in Computer Vision* for more than 50 engineers and researchers from different backgrounds.

Doctoral Dissertation

Title: "Word Spotting in Multilingual Handwritten Documents."
Advisor: Prof. Venu Govindaraju, SUNY Distinguished Professor.

A new approach has been implemented for keywords spotting in multilingual handwritten documents based on statistical Markov models. The approach is script independent scalable over many languages such as English, Arabic and Devanagari and has many applications in information retrieval and indexing including language identification of handwritten documents.

Mentoring

Currently, I am supervising 8 students, Five PhD's and one MS student in Computer science, Complex systems programs and Electrical engineering. During my professional career as researcher at PARC and Xerox research labs I mentored four senior graduate students during their summer internships.

Industry Experience

Xerox, Webster, NY, USA
Software Engineer, Internship **May 2011 to Sep. 2011**

Built a framework to register forms globally and locally by developing machine learning and pattern matching algorithm.

Applied Media Analysis, Collge Park, MD, USA
Software Engineer, Internship **May 2010 to Sep. 2010**

Research and development of software for Arabic Optical Character Recognition using continuous probability-Connected Hidden Markov Models. The developed algorithm alleviated the need for segmenting Arabic text prior to recognition. The algorithm performed

concurrently both segmentation and recognition.

Copanion, Andover, MA, USA
Software Engineer, Internship **May 2009 to Sep. 2009**

Development of advanced convolutional neural network algorithms to recognize English handwritten text used for tax form recognition.

Lead Technologies
Software Engineer **Jan. 2001 to Sep. 2007**
Development and Research at different levels:

- Research in Image, Document, and Video processing algorithms.
- Implementing the developed algorithms under C, C++, Java, and .Net.
- Involved in training and guiding new members and updating work guidelines.
- Team leader (9 Team members), managing and supervising all team projects.

Grants Awarded

Localize Road Signs on both Image Coordinates and Geographic coordinates on real-world maps
Role: Sole PI
Amount: $345,000 (awarded)
Duration: 2018-2022
Funding source: Vermont Agency of Transportation, VT

Machine Learning Algorithm for Power Systems Parameters Verification
Role: PI
Amount: $90,000 (awarded)
Duration: 2019-2020
Funding source: The New York State Energy Research and Development Authority (NYSERDA)

MRI: Acquisition of a GPU Accelerated Vermont Advanced Computing Core.
Role: CO-PI
Amount: $893,120 (awarded)
Duration: 2018-2021
Funding source: NSF

Machine Deep Learning for Detection of Endoleak after Endovascular Abdominal Aortic Aneurysm Repair.
Role: PI
Amount: $25,000 (awarded)
Duration: 2018-2019
Funding source: UVMMC Department of Surgery, VT

OVPR Express
Role: PI
Amount: $3,000 (awarded)
Duration: 2018-2019
Funding source: UVM OVPR

Journal articles

C. Van Oort, J. Ferrell, J. Remington, **S. Wshah**, and J. Li, "AMP-GAN: Facilitating the Design of Anti-Microbial Peptides", To be submitted, arXiv, , 2020.

D. Wilson, T. Alshaabi, J. Minot, *C. Van Oort*, J. Nelson, **S. Wshah**, "Sign-Hunter: Classification & Geolocalization of the US. Traffic Signs", To be submitted, Pattern Recognition Journal.(impact factor 7.0)

K. McClure, B. Erdreich, J. H.T.Bates, R. McGinnis, A. Masquelin, and **S. Wshah**, "Classification and Detection of Breathing Patterns with Wearable Sensors and Deep Learning", submitted, Sensors Journal, 2020. (impact factor 3.275)

J. Ferrell, J. Remington, *C. Van Oort*, M. Sharafi, R. Aboushousha, Y. Janssen-Heininger and S. Schneebeli, M. Wargo, **S. Wshah** and J. Li "A Generative Approach toward Precision Antimicrobial Peptide Design", bioRxiv, 2020.

L. Bonnell, B. Littenberg, , **S. Wshah**, G. Rose, "Automated Identification of Unhealthy Drinking: A Machine Learning Approach". Journal of the American Board of Family Medicine, 2020 (impact factor 3)

F. Almutairy, T. Alshaabi, J. Nelson, and , **S. Wshah**, "ARTS: Automotive Repository of Traffic Signs for the United States", IEEE Transactions on Intelligent Transportation Systems. 2019. (impact factor 5.744).

S Hahn, M Perry, , **S Wshah**, CS Morris, DJ Bertges, "Machine Deep Learning Accurately Detects Endoleak After Endovascular Abdominal Aortic Aneurysm Re-pair", Journal of Vascular Surgery, 2019. (impact factor 3.7)

S. Wshah, C. Skalka and M. Price, "Machine Learning Methods for Post-Traumatic Stress Disorder Patient Prediction", JMIR, 2019 (impact factor 5)

S. Wshah, G. Kumar , V. Govindaraju, Statistical script independent word spotting in offline handwritten documents, Pattern Recognition Journal, 2014.

S. Wshah, I. Mansour, A Robust Algorithm for Face Detection in Color Images Based on Color Segmentation and Neural Network Techniques, Dirasat, University of Jordan, Engineering Science, Volume 33, No. 2, 2006.

Peer-Reviewed Conference Publications

F. Almutairy, R. Shadid, and **S. Wshah**, "Identification and Correction of False Data Injection Attacks against AC State Estimation using Deep Learning". Submitted, The IEEE Power & Energy Society General Meeting, Accepted. 2020. Acceptance Rate ∼**50**%

S. Wshah, R. Shadid , Y. Wu , *M. Matar* , B. Xu , W. Wu , Lin L., R. Elmoudi , "Deep Learning for Model Parameter Calibration in Power Systems", 2020 IEEE International Conference on Power System Technology (POWERCON), Accepted, August, 2020. Acceptance Rate ∼**50**%

W. Wu, L. Lin, **S. Wshah**, R. Elmoudi, B. Xu, "Generator Model Parameter Calibration Using Reinforcement Learning," IEEE Green Energy and Smart Systems Conference (IGESSC), Accepted Nov. 2020. Acceptance Rate ∼**40**%

L. Lin, W. Wu, **S. Wshah**, R. Elmoudi, B. Xu, "HPT-RL: Calibrating Power System Models based on Hierarchical Parameter Tuning and Reinforcement Learning," IEEE International Conference on Machine Learning and Applications (ICMLA), Accepted, Dec., 2020. Acceptance Rate ∼**30**%

A. Elhadad, T. Sullivan, **S. Wshah**, T. Xia, "Machine Learning for Respiratory Detection Via UWB Radar Sensor", 2020 IEEE International Symposium on Circuits & Systems (ISCAS) Acceptance Rate ∼**65**%

S. Hahn, C. Morris, D. Bertges, **S. Wshah**, "Deep Learning for Recognition of Endoleak after Endovascular Abdominal Aortic Aneurysm Repair", submitted to IEEE International Symposium on Biomedical Imaging (ISBI), 2019. Acceptance Rate ∼**35**%

S. Hamshaw , D. Denu,M. Holthuijzen, **S. Wshah**, D. Rizzo "Automating the classification of hysteresis in event concentration-discharge relationships". SEDHYD 2019 conference, At Reno, Nevada. 2019. Acceptance Rate ∼**65**%

S. Wshah, B. Xu, O. Bulan, J. Kumar, P. Paul, Deep learning architectures for domain adaptation in HOV/HOT lane enforcement, 2016 IEEE Winter Conference on Applications of Computer Vision (WACV 2016).

B. Xu, O. Bulan, J. Kumar, **S. Wshah**, V. Kozitsky, P. Paul, Comparison of Early and Late Information Fusion for Multi-camera HOV Lane Enforcement , IEEE 18th International Conference on Intelligent Transportation Systems, (ITSC 2015).

E. Gross, **S. Wshah**, I. Simmons, G. Skinnerl, A handwriting recognition system for the classroom, Fifth International Conference on Learning Analytics And Knowledge, (LAK 2015).

O. Bulan, **S. Wshah**, R. Palghat, V. Kozitsky, A. Burry, USDOT Number Localization and Recognition From Vehicle Side-View NIR Images , IEEE Conference on Computer Vision and Pattern Recognition Workshops, (CVPR 2015).

G. Kumar , **S. Wshah** ., G.Venu , Variational dynamic background model for keyword spotting in handwritten documents, Electronic Imaging. International Society for Optics and Photonics, (IS&T/SPIE 2013).

G. Kumar , **S. Wshah** ., G.Venu , Segmentation-free keyword spotting framework using dynamic background model, In proceeding of: Document Recognition and Retrieval XX, (DRR 2013).

S. Wshah., G. Kumar G., G. Venu , Multilingual Word Spotting in Offline Handwritten Documents , 21st International Conference on Pattern Recognition, (ICPR 2012).

S. Wshah ., Kumar G., Venu G., Script IndependentWord Spotting in Offline Handwritten Documents Based on Hidden Markov Models, International Conference on Frontiers in Handwriting Recognition, (ICFHR 2012).

S. Wshah, G.Venu , C. Yanfen , L. Huiping , A Novel Lexicon Reduction Method for Arabic Handwriting Recognition, International Conference on Pattern Recognition, (ICPR 2010).

S. Wshah , S. Zhixin , G. Venu , Segmentation of Arabic Handwriting Based on both Contour and Skeleton Segmentation, Conference on Document Analysis and Recognition (ICDAR 2009).

S. Wshah , I. Mansour , (2005). A Robust Algorithm for Face Detection in Color Images, IASTED International conference on visualization, imaging, and image processing (2005), Spain, (VIIP 2005).

Abstracts

C. Van Oort, B. Xu, L. Lin, **S. Wshah**, K. Morrissette, "Machine Learning Tools to Predict Clinical Outcomes of Hospitalized COVID-19 Patients", In Review, Society for Critical Care Medicine Congress.

B Erdreich, *K McClure*, AH Masquelin, R McGinnis, **S Wshah**, JHT Bates, Using Wearable Sensors and Deep Learning to Categorize and Detect Different Patterns of Breathing in Healthy Subjects, American Thoracic Society, 2020.

L. Bonnell, B. Littenberg, **S. Wshah**, G. Rose, Automated identification of unhealthy drinking using routinely collected data: A machine learning approach, accepted poster to APHA 2018.

SD Hamshaw, D Denu, MM Dewoolkar, M Holthuijzen, **S Wshah**, D Rizzo, Applying Deep Learning to Event Concentration-Discharge Hysteresis Patterns to Reveal Differences in Sediment Dynamics across Contrasting Watersheds, AGU Fall Meeting, 2018.

D. Wilson, **S. Wshah**, "Sign-Hunter: Classification and Geo-Localization of US Traffic Signs", VTrans Research Symposium 2020, 2020.

M. Clark, T. Laracy, W. Burns, **S. Wshah**, G. L Galford, "Machine Learning for Early Warning of Cyanobacteria Blooms in Vermont's Lake Champlain", AGU, 2020.

T. Osinsk, D. Arpit, **S. Wshah**, Ahmed Ghazi, Computer-generated assessment of technical surgical skills (CATS) , American Urological Association Annual Meeting, (AUA2016).

Patents

S. Hahn, C. Morris, D. Bertges, **S. Wshah**, Method and apparatus for detecting endoleaks on computerized tomography scans after endovascular aortic aneurysm repair, April 8, 2019, V0139.70127US00, (In review)

S. Wshah, B.i Xu, O. Bulan, System and method for expanding and training convolutional neural networks for large size input images, US Patent App. 15/194,757, 2019

R Eschbach, PJ Emmett, **S. Wshah**, EN Chapman, Methods and systems of creating a confidence map for fillable forms, US Patent App. 14/816,142, 2018

S. Wshah, R. Bala, D. Arpit, Method and system for evaluating the quality of a surgical procedure from in-vivo video, US Patent App. 15/138,494, 2017

S. Wshah, B. Xu, O. Bulan, Multi-layer fusion in a convolutional neural network for image classification, US Patent App. 15/179,403, 2017

Balamurugan, L. Stone,M. Samptha, R. Taylor, **S. Wshah**, Method and system for cost optimized crowdsourcing based enterprise form digitization, 20150052, 01, March 2015

M. Maltz, **S. Wshah**, Building tables with row and column heading from a scanned form, 20150435, 09 Jul 2015

S. Wshah, M. Maltz, D. Venable, Method and system of identifying fillable fields of an electronic form, 20151112US01, 10 Dec 2015

S. Wshah , M. Campanelli , Character recognition method and system using digit segmentation and recombination, US Patent App. 15/149,483,2013

S. Wshah ,M. Campanelli, Global registration of filled-out content in an application form, US Patent App. 15/149,483, 2013.

S. Wshah ,M. Campanelli , Y. Zhou, Method and apparatus for classifying machine printed text and handwritten text, US Patent App. 14/284,592, 2014

S. Wshah , M. Campanelli , Methods and devices for form-independent registration of filled-out content, US Patent US Patent App. 14/196,108, 2014

R. Eschbach , **S. Wshah**, Altering scans to include security features identifying scan origination, US Patent 9,258,452, 2014

E. Gross, G. Skinner, **S. Wshah** , Isaiah L Simmons, Confirming automatically recognized handwritten answers, US Patent App. 14/627,457, 2014

Honors & Awards

- PARC Special Award for Contributions to the Most Innovative Project. 2015
- Graduate Teaching Assistantship, University at Buffalo, Sep. 2010 - May 2012.
- Graduate Research Assistantship, University at Buffalo, May 2008 - Sep. 2010.
- Graduate Research Assistantship, University of Cincinnati, Jan 2008 - May 2008.
- Graduate Teaching Assistantship, University of Cincinnati, Sep. 2007 - Jan 2008.

Invited Talks

"**Deep Learning in Transportation Applications**", Invited talk at UVM CEE University, November, 2017.

"**Opportunities and Challenges of Machine Learning in Real-World Applications**", Invited talk at PSUT University, January 2, 2018.

"**Opportunities and Challenges of Machine Learning in Real-World Applications**", Invited talk at UVM EBE University, Feb-2, 2018.

"**Deep Learning in Radiology: Recent Advances, Challenges and Future Trends**", Invited talk at UVMMC, Radiology department, September, 2018.

"**Model Parameters Verification", Invited talk at UVM EBE**, Feb-2, 2019.

"**Machine learning challenges and opportunities in the Energy field**", NYSERDA, NY, Oct. 2019.

"**Deep Learning in Radiology: Recent Advances, Challenges and Future Trends**", University of Pittsburgh, Medical school. 2020

Program Committee

International Conference on Pattern Recognition (ICPR 2020, ICPR2019, ICPR 2018, ICPR2017)

ASIP-2021 Asia Symposium on Image Processing.

The 2017 International Conference on Advanced Technologies Enhancing Education (ICAT2E2017), 2017

The Seventh International Conference on Performance, Safety and Robustness in Complex Systems and Applications(PESARO 2017), 2017

ICDAR Conference on Document Analysis and Recognition, Nancy, France, 2015.

Program Chair, 5th International Workshop on Multilingual OCR, Nancy, France, 2015.

IEEE International Symposium on Multimedia (ISM2013).

Reviewer for Journals and Conferences

IEEE Transactions on Smart Grid

IEEE Power & Energy society general meeting IEEEPES2019, IEEEPES2020.

Energies- Open Access Journal by MDPI

IEEE PES General Meeting

Journal of Pattern recognition.

International Journal of Pattern Recognition and Artificial Intelligence.

International Conference on Pattern Recognition

Signal Image and Video Processing journal.

Journal of smart science.

Patterns Journal.

professional memberships

member of IEEE (Institute of Electrical and Electronics Engineers) and Computing Machinery (ACM)

Technical Skills

Platforms: Windows, UNIX
Programming Languages and toolkits: Python, C, C++, Caffe, Torch, Matlab, OpenCV, .Net (C#, VB), Java, VB, SQL, Assembly, verilog.
Scripting Language: Shell Scripts, Perl.
Web Technologies : HTML, JavaScript, VBScript.
Tools : DirectX, Nvidia GPU processing.