Muhammad Usman Rafique

Contact Information

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Research Areas

Computer Vision and Machine learning. Recent work focuses on weakly supervised deep learning methods for image synthesis and semantic segmentation.

Education

Ph.D. Electrical Engineering **2016 - 2021(Expected)**
University of Kentucky, USA

MS Mechatronics Engineering **2008 - 2010**
National University of Sciences and Technology (NUST), Pakistan

BE Mechatronics Engineering **2003 - 2007**
National University of Sciences and Technology (NUST), Pakistan

Research and Teaching Experience

University of Kentucky, USA
Graduate Research and Teaching Assistant **Aug 2016 - present**
Dissertation title "Weakly Supervised Learning for Multi-Image Synthesis." Supervised by Dr. Nathan Jacobs (CS) and Dr. Samson Cheung (ECE)

The Hong Kong Polytechnic University, Hong Kong
Research Assistant, Department of Computing **June 2015 - Aug 2016**
Research on software defined battery and control of manipulators using recurrent neural networks.

Air University, Pakistan
Lecturer **Sep 2010 - June 2015**
Teaching courses on robotics and embedded systems. Organized autonomous robot competitions.

SUPARCO, National Space Agency of Pakistan
Research and Development Engineer **July, 2007 - Aug 2008**
Worked in Attitude and Orbit Control System (AOCS) Lab.

Research Projects

Outdoor Image Synthesis (Conditional GAN) Given a source image, our method synthesizes novel images of the same scene under different conditions, which could include changes in the time of day, season, or weather conditions. We prepare a large-scale dataset containing short- and long-term changes in visual appearance. (Under Review, 2021)

Novel View Synthesis A novel fully convolutional network that synthesizes images from novel view points from a single input image. The proposed method gets state-of-the-art results on KITTI benchmark and our own dataset (outdoor imagery of Brooklyn). (BMVC 2020)

Multi-Image Fusion A fusion method that combines multiple noisy overhead images to make a single cloud-free weakly image. We proposed a weakly supervised fusion method that is trained without annotations of artifacts such as clouds. (EARTHVISION 2019)

Weakly Supervised Segmentation A weakly supervised algorithm for dense, pixel-wise segmentation of buildings from aerial images. Only horizontal bounding boxes are used as supervision during the training training. (IGARSS 2019.)

Selected Publications

Full list of publications available on Google Scholar: https://goo.gl/LDgdAp

M. Usman Rafique, Y. Zhang, B. Brodie, N. Jacobs, "Unifying Guided and Unguided Outdoor Image Synthesis," Under Review, 2021.

M. Usman Rafique, H. Blanton, N. Snavely, N. Jacobs, "Generative Appearance Flow: A Hybrid Approach for Outdoor View Synthesis," The British Machine Vision Conference (BMVC), 2020.

M. Usman Rafique, H. Blanton, N. Jacobs, "Weakly Supervised Fusion of Multiple Overhead Images," IEEE/ISPRS Workshop: Large Scale Computer Vision for Remote Sensing Imagery (EARTHVISION), 2019.

M. Usman Rafique, N. Jacobs, "Weakly Supervised Building Segmentation from Aerial Images," IEEE International Geoscience and Remote Sensing Symposium (IGARSS), 2019.

N. Jacobs, A. Kraft, **M. Usman Rafique**, R. D. Sharma, "A Weakly Supervised Approach for Estimating Spatial Density Functions from High-Resolution Satellite Imagery," The 26th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems, pp. 33-42. ACM, 2018.

S. C. Cheung, **M. Usman Rafique**, and W. T. Tan, "Privacy-Preserving Distributed Deep Learning with Privacy Transformation," IEEE International Workshop on Information Forensics and Security (WIFS), 2018.

M. Usman Rafique, S. C. Cheung, "Tracking Attacks on Virtual Reality Systems", IEEE Consumer Electronics Magazine (CEM), 2019.

S. Li, H. Wang, **M. Usman Rafique**, "A Novel Recurrent Neural Network for Manipulator Control with Improved Noise Tolerance", IEEE Transactions on Neural Networks and Learning Systems, 2017.

Skills and Tools

Programming Languages: Python, PyTorch, MATLAB, OpenCV, Keras, C/C++

- Computer Vision and Deep Learning
  - Experience with various CNNs for classification, semantic segmentation, and image synthesis
- Robotics
  - Localization (Particle and Kalman Filters), Motion Planning (Bug algorithm, artificial potential field, probabilistic road map, VFH, velocity obstacle and MTSG)
  - Control: Closed loop control of differential drive and Ackermann steering mobile robots, PID control of navigation of self designed mobile robots
- Embedded Systems
  - Worked on several microcontrollers (PIC, Atmel, Arduino), FPGA boards (Altera). Altera FPGA: Verilog HDL and NIOS II Soft Processor

Peer Reviewer

- IEEE Conference on Computer Vision and Pattern Recognition (CVPR) 2021
- IEEE Winter Conference on Applications of Computer Visioon (WACV) 2021
- British Machine Vision Conference (BMVC) 2020
- IEEE Transactions on Image Processiong (TIP)
- IEEE Transactions on Multimedia (TMM)
- International Conference on Acoustics, Speech, and Signal Processing (ICASSP) 2019

Achievements

- Nominated by the department of Electrical and Computer Engineering for the College of Engineering Outstanding PhD student award, 2020.
- Recipient of graduate fellowship by department of Electrical and Computer Engineering, University of Kentucky, 2016.
- Received President's Gold Medal in MS Mechatronics Engineering 2008 - 2010 batch with CGPA of 3.95 / 4.00, 2010
- Won travel grant by government of Pakistan to present paper in ICCAR 2015 in Singapore, 2015
- Organized Robotic Competitions in Air University: 2010, 2012, 2013 and 2014.
- Won university grant of 5,000 USD for Electrical Car "Markhor", 2015
- Participated in Shell Eco-Marathon Asia in Philippines, 2015
- Won grant of 7,500 USD from Higher Education Commission (government) and Air University for electrical car "Air-X", 2011
- Participated in Shell Eco-Marathon Asia in Malaysia, 2011
- Won 1st Prize in the National Engineering Robotics Contest 2006 (NERC)
- Won Higher Education Commission grant of 18,500 USD for Final Year Project in Bachelors of Engineering at NUST, 2006
- Received Academic Scholarship during Bachelors of Engineering at NUST, 2006