Announces the Ph.D. Dissertation Defense of

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for the degree of Doctor of Philosophy (Ph.D.)

“Machine Learning Methods for Image Enhancement in Degraded Visual Environments”

June 24, 2022, 10:00 a.m.
Virtual Dissertation

Zoom Meeting
Meeting ID: 883 1214 0283
Passcode: 376463

DEPARTMENT:
Electrical Engineering and Computer Science

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ABSTRACT OF DISSERTATION
Significant reduction in space, weight, power, and cost (SWAP-C) of imaging hardware has induced a paradigm shift in remote sensing where unmanned platforms have become the mainstay. However, mitigating the degraded visual environment (DVE) remains an issue. DVEs can cause a loss of contrast and image detail due to particle scattering and distortion due to turbulence-induced effects. The problem is especially challenging when imaging from unmanned platforms such as autonomous underwater vehicles (AUV) and unmanned aerial vehicles (UAV). While single-frame image restoration techniques have been studied extensively in recent years, single image capture is not adequate to address the effects of DVEs due to under-sampling, low dynamic range, and chromatic aberration. Significant development has been made to employ multi-frame image fusion techniques to take advantage of spatial and temporal information to aid in the recovery of corrupted image detail and high-frequency content and increasing dynamic range. In this dissertation, a supervised multi-frame image enhancement technique is proposed and evaluated to restore images distorted by DVEs. This approach utilizes a generative adversarial network (GAN) framework to predict the optimal weight maps in a balanced fusion technique that can reduce image distortion, recover crisp image detail, and reduce the overall noise figure. The proposed algorithm is designed based on the analysis of several key research topics in image degradation modeling, single image enhancement, and multi-frame image fusion. A key contribution of this paper is the adoption of an image loss function that incorporates an innovative combined correntropy and Fourier space loss function to reinforce the network in both the spatial and frequency domain. The correntropy loss function allows for the reduction of non-gaussian noise caused by detector noise, whereas the Fourier space loss enforces the correction of geometric distortion caused by turbulence. The performance of the proposed algorithm is then evaluated against images captured by the Unobtrusive Multi-static Serial LiDAR Imager (UMSLI) in the test tank and field experiments and turbulence images captured from experiments conducted at the Naval Research Lab’s Simulated Turbulence and Turbidity Environment (NRL-SS SiTTE).
BIOGRAPHICAL SKETCH
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Time in Preparation: Fall 2019 – Summer 2022
Qualifying Examination Passed: Spring 2020

Published Papers:


Ouyang, Bing, Dennis Estrada, Yanjun Li, and Fauzia Ahmad. "Human activity monitoring using a compressive active sensing electro-optical sensor." In *Big Data: Learning, Analytics, and Applications*, vol. 10989, p. 109890H. International Society for Optics and Photonics, 2019.