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Lifetime Achievement Keynote

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North Carolina A&T State University, USA
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Current trends concerning Secure and Safe Assured Autonomy, Data Stream Processing, Testing& Evaluation, and Efficient Perception Systems

ABSTRACT: The integration of Unmanned Aerial Systems (UAS), personal air vehicles, and Urban Air Mobility (UAM) as part of Advanced Air Mobility (AAM) systems into the National Airspace System (NAS) is quickly becoming mainstream for future transportation systems. New developments leverage technologies in autonomy, UAS Traffic Management (UTM), electric powertrain reliability, multi-redundant flight system architectures, and advanced wireless connectivity, to enable the unique requirements of UAM airspace and aircraft management. However, these advancements lead to numerous challenges for the safety and reliability of UAM deployment. The primary goal of our team effort is to develop new technologies and innovative operational concepts which can ensure safe, secure and robust integration of autonomous vehicles into UAM while maintaining inter-operability with existing civil air transportation safety standards. My presentation will cover three main topics which aim to advance future autonomous air traffic transportation systems using artificial intelligence. First, with the large volume of sensor data streams generated by UAS, the information processing module demands fast and efficient techniques for ensuring the safe operation of the entire air traffic network. By focusing on developing efficient techniques to capture the patterns of sensor streams with no prior knowledge, we've proposed a novel density-based stream data clustering method to explore the characteristics of those data streams without utilizing prior knowledge. An efficient unsupervised feature selection procedure created through feature clustering is introduced to enhance computational efficiency. Second, the testing and evaluation of multi-agent UAV systems plays an important role in ensuring the safety of UAS in future UAM. We proposed a data-driven framework for multi-UAVs to evaluate their performance in executing missions in the physical world. The seven micro-behaviors, listed here as modes of operation are leveraged to describe the autonomous functionalities of the UAVs. To incorporate the impact of uncertainties caused by different environmental parameters, we adopt data mining tools to generate challenging and complex scenarios from the simulated flight log data collected from the UAV missions. We also developed

reinforcement learning based safety control mechanism to ensure hardware safety of the UAV systems during the testing and evaluation phase. Finally, Convolution Neural Network (CNN) is widely used for gauging perception tasks in UASs. However, the resource limitations (such as the battery life, and computation power) prevent their use in complex, high-end, and computationally expensive CNN models. Hence, we are tasked in investigating ways to efficiently and effectively improve CNN performance utilizing self-attention mechanisms. We have validated that the self-attention mechanism will increase CNN performance with very minimal computational overhead compared to the conventional approaches which increase the depth, or width of the network.

Bio: Ebbie Homaifar is a Samuel P. Langley Distinguished Professor, Duke Energy Eminent Professor and professor in the Department of Electrical and Computer Engineering at North Carolina A&T State University (NCA&TSU). He received both a B.S. and M.S. degree in Electrical Engineering from the State University of New York at Stony Brook in 1979 and 1980, respectively. In 1987, he obtained a Ph.D. from the University of Alabama in Electrical Engineering. In addition, he is the current Director of the Autonomous Control and Information Technology Institute and the Testing, Evaluation, and Control of Heterogeneous Large-scale Systems of Autonomous Vehicles (TECHLAV) at NC A&T SU.

His research interests include machine learning, testing and evaluation of autonomous vehicles, big data processing, optimization, optimal control, flexible robotics, modeling, and signal processing. Dr. Homaifar has authored and co-authored over three hundred articles in numerous journals and conference proceedings, published one book, and is featured in three chapters of others. He has participated in six short courses, serves as an associate editor of the Journal of Intelligent Automation and Soft Computing, and is frequent reviewer for IEEE Transactions on Fuzzy Systems, Man Machines & Cybernetics, and Neural Networks. He is a member of the IEEE Control Society, Sigma Xi, Tau Beta Pi, and Eta Kapa Nu.

Most recently, he was awarded the honor to serve as Lead PI on behalf of North Carolina A&T State University for “Secure and Safe Assured Autonomy S2A2”. Because of his leadership in the field this NASA selection was awarded to NCA&T out of over 90 university applicants. After 30 years, despite his many accomplishments and research successes his passion remains his students. While he currently acts as lead PI for over a half dozen large grants he still makes time to teach and mentor. Even during this current pandemic challenge he still supports over 30 graduate students and meets virtually with them to guide them in their research and studies. As he often states, “I get my energy from my students and it’s why I get up in the morning. I love what I do!”