NSF CREST MECIS – Spring 2024 Webinar Series – 5/8/2024

Presentation 1: **Daniel Perez (Master's Student) and Dr. Bo Zou, University of Illinois – Chicago (UIC)**

Title: Modeling Early-Stage Advanced Air Mobility Services and a Case Study in the Chicago Metropolitan Region

Abstract:

In the rapidly evolving transportation landscape, one of the most remarkable transformations is the development of Advanced Air Mobility, or AAM, which expands the mobility space from predominantly surface-based to encompassing the airspace. In this research, we propose a time-expanded network flow model to investigate early-stage deployment of AAM for daily commuting where trips are made between two vertiports, one located in the suburb and one located in the downtown central business district, in a metropolitan region. The model seeks to minimize the total AAM operating cost while accounting for a variety of operational constraints such as AAM vehicle fleet size, seat capacity, and traveler time windows. Using realistic parameters values and traveler demand profiles, we apply the model to a case study in the Chicago metro region. Preliminary results show that AAM may lead to reduced system travel time, energy consumption, and CO_2 emissions compared to today's auto commuting. Sensitivity analysis is further conducted. These findings will inform near-future design and implementation of AAM operations in metropolitan regions.

Presentation 2: **Eric X. Rodriguez (Master's Student) and Dr. Qi Lu, MARS Lab@ Computer Science, University of Texas Rio Grande Valley (UTCRS)**

Title: Tuning PID Controller for Quadrotor Using Particle Swarm Optimization

Abstract:

The objective of this research is to establish a fundamental approach to tuning PID (Proportional-Integral-Derivative) parameters for a simulated quadrotor drone. Implementing a PID controller for autonomous flight provides a straightforward and efficient method for monitoring and correcting robotic movement based on the robot's current state. However, applying a PID approach to a quadrotor's flight controller poses challenges, such as assigning multiple parameters to control an inherently under-actuated system. This includes the need to find optimal parameter values that reduce the likelihood of large overshoots and lengthy adjustment times. Ineffectively tuning PID parameters can have detrimental effects on autonomously designed controllers, and manual tuning, while possible, can be a time-consuming and sub-optimal process. To address these challenges, this research proposes the utilization of Particle Swarm Optimization (PSO) for tuning PID parameters in a simulated quadrotor. The performance of the quadrotor is evaluated using a specific set of PID parameters. The PSO algorithm is employed to find optimal PID values for thrust, yaw, and translational PIDs for x- and y-positions by identifying converging values across randomly created particles. The results demonstrate converging properties for particles that achieve minimal fitness scores, particularly in reducing overshoot. Furthermore, the results indicate that the optimized PID controller outperforms the default PID controller without optimization.

Presentation 3: **Dr. Fatemeh (Noosheen) Nazari and Dr. Mohamadhossein Noruzoliaee, University of Texas Rio Grande Valley (UTRGV)**

Title: Willingness-to-Pay for Flying Taxi in the City of Chicago

Abstract:

Recent advances in electric vertical takeoff and landing (eVTOL) aircraft technology have made urban air mobility (UAM) viable in the foreseeable future. UAM is expected to mitigate traffic congestion and reduce travel times by providing ubiquitous on-demand shared mobility services, conditional on overcoming barriers to its mass deployment, including vehicle technology, infrastructure, and consumer acceptance. Focusing on public acceptance behavior, this study makes three empirical contributions. First, consumer willingness-to-pay (WTP) for using UAM services is derived by estimating a hybrid choice model, which is much needed given that UAM service price may hinder its widespread acceptance. Second, the presented model captures the effects of three latent attitudinal and perceptual factors, including (i) acrophobia, (ii) utilitarian beliefs, which relate to individuals' rational decision-making (i.e., behavior driven by satisfying basic needs and solving problems), and (iii) hedonic beliefs, which mainly express emotional decision making (i.e., behavior driven by stimulating pleasure or pain receptors). The third contribution relates to the design of a stated preferences experiment and data collection in the U.S. City of Chicago. Specifically, the survey focuses on access trips to the Chicago O'Hare International Airport, which can be made using eVTOL, car, rail, and ground ridesharing. By estimating a hybrid choice model on the dataset, the study findings shed light on the determinants of user preference for eVTOL, which further provide policy implications intriguing for policymakers and stakeholders.

Presentation 4: **Alejandro Barrera (Master's Student), Dr. Constantine Tarawneh, and Dr. Farid Ahmed, University of Texas Rio Grande Valley (UTRGV)**

Title: Development and Testing of a Prototype Erbium-Doped Lithium Tantalate Based Sensor for UAV Infrastructure Crack Detection

Abstract:

Ensuring the safety and longevity of infrastructure is crucial to safeguarding communities and promoting economic competitiveness. In this study, the development of a novel sensor for detecting and characterizing cracks in infrastructure, particularly suited for deployment on Unmanned Aerial Vehicles (UAVs) is presented. The sensor utilizes a sophisticated setup involving laser triangulation and nanoparticles, with a focus on leveraging Erbium-doped Lithium Tantalate nanoparticles. Experimental evaluation of these nanoparticles across the near-infrared spectrum has been conducted to optimize their absorption and emission properties, crucial for enhancing sensor performance. The investigation encompasses various crack characterization methods, integrating innovative nanoparticle techniques to augment sensing capabilities. Preliminary experimental data acquired from the laboratory testing demonstrates the viability of this sensor in accurately detecting and quantifying cracks from distances of up to 4 feet. This research presents a significant step forward in advancing infrastructure health monitoring through innovative sensor technologies embedded within UAVs.