ECE Graduate Research Seminars-Summer 2024

In Person Sessions: June 3-4, 2024

Remote Sessions: June 17-18, 2024

June 17, 2024-Morning Session

Name: Oswald Lawson
Area of Research: Power Systems Engineering
Name of Supervisors: Jing Jiang and Dennis Michaelson

An Analysis of a Structure for Bidirectional Power Transfer
A major goal of many countries in the world is to increase the proportion of electricity sources that is renewable. Because of that goal, there is a requirement to build the infrastructure necessary to accommodate the differences and challenges of an electrical grid based on renewable resources. Various avenues are being researched to construct these requisite supporting mechanisms. These avenues include the idea of bidirectional energy transfer as a means of increasing the electricity storage capacity of the grid; a popular conception is V2X (vehicle-to-everything) based technology, wherein power flows between a larger grid and one or more electric vehicle(s). However, in most of the literature, implementation of bidirectional energy transfer typically consists of a DC voltage source at one of the terminals; in other words, it does not consider two voltage sources that may be operating at different frequencies. This project thus investigates an architecture to facilitate power transfer between two voltage sources that are operating at two different frequencies. It conducts analysis to determine an appropriate digital controller to implement the investigated architecture. Finally, the analysis is verified in MATLAB/Simulink.

Name: Moteaal Asadi Shirzi
Area of Research: Robotics and Control
Name of Supervisor: Mehrdad Kermani

Real-time Point Localization on Plants using Feature-based Soft Margin SVM-PCA Method
This manuscript presents a real-time method designed for the recognition and precise localization of specific points on plants. Identifying these points is an essential component of a robotic stem-stake coupling system currently in development. The system is engineered to accurately place clips at designated points along the stem, termed 'clipping points,' to secure the stem to a stake. This support mechanism is vital for stabilizing plants during transport or throughout their growth phase. Traditionally, the execution of this task has depended on the expertise of trained horticultural workers. We have leveraged such expertise to validate our algorithm's output, particularly the accuracy of the identified clipping points. Our approach has been applied to real-world image data collected from various propagation facilities and greenhouses for these evaluations. Comparative analysis with existing algorithms reveals that our results are notably satisfactory. The results also demonstrate the potential and value of our proposed approach for other autonomous operations in the field of precision agriculture.

Name: Kimia Aghamohammadesmaeilketabforoosh
Area of Research: Software Engineering
Name of Supervisor: Joshua Pearce

Creating Custom 3D Printing Material Colors Using Optical Modeling of Waste Plastic
This initiative has developed a software capable of replicating the spectral information of a specified color by utilizing hues accessible in the color inventory. Additionally, it reconstructs 3D printing filament utilizing discarded plastic from 3D printing processes.

Name: Joel Miller
Area of Research: Software Engineering
Name of Supervisors: Dr Soodeh Nikan and Dr Mohamed Zaki Hussein

Autonomous Vehicle Driver Takeovers
An adaptive takeover offers a novel approach to solving the Autonomous Vehicle (AV) control transfer problem. By tailoring an AV takeover request to suit an individual driver based on their specific situation, an adaptive takeover serves to optimally support the driver, offering a human-centered approach to AVs while ensuring road safety whenever the automation is unable to operate.

Name: Roksana Yahyaabadi
Name of Supervisors: Soodeh Nikan and Abdallah Shami

From Wheels to AI: Advances Driving Maneuver Detection Through Active Learning Employing Vehicle Dynamics
Detecting driving maneuvers from vehicle dynamics and other driver-specific data can improve the safety margins of Advanced Driver Assistance Systems (ADAS) by enabling early detection of dangerous driving events. Building these predictive models requires large, annotated datasets that are labor-intensive to construct using manual labeling. To overcome this challenge, this paper introduces a novel and effective approach for maneuver detection by harnessing vehicle dynamic signals through Active Learning. By engineering informative dynamic signals as features and employing an Active Learning strategy, maneuver types can be accurately identified. Utilizing XGBoost as its core, our approach achieved a Macro accuracy of 91.40\%—a critical metric for assessing performance in imbalanced datasets— across more than 44,200 test samples from a total of 58,936.

Name: Oluwadamilola Kadiri
Area of Research: Robotics and Control
Name of Supervisor: Ken McIsaac

ScaleSense: Scale-Aware Improvement of AI-Based Monocular Depth Estimation via Camera Pose Adaptation

Depth estimation is crucial for robotic navigation, particularly in extraterrestrial exploration. However, the accuracy of monocular depth estimators can be compromised in atypical camera poses, such as during mobile robot traversals over inclines and uneven terrain. This research introduces “ScaleSense,” a novel approach that addresses pose biases in AI-based monocular depth estimation by incorporating camera poses obtained using scale-aware feature extraction as prior information during model training. The objective is to create a more adaptable depth estimator capable of producing accurate depth maps in uncommon camera poses. The methodology involves encoding the front-facing camera pose of a rover as an additional input to a U-Net-based monocular depth estimator. This is achieved by leveraging images from a rear-facing camera, typically used for regolith tracking, and extracting pose information through SIFT and RANSAC algorithms. The pose is scaled using known dimensions of objects in the rear view and refined using a particle filter algorithm. This refined pose is translated to estimate the front-facing camera pose. The estimated front-facing camera pose will be evaluated by comparing it with a ground truth obtained via Stereo SLAM, using the Absolute Trajectory Error metric. “ScaleSense” demonstrates how traditional computer vision techniques can enhance the performance of AI algorithms in depth estimation, offering a viable solution for micro-rover teams operating under budget constraints. This presentation will primarily focus on the novel method for front-facing camera pose estimation, detailing the process and its implications for monocular depth estimation.