Sabbatical Report

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During my sabbatical, I focused on advancing my research portfolio, completing long-term projects, and enhancing my professional expertise in emerging technologies. This report summarizes key accomplishments in publications, intellectual property development, conference participation, and technical skill advancement that will directly benefit my teaching and research capabilities moving forward.

Research Accomplishments & Publications

Peer-Reviewed Journal Article

Title: At-Home Breath Data Collection for Signatures of Type 2 Diabetes: A Pilot Clinical Study
Journal: Biosensors, Vol. 15, No. 3, February, 2025, DOI: 10.3390/bios15030149.
Abstract: This study investigates the potential of volatile organic compounds (VOCs) in breath as non-invasive biomarkers for monitoring blood glucose levels in individuals with Type 2 diabetes mellitus (T2DM). A pilot clinical study was conducted to explore the correlation between VOCs and blood glucose levels in six T2DM patients. Participants used a custom-developed sensor device to collect breath data at home, alongside finger-stick blood glucose readings. Breath data were transmitted to a cloud database, while blood glucose readings were recorded on paper charts. The sensor data from the device and the blood glucose readings from the charts were consolidated to create the study dataset. Support vector machine and random forest models were employed to analyze the dataset, which achieved accuracies of 85% and 82%, respectively. The results demonstrate the feasibility of at-home breath sensor data collection for clinical studies and suggest its potential as a viable alternative to traditional invasive glucose monitoring methods. Future studies will expand the dataset to include more participants and additional clinical variables to enhance model performance and predictive power. This research highlights the promise of non-invasive breath analysis for glucose monitoring, which could improve patient compliance and diabetes management.

Conference

Conference: Third International Conference on Disruptive Technologies (ICDT), Greater Noida, India, March 7-8, 2025
Title: Deep Reinforcement Learning for a Four Degree of Freedom Robot Arm Accelerated by Human Demonstration, pp. 537-542, doi: 10.1109/ICDT63985.2025.10986448
Abstract: This work investigates the use of deep reinforcement learning (DRL) for training a four-degree-of-freedom (4-DOF) robotic arm to efficiently and adaptively reach arbitrary target positions. A dueling double deep Q-network (D3QN) manages the large state-action space, while human demonstration data guides the agent's policy toward more human-like and effective trajectories. Experimental results show that integrating human demonstrations enables

the robot arm to achieve more precise target positioning more frequently and in fewer steps than a purely self-trained agent. To assess generality and adaptability, the approach is tested on both a PhantomX Reactor robot arm and a Dobot Magician robot arm, with adjustments made to the Denavit-Hartenberg parameters of the latter. After running 5000 simulated training episodes on each platform, the resulting model is then implemented on the Dobot hardware for 50 episodes, demonstrating the feasibility of accurately controlling a robotic arm model different from the one used during training. The method's potential extends to practical computer vision-guided tasks such as pick-and-place or peg insertion, thus showcasing its versatility in both simulation and physical implementations.

Title: Pre-contextualized Augmented Language Instructions for Autonomous Vision-and-Language Navigation, pp. 386-390, doi: 10.1109/ICDT63985.2025.10986598
Abstract: Advances in natural language has allowed for the automation of robotic tasks with minimal supervision, even in ambiguous situations. In the field of robotic navigation, human instruction can be utilized to allow a robotic agent to traverse unknown environments using instructional commands that mimic human-to-human interaction. This paper demonstrates the success of one such machine learning algorithms, delineating each machine learning architecture, and processes alternate fields where learning techniques can be applied for robotic automation.

Patent
A Device to Collect Breath Data from Type-2 Diabetes Patients in Real-Life Situations. US 12,278,013 B2 (Published: April 15, 2025)

New Initiative Robotics: Sim-to-Real Transfer Learning

This project implements a complete sim-to-real Reinforcement Learning pipeline for robotic manipulators with a unified control architecture that operates seamlessly in both simulation and real-world environments, enabling direct transfer of trained agents from virtual to physical systems. The system incorporates a vision-based detection and control pipeline, Robot Operating System (ROS), and NVIDIA GPU acceleration. Knowledge from this project will be directly integrated into the Robotics course I am teaching this semester, and will significantly expand both the research and teaching capabilities of the Intelligent Systems Lab.

Conclusions

I utilized my sabbatical semester to further my research and professional development. Several manuscripts and intellectual property projects that have been in development for quite some time have been completed and published. I completed data analysis on datasets I have collected over the past several years, which will be used for future funding applications. I attended conferences and worked on advancing my expertise in the robotics and AI space to bring the department's knowledge to the current state, which will be greatly impactful for teaching and research in the department, given the recent advancements in the field.