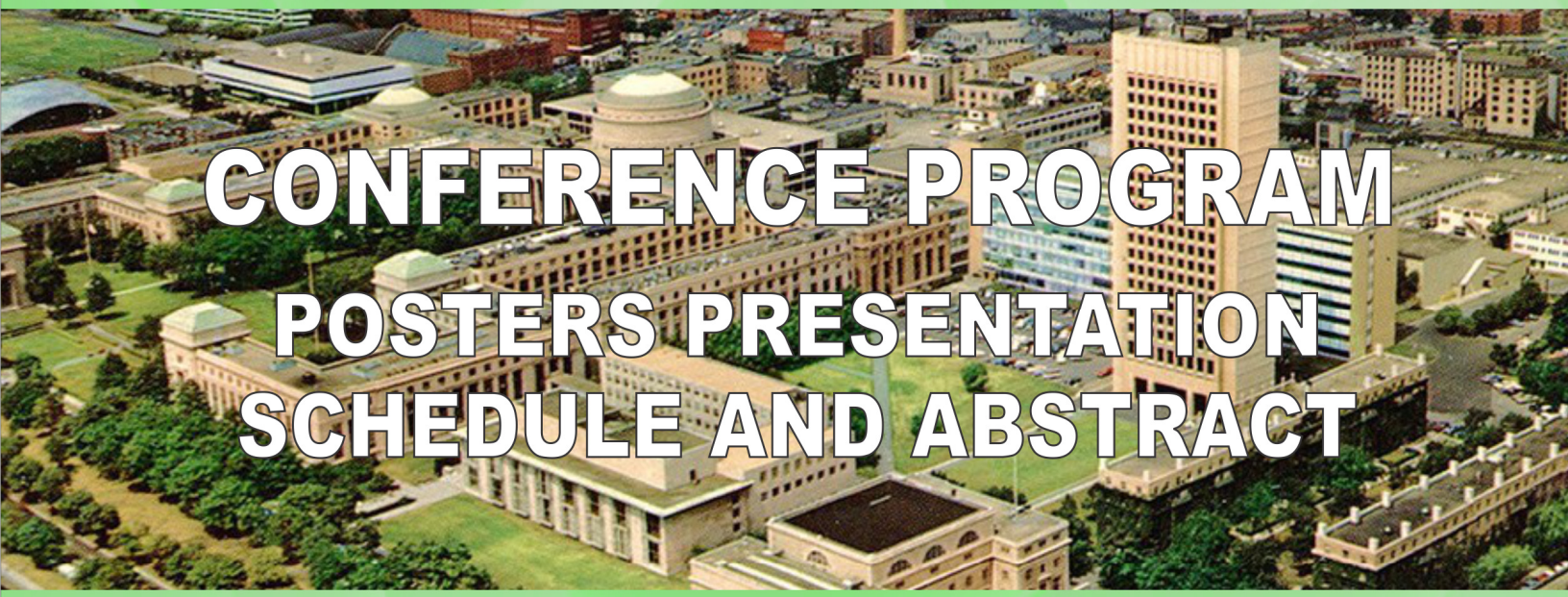
IEEE MIT URTC 2020

UNDERGRADUATE RESEARCH TECHNOLOGY CONFERENCE

October 09 - 11, 2020 | Cambridge, Massachusetts, USA (Virtual)

MEET INNOVATIVE TECHNOLOGY



CONFERENCE PROGRAM
POSTERS PRESENTATION
SCHEDULE AND ABSTRACT

Organized and Sponsored by IEEE Boston Section and MIT IEEE Student Branch

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IEEE Catalog Number: CFP20E50
ISBN: 978-1-7281-7571-3

October 11, 2020 (Sunday)

Technical Poster Presentation (Session #2 Room A)

EST 10:30am - 12:30am

Robotics and Controls, Security and Communications, Computer Systems, Human-Computer Interaction and Graphics Tracks

Track Chair: Meenu Singh

➢ **10:40am (PO20-0034)**

Active Domain Randomization for Robust Control

Qixuan Jin (California Institute of Technology)

The design of accurate and robust controllers for regulating robotic systems can be difficult due to the complexity of real world systems. Robust control strives to ensure desirable policy performance under the assumption that the real world parameters are bounded. Training controllers on real-world data can be expensive and inefficient. In recent years, simulations are used increasingly more often to train controller policies. However, discrepancies between simulation and reality can cause the failure of simulation-trained policies to generalize to real world applications. Domain randomization (DR) seeks to minimize this Sim2Real gap. The classic DR technique uniformly samples simulation parameters and trains the controller on the collection of these sampled simulations. The primary objective of our research is to improve the sampling efficiency of existing DR methods through active learning. We investigate the performance of model-based, active DR frameworks such as uncertainty sampling with Gaussian processes and meta-learning with neural networks. We observe notable faster empirical training convergence of these active frameworks for simulation environments such as the inverted pendulum and the 2D quadrotor.

➢ **10:50am (PO20-0035)**

Talk and Roll Bot – Mindcontrol

BingFang Chen (New York City College of Technology)

With the development of science and technology, many current research projects are focused on combining the fields of biology and computer technology to change people's â€œmisfortune" and improve and facilitate their lives. The focus of this research project is to design a controller to control an output device by using brain waves with the goal of creating an assistive technology device for people with physical disabilities. In the current phase of the research project, background research is done to learn to use the Electroencephalogram (EEG) measurements of brain waves to control an electromechanical device such as a DC motor. A modified Mindflex game controller is connected to Arduino and brain activity data is passed on to Processing code running on a PC in order to track and record brain wave patterns. The electrical activity of the brain will be used to control the DC motors in Talk and Roll Bot. Talk and Roll Bot is a mobile robot project created in the earlier phase of this research project. It combines computer hardware, computer software, mechanical, electrical, data communication and networking subsystems to create a working prototype of a computer controlled mobile robot system. Future work in this research project will focus on using the mind controller as an assistive technology device to help a person with a physical disability carry out some mobility tasks.

➢ **11:00am (PO20-0046)**

Hero-1 Robotic Arm

Joycephine Li (New York City College of Technology)

Motivation: Heathkit Educational Robot (HERO-1) had helped students to learn Computer and Robotics Technology for 15 years and then went into hibernation in 1995. The members of the Women Engineers Club at New York City College of Technology discovered a couple of these robots in a storage room and decided to revive and upgrade it by using modern technology as an assistive technology SuperHERO robot to help people with disabilities. The upgrade also involves the attachment of its robotic arm and gripper. In the current phase of the research project, the arm attachment will further enhance the purpose of SuperHERO with its Assistive Technology by helping people with limited arm movements. Approach: With the two robotic arms available, one robotic arm is used as a reference to look at its overall structure. The other arm is reverse-engineered by opening its outer shell to reveal the motors of the arm. The motor types and connections are researched and retested due to its 30 year old condition. The outer shell of the arm is planned to be replaced by a 3D printed arm. The 3D design is done by taking measurements of the arm and creating a 3D model in a software called Autodesk Fusion 360. Then, after saving the final design as a stereolithography (STL) file from the 3D model, this file is imported in the slicing software and transformed into G code based on the printing setup. Finally, by transferring files to a SD card into a 3D printer or sending the G code wirelessly, the poly lactic acid (PLA) plastic is inserted in the printer opening to print. Results: The robotic arm consists of 3 stepper motors with translation and rotation movements, where they are labeled as arm extension, arm rotation, wrist rotation, and gripper control. The arm extension stepper motor consists of eight wires, where the internal coils of the motor can either be connected in series or parallel. The difference between these two configurations is that series connection provides more torque with a configuration similar to a six wire unipolar stepper motor and the parallel connection provides more speed with a configuration similar to a four wire bipolar stepper motor. Because the arm requires a lot of torque to extend, this eight wire motor has an internal series connection. The arm and wrist rotation motors are configured as unipolar motors. The measurements are done carefully, and with the use of a revolve command in Autodesk Fusion 360, the 3D robotic arm design has been completed. This design is later translated in an orthographic view. Conclusion: In the future, the 3D printed robotic arm will be tested for its overall movements. Further testing of the combined movement of the Heathkit Educational Robot and the robotic arm working together will be done to fulfill the purpose of helping people with disabilities.

➢ **11:10am (PO20-0065)**

Exploring Post Quantum Analog Encryption

Anant Sinha (University of Michigan Ann Arbor)

As the much-promised quantum dominance is all but at the horizon, the future of encryption remains uncertain. Current symmetric and asymmetric encryption standards such as RSA/AES will not be able to maintain the root of security in the foreseeable future. To address these issues, several new encryption schemes for post-quantum security are now being explored. In this poster, we propose a chaotic system based encryption technique that is modeled around the classical double pendulum system to implement a possible post-quantum analog encryption scheme. A model of encryption and its possible implementation is presented in this poster. A circuit implementation of the encryption scheme is also explored using Chua's chaotic oscillator system.

➢ **11:20am (PO20-0059)**

Implementation of MPI in A Data-Driven Thermal Simulation Approach for CPUs

Kayla Ruttan (Clarkson University)

Prediction of thermal hot-spot formation in CPUs or GPUs has been an extremely challenging task due to their large domain structures with many functional units. Although direct numerical simulation (DNS) methods are able to provide good resolutions to capture the hot spots, these approaches are essentially prohibitive in CPUs or GPUs. Recent advances in CPUs with tens of cores or GPUs with thousands of cores make hot-spot prediction even unreachable. Thermal simulation of CPUs in the past decades has been derived from thermal circuit models because of their efficiency. However, the incapability of obtaining accurate thermal prediction with high-enough resolutions for CPUs (and GPUs as well) offers insufficient thermal information for thermal management and reliability assessment, which will eventually limit technology development. An innovative thermal simulation technique enabled by data-driven proper orthogonal decomposition (POD) developed recently has been proven useful for semiconductor chips. The approach offers very accurate thermal prediction with an efficiency as good as the thermal circuit models. The developed POD technique also provides a resolution as fine as the DNS and is thus able to predict hot-spot formation with high efficiency and accuracy. The POD approach needs to process a massive amount of thermal data to generate POD modes that are then used to construct its functional space to describe dynamic thermal behavior in CPUs/GPUs. The generation (or training) of the modes and calculation of the model parameters for developing the POD model require intensive computing power. In order to improve the computing efficiency for POD mode training and model development, a parallel processing technique, known as Message Passing Interface (MPI), has been implemented in our code developed in the C language to enhance computing performance. MPI is a portable message-passing standard developed to use commonly available operating system services to create parallel processes and exchange information among these processes. As MPI is one of the most common techniques used in high-performance computing (HPC), there are several efficient implementations of this method encouraging portable and large-scale parallel applications. Our work is based on the widely used open source implementation named OpenMPI, which supports programming in C language with the ability to function on a variety of HPC architectures from the servers with advanced multi-core CPUs, computer clusters and top supercomputers in the world. The implementation of OpenMPI is through adapting our code to work with the corresponding parallel computing features provided by the Portable Extensible Toolkit for Scientific Computation (PETSc) and the Scalable Library for Eigenvalue Problem Computations (SLEPc). Thus, it has been utilized in multiple aspects of the POD method including generating modes, evaluating model parameters, and performing the simulation. The objective of this study is to accelerate the generation of POD modes and calculations of POD model parameters. It is expected that with the integration of OpenMPI with the POD training method this will significantly reduce the computation time and lead to a more efficient thermal simulation for future real-time applications of the proposed method.

➢ **11:30am (PO20-0027)**

Development of Mobile Applications for Medical Isotope Reference

Vanessa Rodriguez (St. Joseph's College)

Brookhaven National Laboratory's (BNL's) National Nuclear Data Center (NNDC) maintains a series of databases that deal with nuclear structure and nuclear reaction data. One of these databases is the Medical Internal Radiation Dose (MIRD) database from the Evaluated Nuclear Structure Data File (ENSDF). MIRD is used as a reference for half-lives, radioactive emissions, and decay products when conducting experiments. Currently, scientists can only access this reference material through a website. However, there are times where scientists do not have such access. This is where a mobile application comes in. The mobile app I have developed is based on the MIRD website and will provide access wherever a user can bring their phone. To create such an application, I first needed to learn how to code in HTML, CSS, and JavaScript. I then built and tested the app in Apache Cordova until I had a working prototype. With this mobile application, it will be more convenient to reference MIRD without having so many constraints. The mobile app will have access to mobile hotspots and data networks, while laptops and desktops would require Ethernet or Wi-Fi. A phone is also easier to carry and more user-friendly. This is important for MIRD because medical isotopes are used in imaging. When a patient takes in medical isotopes, those can be tracked through the patient's body. This allows doctors to check for diseases or any form of damage inside the patient's body, such as cancer. Thanks to the SULI program, I can now add programming in HTML and JavaScript to my list of skills. Also, I have a better understanding of what goes into a project at BNL and have developed a passion for mobile applications.