Undergraduate Research Symposium May 19, 2017 Mary Gates Hall

Online Proceedings

POSTER SESSION 1

Commons East, Easel 69

11:00 AM to 1:00 PM

Visualizing Geoengineering Data on Mixed and Virtual Reality Devices

Chang Yu Jonathan (Chang-Yu) Wu, Senior, Electrical Engineering
Michael Jeffrey (Michael) Omori, Senior, Electrical Engineering
Travis Espiritu (Travis) Bailey, Senior, Electrical Engineering
Liyuan Wang, Senior, Electrical Engineering
Mentor: Robert Bruce Darling, Electrical and Computer Engineering
Mentor: Payman Arabshahi, Electrical and Computer Engineering
Mentor: John Sahr, Electrical Engineering
Mentor: Daniel Cook

The purpose of this research is to generate immersive, natural-looking environments from geoengineering data that can be viewed on hardware-constrained virtual and mixed-reality platforms. Current mixed and virtual-reality technologies, such as the Microsoft HoloLens, are constrained by limited hardware resources. These constraints set limits on the realism and quality of immersion of virtual reality environments. Thus, no software previously existed to intelligently render immersive 3D terrain on hardware-constrained virtual and mixed reality devices. Through research in terrain generation and 3D rendering, the Viewpoint Generator application was created that can accurately and realistically render 3D environments. To render the terrain, 3D environments generated in Unity, a game rendering software, are preprocessed on a host machine. The 3D terrain is sliced into a grid containing individual slices. For each slice of terrain, a set of concentric panoramas and a skybox are generated. These static components require relatively little power to render. Performance was benchmarked through simulations in Unity and on-device with a Microsoft HoloLens, with a minimum frames-per-second (fps) requirement of 60 fps to prevent nausea induced by slow rendering. These components form the Viewpoint Generator application that can be deployed to hardware-constrained devices, which allows users to explore areas of a 3D environment not previously possible on hardware constrained devices. Applications for the Viewpoint Generator include uses in civil engineering and environmental restoration and visualization. Large-scale environmental projects too large to convey through static 3D renderings or by human imagination can now be explored in an accurate and realistic virtual environment. As the Viewpoint Generator is designed to operate on compact devices, it is easily deployed to remote environments. The Viewpoint Generator sets the foundation for development in procedural environment generation based on geoengineering data, allowing new visual insight into civil engineering and environmental restoration projects.

POSTER SESSION 2

Commons East, Easel 72

1:00 PM to 2:30 PM

Millennium Space Systems: 16QAM Communications Waveform

Emerson Jung (Emerson) Kim, Senior, Electrical Engineering
Kevin Sadykhov, Senior, Electrical Engineering
Mentor: Nick Morello, Millennium Space Systems
Mentor: Sumit Roy, Elect. Engineering
Mentor: Payman Arabshahi, Electrical and Computer Engineering

Quadrature amplitude modulation (QAM) is a form of modulation in which two signals, differing in phase by 90 degrees, are modulated and summed together in order to create a final output wave. QAM is often utilized in radio communication systems to transmit data. The objective of this project is to develop a 16-QAM communications system on an X310 Universal Software Radio Peripheral (USRP). This system would provide a high data rate communication line for the usage of space-ground links. The applications of such a waveform would allow for massive transmissions of data such as ultra-high-definition video or fast internet. The development of the product will begin with developing a simulation of the system using GNU Radio. After the simulation has been successfully developed, work will be begin to implement the design onto the X310 device. This will be accomplished by using GNU Radio or a hardware description language (HDL) such as Verilog. Testing will take place in order to ensure that data is being properly communicated between the motherboard and daughterboard. It is our hope that our communications system will improve the communication between space and

ground centers.

SESSION 2E

ADVANCED TECHNOLOGIES FOR HEALTHCARE AND OTHER APPLICATIONS

Session Moderator: Daniel Kirschen, Electrical Engineering
MGH 238
3:30 PM to 5:15 PM
* Note: Titles in order of presentation.

UW Medical Center - Motion Control for Fast Neutron Collimator
Joey Thai, Senior, Electrical Engineering
Marissa E (Marissa) Kranz, Senior, Electrical Engineering
Matthew Ross (Matt) Dentinger, Senior, Electrical Engineering
Mentor: Howard Chizeck, Electrical Engineering
Mentor: Robert Emery, Radiation Oncology
Mentor: Jonathan Jacky, Radiation Oncology
Mentor: Payman Arabshahi, Electrical and Computer Engineering

The goal of this project is to design a faster and more efficient motion controller for the leaf collimator that is used to shape a neutron beam around a tumor for use in intensity modulated neutron radiation therapy. The system currently in operation was developed in the 80's and is too slow for new treatment techniques we plan to support. We started with familiarizing ourselves with the Galil motion controller and the Experimental Physics and Industrial Control System (EPICS) software to control 40 motors that will adjust the position of the collimator leaves within an accuracy of 2 mm. Because we augmented an existing system, there are some system aspects that could not change and needed to be worked into our design: the 40 motors need to be driven manually with analog feedback and the overall mechanical setup should remain mostly the same. Additionally, we rewired the system to accommodate bipolar power supplies in order to half the number of wires used in the gantry, allowing us to save on space and increase the ease of future system maintenance. This was accomplished by configuring diodes in parallel with relays that allows us to control the direction of the current, which in turn controls the rotation of the motors. Since our system's internal components are heavily exposed to radiation, we implemented the diodes on a printed circuit board to ensure that the system upkeep and component replacement is manageable. Finally, we updated the existing Extensible Display Manager (EDM) user interface so the radiation therapists and technicians can see real-time leaf locations and interact with our motion control system. The final deliverable is a complete installation of our new fully tested system inside the the gantry.

POSTER SESSION 3

Commons East, Easel 65
2:30 PM to 4:00 PM

Ticket Classification via Data Science and Machine Learning
Huy Phuong (Huy) Nguyen, Senior, Electrical Engineering
Zehao (Hubert) Hu, Senior, Electrical Engineering
Ruolan (iris) Wei, Senior, Electrical Engineering
Mentor: Xiang Chen
Mentor: Sreeram Kannan
Mentor: Payman Arabshahi
Mentor: Swetha Kannan

Companies care of their image in the customers' mind, then offer customer service to understand and take care of customers' need. However, customer services seem to be overwhelmed, while they have to serve an increasing huge number of customers. Companies have to pay a lot of expenses for employing labor, while customers are not taken care of well enough. Customer Ticket Classification project offered by Tupl Inc. delivers an algorithm that takes in customer queries, then categorizes and generates responses to those queries. In detail, the algorithm classifies thousands of customers' messages into different categories and automatically responds to these messages based on the detected categories by using data science and machine learning. In detail, the project employs new data science tools such as Spark and Zeppelin to improve effectiveness. Thus, this algorithm can help companies save man power or labor hours and expenses in operating customer services.

POSTER SESSION 4

Commons West, Easel 27
4:00 PM to 6:00 PM

Ocean Lens Submersible ROV
Yicheng (Jerry) Wang, Senior, Electrical Engineering
William Hunter (Will) Butterton, Senior, Electrical Engineering
Jared Nakahara, Senior, Electrical Engineering
Justin Adam Skubic, Senior, Electrical Engineering
Mentor: Payman Arabshahi, Electrical and Computer Engineering

Exploring the ocean always requires human divers going undersea. Due to the complicated environment, undersea human activity is normally dangerous. Additionally, there are limits to what human operators can collect in terms of underwater data, often relying on larger, more expensive manned vehicles to acquire the desired data. We want a remotely-operated

device that captures the undersea views, with geological data attached. Thus, we are presenting a submersible ROV, tethered to a clean-energy, self-sustained buoy for power and user communication, that carries cameras and positioning sensors to explore the ocean.The ROV can capture video and images that are transmitted to a host computer, which will interface with Booz Allen Hamilton's Ocean Lens VR platform to create a user-friendly 3D environment. Based on the design requirements stated above, we built a system block diagram of the project, showing the planned system component hierarchy. From that, we assigned design subtasks according to each team member's expertise. The primary design sections are as follows: power (conversion and distribution of power from buoy), controls (physical operation and movement of ROV), sensors (video, temperature, positioning, etc.), and mechanics (ROV chassis design, construction, and hydrodynamics). The ROV comes with an inertial measurement unit to track vehicle orientation, as well as a GPS, to provide accurate positioning data. The ROV will operate up to 100 meter clear- and salt-water depths and will collect pressure, ambient light, pH, and temperature data while giving the user near-real-time control. The ROV comes in a watertight acrylic chassis with 3 thrusters to control forward, backward, and vertical movement while in motion and idle. Receiving power from the buoy, the ROV will charge up internal batteries that will allow it to operate for 1.5 hours.

POSTER SESSION 4

Commons West, Easel 26

4:00 PM to 6:00 PM

The Development of Automated Sensors for Households

Kevin J. Wong, Junior, Electrical Engineering
Sharyar (Sharyara) Khalid, Senior, Electrical Engineering
Duong Nguyen Thai Bui, Senior, Electrical Engineering
Sheng Li, Senior, Electrical Engineering
Mentor: Payman Arabshahi, Electrical and Computer Engineering

We live in a world driven by efficiency, optimized by technology. In this project, our team is developing specialized commercial smart home products as we investigate their efficacy. With the industry's unprecedented growth over the past several years, we believe that smart home technology will quickly become a cornerstone of today's automation paradigm. To focus our scope, we are working with an industry leader: Wally, who has already launched a successful commercial package. Our job is to ideate, design, and create prototypes for new sensors that will augment and enhance their existing product. We are focusing on utilitarian applications of smart sensors. As such, the first product we are developing is a sensor that detects various gas leaks, ranging from volatile organic compounds to natural gases. The second product we are developing is a water pressure sensor that measures flow rate throughout a house. Both sensors will connect to a cloud infrastructure and data is sent to a mobile application where users will be alerted in real-time and can view analytics. Additionally, both sensors will interface with other automated products such as shutoff valves. If our research and development goes as planned, we hope to add both products to the existing Wally line and release them commercially.