Undergraduate Research Symposium May 18, 2018 Mary Gates Hall

Online Proceedings

Poster Session 1

Commons West, Easel 43

11:00 AM to 1:00 PM

The Importance of Yapese Knowledge: Sustainability through Canoe Building

Kevin K. Chu, Senior, Anthropology: Medical Anth & Global Hlth
Summer A. Godfrey, Junior, Anthropology: Medical Anth & Global Hlth
Celeste C. Le, Junior, Anthropology
Zachary Taylor Dietz, Junior, Anthropology
Mentor: Holly Barker, Anthropology
Mentor: Randizia Crisostomo, Interdisciplinary Arts and Sciences

How is the representation of Yapese knowledge brought to the forefront of musuem spaces? How is Oceanic knowledge recognized as a way of life, through what Epeli Hau'Ofa draws from interconnectedness between community, family, and beyond the Western concept of Yapese outriggers being represented as: Just a boat? Our reserach dives into the history of the Yapese canoe, the spirituality behind its meaning, how it is constructed, and how the outrigger connects to resources and sustainability. Through interviews done with Yapaese youth and elder within the community, analyzing material culture, and participartory knolwedge through the emerison of Yapese dance, we were able to bring Yapese voice into the display that will be at the Burke Museum. We aimed to connect the modern knowledge we have today with the cultural context surrounding daily Yapese society. The importance behind bridging these two forms of knowledge is to expose and provide a deeper understanding to those who only have access to non-indigenous studies of the Yapese culture.

Poster Session 1

Balcony, Easel 89

11:00 AM to 1:00 PM

Identification of Non-canonical DREADD-Receptor Signaling and Overexpression

Hafsa Abdinasir Abdinur, Sophomore, Pre-Health Sciences
Mentor: John Neumaier, Psychiatry
Mentor: Atom Lesiak, Genome Sciences

DREADD receptors (Designer Receptor Exclusively Activated by Designer Drugs) are engineered G-protein receptors which are exclusively activated by the inert-molecule CNO (clozapine-N-oxide) and to a lesser degree clozapine. DREADD receptors are often used, to identify the circuitry and cellular signals that specify behavior, perceptions, emotions, motivation, and motor functions in species ranging from flies to nonhuman primates. Heterologous overexpression of non-native genes in biological systems, is often confounded by varying degrees of overexpression and result in non-specific effects. Thus, our purpose is to determine effects on cell signaling pathways following varying levels of DREADD receptor expression. Our hypothesis is that, increased levels of DREADD receptor expression increase non-canonical cellular signaling pathway activation. We used human embryonic kidney cells (HEK cells), as our model system, then expressed various levels of DREADD receptors using Lipofectamine transfection and DNA-plasmids expressing Gs- and Gi-coupled DREADD receptors (Canonically, Gs-increases cAMP and Gi-decreases cAMP). After transfection, we treated transfected cells with 1μM of CNO or VEH (a control) for 5-30min and then lysed the cells with RIPA Buffer, and prepared samples for western blotting to detect activation of proteins of interest in the GPCR non-canonical signaling pathways (example: kinases and transcription factors). We used anti-HA antibodies to ensure dosage of receptor expression, and used a panel of antibodies to detect activated proteins in well-established non-canonical GPCR signaling pathways. Western blot results were measured using Odyssey scanner and the Image studio software suite. We expect to see an increase in non-canonical signaling with increased expression of both Gi- and Gs- coupled, specifically in the MEK/ERK and CREB signaling pathways. In summary, our findings will highlight additional considerations regarding the level of receptor expression when using DREADD receptors in vitro and in vivo experiments, and specifically measure the off-target "non-canonical" signaling pathways induced by DREADD receptor overexpression.

Poster Session 1

Commons East, Easel 69

11:00 AM to 1:00 PM

Pulse Tectonics in the Radial Artery

Quinn Mathew L'heureux, Senior, Physics: Applied Physics
Mentor: Tom Furness, Industrial & Systems Engineering

The goal of the Pulse Tectonics project is to apply the traditional Chinese practice of pulse diagnosis in the radial artery, to detect heart problems in a non-invasive manner. If we can detect heart disease early, we could potentially save hundreds of thousands of lives (there are 610 thousand deaths per year attributed to heart disease in the US alone), as in many cases it is only diagnosed after the first cardiac event (heart attack). Our research is to achieve diagnosis by capturing a short (5-10 second) video of the forearm. This video is then put through a video magnification algorithm developed by MIT, with different frequency and magnification parameters. By varying these parameters we can 'tune in' to the pulse in the radial artery and see it visually in full time. The pulse appears as a pattern of peaks and troughs which seem to change in response to a number of variables, from recent eating, exercise, health, etc. Currently we are working to synchronize these visual pulse readings with readings from an EKG and pulse oximeter to identify the information we can obtain from the videos, and thereby achieve diagnosis via visual pulse waveforms. This involves creating a baseline for a healthy pulse, and then identifying which parameters in the video correspond to different health readings. When successful, this technology would bring early heart disease diagnosis within reach of all people in an effort to mitigate heart disease related deaths.

POSTER SESSION 1

Commons East, Easel 70

11:00 AM to 1:00 PM

Real-Time Measurement of Flow State in Virtual Reality Learning Activities using EEG Data: A Preliminary Study

Anushka Wadhawan, Senior, Industrial Engineering
Brad Floeter, Junior, Industrial Engineering
Matt Cook, Senior, Mechanical Engineering
Qihua (Garret) Yang, Senior, Electrical Engineering
Griffin Wu, Senior, Electrical Engineering
Joseph Hyobeum Shin, Senior, Electrical Engineering
Lucky Agung Pratama, Graduate, Built Environment
Evan Robert Kirkpatrick, Senior, Industrial Engineering
Noah Saul Bostick, Junior, Mechanical Engineering
Madalyn Li, Senior, Industrial Engineering
Mentor: Tom Furness, Industrial & Systems Engineering
Mentor: I Chun Hung

Flow is a mental state achieved by a person performing a task when there is a balance between skill and challenges, thereby evoking focused attention, full involvement, and enjoyment. For education applications, achieving a flow state may accelerate learning, retention and improve learning outcomes. Most current methods for assessing the extent of flow state use a self-reported questionnaire only when participants finish a learning activity. Alternatively, using objective real-time measurement such as electrophysiological techniques to assess the flow state, especially during a learning period, affords the possibility of timely adjustment of challenges to keep up with learners' growing abilities. Such an adaptive approach may provide a more improved way to enter and sustain flow in learning activities. Previous studies also indicate that gamification is a proven way to induce the flow state, and virtual reality (VR) activities provide learners more immersive experience. The purpose of this preliminary study is to investigate an adaptive approach for assessing flow state during VR learning activities with electrophysiological measurement. This study used a NeuroSky EEG headset with a supervised machine learning algorithm to identify the features of attention, meditation, and eye blinks with flow state while performing VR learning activities. To evaluate the effects of the proposed approach, data collection was through an experiment with 10 UW students by assessing their flow state while playing VR educational games. The first version model trained by the three types of indicators is capable of determining if a learner performing VR learning activities enters the flow state. In turn, the result of this preliminary study serves as a metric for the follow-on research addressing the development of adaptive learning strategies to help each learner enter into a flow state and improve learning outcomes with the sustained flow state.

SESSION 1H

SOCIAL SCIENCE STUDIES OF GENDER, RACE, AND SOCIAL HIERARCHIES IN PRACTICE

Session Moderator: Judith A Howard, Sociology

MGH 242

12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

The Significance of Charismatic Authority on Prominant Terrorist Groups

Ignacio Pedro Cabezudo, Senior, Sociology
UW Honors Program
Mentor: Sarah Quinn, Sociology
Mentor: Sara Tomczuk, Department of Sociology

Scholars in many disciplines have used the concepts of charisma and charismatic authority to describe leaders of prominent terrorist groups. These researchers do not give the breadth and depth these topics require when attributing them to casual relationships between leaders and followers. As a field, the study of terrorism is lacking in substantial work on the subject. This leads to an absence of deep conceptual understanding and incorrect or ill-defined usage. I will address the gap created by these missing definitive parameters to build

a clearer understanding of the concepts. Through systematic comparison of the social tools employed by the leadership of Al-Qaeda and Boko Haram I will explore the characteristics of charismatic authority. I will analyze comparative parameters of group leaders, local demographics, institutional structures, and major national or regional events that precede violence. This goal will be achieved through historical document analysis using primary and secondary sources. Primary sources include documented speeches and interviews, documents released by the groups, and personal documents of leaders. Secondary sources include news stories, scholarly articles, and other academic literature. The purpose of this research is to set the stage for those with access to their followers to adequately explore the potential causal relationship between charismatic leadership and the actions of their followers.

POSTER SESSION 2

MGH 241, Easel 124

1:00 PM to 2:30 PM

Virtual World Building at the Robert Eagle Staff Middle School

Matt Cook, Senior, Mechanical Engineering
Brandon Pittaway, Senior, Industrial Engineering
Marcus Benton Deichman, Senior, Electrical Engineering
Mentor: Tom Furness, Industrial & Systems Engineering

Prior research has shown that virtual reality (VR) has great promise as a science and engineering teaching tool at the primary and secondary school levels. Unfortunately there is little VR educational content for schools since the education marketplace is poorly funded. Our objective is to solve this problem by teaching middle school students how to build their own immersive 3D virtual worlds that can used as teaching aids for other students and schools. To investigate this approach we are working with Robert Eagle Staff Middle School in an after-school engineering club teaching world building tools and processes to 6th graders. We have organized the students into four teams to create VR games that teach STEM concepts including scale, gravity, light, and momentum. University of Washington engineering students are assigned to mentor these teams while serving as role models to the middle school students.The middle school students not only learn world building techniques but also understanding of these STEM concepts well enough to teach others. To create the VR games, we are instructing the students how to use Unity3D as a game engine. The virtual worlds will operate in real time on the HTC Vive VR headsets with high-end Intel-powered computers. In addition to the world building efforts student learn how to set up, configure and operate the technology within the VR workspace at the school. Our final product will be both the educational content designed by the students but also a prototype of the way to do it. We are documenting our findings in scholarly reports and a documentary film that can be used to inform schools across the nation of how to use virtual reality as a teaching tool and to build a repository of virtual worlds that can be exchanged across schools.

POSTER SESSION 2

Balcony, Easel 114

1:00 PM to 2:30 PM

The Combinatorics of Factorial Base Representation

Tina Rajabi, Sophomore, Mathematics, Edmonds Community College
Mentor: Tom Edgar, Mathematics, Pacific Lutheran University

Every non-negative integer can be written using what is known as the factorial base representation. We define this notion and explore certain combinatorial structures arising from the arithmetic of these representations. In particular, we investigate the sum-of-digits function, carry sequences, and a partial order referred to as digital dominance. Finally, we describe an analog of a classical theorem due to Kummer that relates the combinatorial objects of interest by constructing a variety of new integer sequences. Many of the combinatorial objects we describe are of interest in their own right and provide interesting avenues for future discoveries. For instance, the carry sequences we describe correspond to a new family of integer partitions that are analogous to hyper-binary partitions, which have been extensively studied. Moreover, the digital dominance order most likely contains interesting combinatorial information about the integers as represented in the factorial base. Finally, our analog of Kummer's theorem has helped to explain how the classical version of Kummer's theorem can be altered to fit with almost any positional numeration system.

POSTER SESSION 2

MGH 206, Easel 173

1:00 PM to 2:30 PM

Investigating the Bone Microstructure of Extant Small-Bodied Mammals

Henry Zenkichi Fulghum, Junior, Earth & Space Sciences (Biology)
Mary Gates Scholar
Mentor: Gregory Wilson Mantilla, Biology
Mentor: Lucas Weaver, Biology

Bone histology, the study of bone tissue, has become a critical tool in the field of paleobiology as a proxy for life-history information, such as growth rates, that is otherwise inaccessible from fossils. However, the bulk of bone histological research has focused on birds, crocodilians, and large-bodied

mammals, leaving the extent to which bone microstructure acts as an indicator of growth rates among small mammals largely unknown. Therefore, we generated thin sections from the limb bones (e.g., tibiae, humeri, and femora) of a taxonomically diverse sample of 12 extant, small-bodied (<1 kg) mammals in an attempt to build a framework upon which we may make inferences about the evolution of mammalian growth dynamics. In general, vascularity is low or absent in our samples, and the degree of vascularity appears to decrease with decreasing body mass. All specimens exhibit two types of bone matrix: well-organized parallel-fibered bone and disorganized woven bone. Often, this parallel-fibered tissue lines the interior and exterior of the bone cortex, bordering an intermediate band of woven tissue. This middle band likely represents a period of rapid bone deposition, possibly corresponding with rapid growth in early ontogeny, while the parallel-fibered bone represents deposition after growth had slowed. We hypothesize that the structurally competent parallel-fibered bone bordering the cortex may act to buffer the intermediate, structurally weak, woven bone against mechanical strain during locomotion. To test these hypotheses, we will compile existing life-history data and quantify the histological features of our sample using NIS Elements photo documentation software, and apply multiple linear regression models to test for relationships of significance. By investigating the impact of life-history characteristics upon small mammal bone microstructure, we hope to make important inferences about the lives of extinct small mammals, and thus create a more comprehensive understanding of mammalian growth dynamics.

SESSION 2E

MODELS OF BRAIN AND BEHAVIOR

Session Moderator: Tara Madhyastha, Radiology
MGH 238
3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Moths Regulate Body Attitude and Gaze to Stabilize Small- and Wide-Field Visual Cues
Monica Dee (Monica) Harris, Senior, Neurobiology
Mary Gates Scholar, Washington Research Foundation Fellow
Mentor: Tom Daniel, Biology

Insect flight relies heavily on visual sensing. In many flight behaviors (e.g. navigating over long distances or through cluttered environments, finding food sources, or evading predators), insects must parse the visual scene to extract an estimate of their own motion and identify external objects or agents moving in their environment. Across numerous taxa and behaviors, there is a rich literature exploring behavioral responses to wide-field optic flow (visual stimuli arising from egomotion) and small-field target motion (cues corresponding to exogenous motion), primarily in the yaw dynamics involved in navigation. In contrast to yaw which is marginally stable, the equilibrium about pitch angle is inherently unstable, hence there are significant consequences to adjusting the flight attitude. To stabilize the visual scene under this constraint, insects can either reorient their body or move their head to redirect gaze. In this work, we investigate how the hawkmoth, *Manduca sexta*, modulates body pitch and gaze angle in response to wide- and small-field visual motion. Moths are tethered to a freely rotating armature at the center of a cylindrical arena and presented an image of a circular flower against a background grating. Figure and ground are oscillated both individually as well as simultaneously (both synchronously and incongruously). A multi-input–multi-output analysis reveals correlations that suggest moths employ parallel strategies for stabilizing posture and gaze dependent on the spatio-temporal content of the visual scene. The inherent instability in pitch dynamics necessitates these dual strategies. Distinguishing between and reacting to wide- and small-field visual stimuli are necessary parts of many animal behaviors; through this research we hope to better understand how biological systems assimilate motion and mechanical cues to coordinate effective movements.

SESSION 2S

HOT TOPICS: ROBOTS, AR, CV, AI

Session Moderator: Kurtis Heimerl, Computer Science and Engineering
JHN 175
3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Virtual Reality as an Alternative Therapy for Dementia Patients
Olivia Jean Chicoine, Junior, Industrial Engineering
Qihua (Garret) Yang, Senior, Electrical Engineering
Thanika Painruttanasukho, Junior, Industrial Engineering
Vicky Yu Ju Tseng, Senior, Industrial Engineering
Katherine Justine Tran, Junior, Biochemistry
Evan Robert Kirkpatrick, Senior, Industrial Engineering
Deborah Jihye Huh, Junior, Industrial Engineering
Mentor: Tom Furness, Industrial & Systems Engineering

Dementia is a neurological condition that impairs memory, cognitive functions, and the performance of daily activities. It is estimated that 5.5 million Americans suffered from dementia in 2017. Currently, the predominant method used to treat persons with dementia is through pharmacological means. However, through a review of current research we have found evidence to suggest that cognitive behavior ther-

apies (CBT) may be more beneficial to patients, with the potential to reverse some symptoms of dementia. Our study aims to improve CBT through virtual environments. Virtual Reality (VR) is not merely a visual platform but an immersive environment that stimulates the brain in the same way real environments do. Patients with dementia living nursing homes are rarely exposed to different environmental interactions or thought inducing stimuli, resulting in an escalated progression of their condition and a loss of "sense of self." CBT, specifically reminiscence therapy, has shown promising results in improving cognitive functioning as well as morale. We hypothesize that if we use visual and audio equipment as well as tangible artifacts, we could create an immersive therapy to stimulate cognitive functions. We track certain markers like head and eye movement to track the progression of the disease as well. In collaboration with a UK based game development company we have identified a software with both therapeutic and a diagnostic capabilities. We have made connections with senior centers in the area to identify persons wishing to participate VR therapy sessions. This project will offer understanding of how implementing VR therapy can improve patients' morale and cognitive capabilities, as well as exploring the use of VR as a diagnostic tool.

POSTER SESSION 3

Commons West, Easel 35

2:30 PM to 4:00 PM

Contested Rumor Permutations and Disinformation on Twitter

Kaitlyn Zhou, Senior, Computer Science, Human Ctr Des & Engr: Human-Computer Int
Mentor: Kate Starbird, Human Centered Design & Engineering
Mentor: Tom Wilson, Human Centered Design and Engineering
Mentor: Ridley Le Doux

An important and under-explored component of information exchange and diffusion on social media involves permutations—i.e. how information changes, or more accurately, is changed as it flows. In this research paper, we aim to identify the various rumors and narratives that exist within a conversation surrounding Omran Daqneesh, the 'Aleppo Boy', on Twitter, and to investigate the actions that users take to propagate a certain permutations of these narratives. Before we can see how narratives propagate, we must first seek to understand these narratives at various levels of analysis, representing both the individual and society more generally. To this end, we examine narratives within the conversation at various levels: the micro, meso, and macro, representing individual actions and rumors, context-specific narratives, and a higher-level beliefs and worldviews. In this research we adopt a mixed methods approach. We quantitatively analyze our data to gain insights into the key events and influential actors in the space, and qualitatively code tweets to identify 1) rumor permutations that contribute to larger narratives surrounding the Syrian conflict; and 2) specific actions that help us to understand how individuals interacting within this information space. We aim to build a deeper understanding of how rumors are spread, how disinformation effects the online information space, and to develop a robust coding scheme that is transferable and can be applied to other rumors outside of the Syrian context in the future.

POSTER SESSION 3

Commons West, Easel 34

2:30 PM to 4:00 PM

Understanding the Alternative Media Landscape Surrounding the Syrian White Helmets

Katherine Anne Van Koevering, Senior, Statistics, Computer Science
UW Honors Program
Ostin Kurniawan, Senior, Human Ctr Des & Engr: Human-Computer Int
Gordon Duncan, Sophomore, Pre Engineering
Vera Liao, Senior, Psychology, Communication
UW Honors Program
Mentor: Kate Starbird, Human Centered Design & Engineering
Mentor: Ahmer Arif, HCDE
Mentor: Tom Wilson, Human Centered Design and Engineering

At a time of heightened global attention to the threat of misinformation, disinformation, political propaganda, and the role of technology in facilitating their spread, this research addresses the media ecosystem encompassing the Syrian Civil War. We examine the competing narratives surrounding the role of Syria Civil Defence, a volunteer humanitarian organization popularly known as the White Helmets, working in war-torn Syria. Mainstream media articles sympathetic of the White Helmets and their efforts brought global awareness to the plight of Syrian people, especially those resisting the Assad government. However, this narrative was not aligned with other views of the complex geopolitical landscape of the Syrian conflict, and in response counter-narratives challenging the White Helmets emerged and spread to other online communities. Using a mixed-method approach based on seed data collected from Twitter, and then extending out to the websites cited in that data, we examine content sharing practices within news articles across distinct media domains that functioned to construct, shape, and propagate these narratives. We articulate a predominantly alternative media "echo-system" of websites that repeatedly share content about the White Helmets. Among other findings, our work reveals a small set of websites and authors generating content that is spread

across diverse sites, drawing audiences from distinct communities into a shared narrative. This analysis also reveals the integration of government-funded media and geopolitical think tanks as source content for anti-White Helmets narratives. More broadly, the analysis demonstrates the role of alternative newswire-like services in providing content for alternative media websites. Though additional work is needed to understand these patterns over time and across topics, we provide insight into the dynamics of this multi-layered media ecosystem.

POSTER SESSION 4

Commons West, Easel 24

4:00 PM to 6:00 PM

Multi-Modal Actuation in Unsteady Flight Control
Clara Orndorff, Junior, Mechanical Engineering
Mentor: Tom Libby

This project aims to influence the next generation of flying robots by first studying how moths use multi-sensory information to increase their agility. These different types of multi-sensory information include visual- and touch-based feedback, which are influenced by forces such as those from flapping wings and changes in body posture (which affect a moth's inertial distribution). To visualize and analyze moth flight in a controlled environment, the goal is to implement a virtual environment, in which projected video will simulate a changing environment and provide a haptic-type virtual reality interface for the moths. Varying the dynamics of the moth's motion (for example, angle of rotation and speed of movement) in this manner will enable an analysis of how the moths respond to inertial and aerodynamic forces. The first engineering challenge is to design and build a system to electronically control and monitor the motion of the moth while having a minimal affect on a moth's inertia and natural flight patterns. This requires the design to have low mass, inertia and friction. After this, cameras and sensors will be used to record data that will contribute to a more realistic understanding of how the principles of animal flight can be used in robotics.