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Applications of the Quantum Zeno Effect

Aaron Soriano, Christopher Osorio

Dr. Seth Cottrell

The Quantum Zeno effect (QZE) is a fascinating phenomenon in Quantum Computing in which frequent measurement of a system can delay its progression indefinitely. Effectively freezing it in its initial state, or at the very least, the state in which it was measured in. While most research into QZE is focused on its physical applications, relatively little is known about the conditions under which such applications are appropriate. In this study, we explore the conditions in which this effect arises by examining both examples and counter examples. Our findings suggest that the changes in the relevant survival functions will indicate when this will occur. We hope that this will guide future research into the quantum zeno effect and its appropriate use.

Assistive Technology in Health & Fitness for Disabled Individuals

Zelea Hall

Prof. Farrukh Zia

In recent decades, the United States has experienced an increased interest directed toward holistic health, which highlights the well-being of every facet of what makes a person whole and complete addressing their entirety. The four dimensions necessary for optimal health include physical, mental, social, and more recently incorporated spirituality. More than 1 in 4 adults (28.7%) in the US are living with a disability leading to a sizable portion of the population without balance of holistic health. Despite research and medical professionals emphasizing the importance of an active lifestyle and preventative care physical activity continues to steadily decline. The recommended levels of physical activity are linked to a lower risk of numerous preventable health conditions including chronic illness, depression, anxiety, and even addiction. However, individuals living with one or more disabilities engage in significantly less physical activity compared to the average healthy individual. The first phase of this project consists of collaborating with engineering experts and learn how to use 3D printing to create assistive devices. The second phase will consist of surveying a group of people in various settings such as clinical, gyms, and schools and whether these individuals have access to assistive technology based on their socioeconomic status within low and high-income communities. The findings of this study will evaluate the effects and raise awareness that assistive technology has on all four dimensions of holistic health in all phases of life.

Heteromorphic Robot

William Morales

Prof. Xiaohai Li

This project focuses on the design and development of a heteromorphic transformable robot capable of shifting between a humanoid configuration and a functional mobile ground vehicle. The objective is to explore mechanical design strategies, control systems, and computational logic required for multimorphism robotics. The robot is fully designed and programmed using different free tools, with all structural components modeled in Fusion360 and fabricated through 3D printing. Motion is achieved using a series of servo actuators and custom link ages integrated into both transformation modes. The control system is implemented using a custom software from ROBOTIS and coding that into a MCUboard, enabling coordinated movement, stability management, and transformation sequencing. The project investigates challenges such as weight distribution, torque capacity, time-delay in the network, structural integrity during transformation, and synchronizing motor actuation across multiple joints. Final results should demonstrate successful transformation between forms and stable operation in both humanoid and car modes. This work highlights the potential of heteromorphic robotics in adaptable mobility systems and provides a foundation for future improvements in automated transformation mechanisms and advanced locomotion control.

Standards And Reporting Of Biodiversity In Turf To Wildlife

Naomi Vasquez

Prof. Heather Glickman-Eliezer

Accurate quantification of U.S. lawn and turfgrass extent is essential for modeling water consumption, carbon sequestration, and urban ecosystem services, yet prior estimates vary widely (128,000-163,800 km²). This study develops a time-efficient protocol to estimate continental U.S. lawn/turfgrass surface area. The methodology employs design-based stratified sampling from NLCD 2021, generating 2,000 sample points proportionally allocated across five land cover classes: Developed Open Space, Low Intensity, Medium Intensity, Grassland/Herbaceous, and Pasture/Hay. Sample points will be generated via Google Earth Engine JavaScript with automated validation checks. The approach integrates automated processing with human validation for design-based statistical inference. Study design development involved AI-assisted methodology refinement using Claude (Anthropic) across multiple iterations, with earlier attempts exhibiting systematic biases toward dated methodologies when literature review documents were included in project knowledge, and failure to leverage available high-resolution datasets (NAIP 0.6-1m vs. Landsat 30m). Expected results include unbiased area estimates. The protocol demonstrates that AI-assisted research design, when properly governed by domain expertise and methodological constraints, can compress traditionally labor-intensive workflows into fewer researcher-hours. The methods integrate best practices for transparent documentation of AI-generated code with predetermined project instructions.

Plant Responses to Radiation: The Central Role of Reactive Oxygen Species

Andrew Feng, Shaibu Alhassan, Lianghao Mai

Prof. Eric Lobel

Radiation is comprised of both natural and man-made environments, and plants are consistently being exposed to radiation. Radiation includes natural radiation like ultraviolet lights (UV) and anthropogenic (man-made) sources of radiation such as ion beams and plasma., Both can cause harmful and beneficial effects to plant physiology. In recently studies have shown that reactive oxygen species (ROS), such as superoxide, hydrogen peroxide, and hydroxyl radical (all forms of ROS) play an important role in plant responses to radiation. The reason why ROS can be harmful to plants is that UV rays, specifically UV-B rays, can slow growth and cause plants to age faster, but it can also result in the production of a substance similar to sunscreen to protect themselves against UV radiation. With plasma, if the dosage is too high, it can stop plants from growing and sprouting. When the amount of plasma is controlled it can help seed germination. Simultaneously, ion beams can also stop plants from growing, specifically by stopping meristematic cell division. Yet, ion beams can also bring benefits such as temperature resistance both for heat and cold. This review aims to help show the response of plants to radiation in both negative and positive ways to improve crops.

Frameworks for Data Visualization Methods

Kazi Tamim Nomany, Kazi Rahimu Islam

Prof. Patrick Slattery

This research project evaluates a conceptual framework for selecting data visualization methods (plots, charts, and graphs) based on analytical problems and information types. The study assesses this draft framework against visualization theory literature, visual perception studies, and current data analysis practices across various domains. By comparing theory with practical application, the research identifies strengths, limitations, and refinement opportunities. The goal is to develop a systematic, evidence-based approach to visualization selection that improves clarity, interpretability, and decision-making.

Validating an Artificial Intelligence Model for Achalasia Detection in Chest Radiography

Joel Perez, Shauyen Ng Mei

Prof. Eric Lobel

Earlier research on achalasia shows that diagnostic delays often lead to severe esophageal dilation and deformity, but the question whether an AI model can detect early diagnosis through diagnostic imaging remains unaddressed. The core of this study is to analyze the validity of artificial intelligence to detect achalasia. 447 chest radiographs were collected between 2017 and 2023, including achalasia patients and non-achalasia controls matched by sex and age. A deep learning model based on ResNet18 was trained to classify chest x-rays as achalasia positive or negative. Data were split into training, validation, and temporal test datasets. The study revealed that ResNet18 achieved excellent diagnostic performance with high accuracy and specificity, signifying its reliability to identify achalasia. Following the research, future studies can focus on the use of AI models in the early detection of other pathologies present in routine chest examinations. Although this model proves to be a great screening tool, the findings of this study helps support AI's inclusion in healthcare and computer aided diagnosis.

Gaze patterns on images of intact versus anatomically exposed human images

Jazmine Martin

Prof. Daniel Capruso, PhD.

This experiment sought to determine the relative allocation of visual interest to normal versus anatomically exposed human images. Stimuli were two quasi-realistic art images of unclothed females, one of which had apparently performed abdominal vivisection on herself. Subjects were CityTech students ($n = 56$). Foveal fixations were recorded with a Tobii T-60 eye tracker with a temporal resolution of 60 Hz and a typical gaze position accuracy of 0.5° of visual angle. There was no difference in gaze duration on the face and head of the intact female ($M = 0.87s$, $SD = 0.71s$) versus the vivisected female ($M = 0.89s$, $SD = 1.00s$), $F(1, 55) = 0.01$, not significant, $\text{partial } \eta^2 = .00$. When compared to gaze duration on the abdomen of the intact female ($M = 0.28s$, $SD = 0.38s$), there was an increase in gaze duration on the exposed viscera of the vivisected female ($M = 3.50s$, $SD = 1.89s$), $F(1, 55) = 169.02$, $p < .001$, $\text{partial } \eta^2 = .75$. The presence of a morbid visual element resulted in substantially increased gaze duration. To express the finding in everyday parlance, the subjects “gawked” at the apparent elements of horror.

Bio-Aware Blended Spaces: Stage 1 Sprint

Francky Duperval

Prof. David Smith

The significance of the project is, while prior creative applications with audiovisuals have relied on mechanical input, this project relies on biofeedback. This research highlights the potential of creative applications powered by human physiological input. Through the implementation of an experimental, practice based approach, biosensors recording human physiological data will be streamed through Python-based middleware. These biosignals are then mapped into MAX/MSP and Jitter for audiovisual generation, and finally an augmented reality projection sandbox for output. The creative methods of this project have the potential to inform future work in blended and immersive spaces powered by biosignals including more intentional application of audiovisual generation, single modality media output, or powering alterations to the physical environment. The anticipated findings suggest the viability of using physiological signals as generative input within an immersive environment.

First mammography screening participation and breast cancer incidence and mortality

Forruk Ahmed, Oman Balan, Ashley Hassang, Anna Aleksyeyeva

Prof. Zoya Vinokur

This population-based cohort study evaluated the long-term relationship between initial participation in mammography screening and subsequent breast cancer outcomes among approximately 432,000 women in Stockholm, Sweden. Women were invited to their first screening between 1991 and 2020 at ages 40 or 50 and followed for up to 25 years through national health registries. Overall, 32% did not attend their initial screening. Non-attenders were significantly less likely to participate in later screening rounds and were more likely to be diagnosed with advanced disease, showing 1.5-fold higher odds of stage III and more than 3.5-fold higher odds of stage IV breast cancer compared with attenders. Although cumulative 25-year breast cancer incidence was similar between groups (7.6–7.8%), breast cancer-specific mortality was markedly higher among non-attenders (adjusted HR 1.40; 95% CI 1.26–1.55). These findings indicate that missing the first mammography screening is associated with delayed detection and worse survival, underscoring the importance of promoting early participation as a key strategy in population-based breast cancer.

NASA Microgreen Cultivation in Space Utilizing PEGDA Hydrogels

Elva Zhang

Prof. Ozlem Yasar

The purpose of this study is to investigate how to provide life support to astronauts for long-term space expeditions. Due to Mars' cold, dry environment and toxic soil saturated with perchlorates, space agriculture poses a challenge for providing sustenance to astronauts. Polyethylene Glycol Diacrylate (PEGDA) is a biocompatible polymer that can form versatile hydrogels. The hydrophilic properties of PEGDA allow plants to germinate without the use of Martian soil. Arugula seeds were selected for the initial stages of the project due to their fast growth cycle. Using 3D printing techniques, the current priority of this project is to create a Y-shaped mold to hold the seed in place while it germinates. Environmental factors will continue to be introduced to replicate the Martian environment and improve moisture retention, antibacterial properties, as well as other qualities that will lead to successful germination.

Distinguishing Quantum Mottle from Information-Bearing Fluctuations (“Quantum Communication”) in X-ray Imaging

A. Ali Algemsh,^a B. Jaskaran Singh,^a C. Al Emran,^a D. Feldy Liriano,^a E. Hailah Nagi,^b F. Daler Djuraev,^c G. Natalya Tomskikh,^b H. Hanna Baghdadi,^b I. Jennifer Balbuena,^b J. Zeenia Ahmed,^b K. Taro Suzuki,^b L. Halima Alazeb,^b
Prof. Subhendra Sarkar

Conventional imaging practice interprets all image “noise” as negative relative to diagnostic quality. For example, X-Ray quantum mottle Poisson fluctuations arising from the statistical nature of photon detection are presumed to predominate at low dose. However, not all informationally noisy pixels arise from a quantum nature: in ultrasound, considerable grain occurs from digitization/quantization and system electronics far more than photon detection statistics. Thus, we pose whether fluctuations at low doses purely constitute unpatterned quantum mottle or whether a percentage carries reproducible, material-based information. We present a two-tiered distinction for operational potential (i) for a random, exposure-dependent increase/decrease in patterned mottle versus (ii) for an information-bearing aspect of “quantum communication” stemming from substantial, systematic compositions where composition and electron shells imprint spatial/temporal correlations from scattering/secondary photon excitation, which determines what is/what isn't detected once observed. To validate this challenge, we will image photon-starved images of phantoms with lanthanide-cation nanoparticles and simultaneously control phantoms of salts dominated by large anions and matched controls. Expected data include photon-transfer/Fano statistics to assess Poisson behavior, noise-power spectra and spatial autocorrelation to demonstrate random structure and frame-to-frame crosscorrelation against phase-randomized controls to highlight reproducibly detectable information. Regions with more lanthanide occurrence (high-Z, characteristic shells) will be compared against the large-anion preparations with the same entrance dose to determine the extent at which fluctuations beyond mottle occur and whether features can be drawn from scatter. Our goal is to clarify the extent to which “noise” can harbor informative signals within the field of x-ray imaging for ultra-low-dose improvements and nanoparticle-enabled contrasts without assuming a positive finding.

Evaluating the Potential Impacts of Quantum Computing on Enterprise Resource Planning (ERP) Systems

Andy Lopez

Prof. Patrick Slattery

Quantum Computing is being regarded as the future of computing, and it's projected to revolutionize the technological and scientific world. While it's still in its infancy and not ready to provide its services, experts are weighing in on the possible impacts it could have on ERP Systems. Enterprise Resource Planning (ERP) Systems are third-party cloud-based software used by companies to organize their business operations in one place to keep things running smoothly among their departments while rendering all the business data consistently and accurately. This research aims to envision the potential impacts when Quantum Computing is used on ERP Systems for a potential business environment that companies may use in the future. Evaluating the potential impacts of Quantum Computing used with ERP is a major talking point in the tech enterprise. Scientists, engineers, and business consultants are using problem modeling, simulations, and strategic planning to grasp the potential of Quantum Computing with ERP Systems. Studies indicate that ERP Systems would create more efficient, complex supply-chain optimization, something modern classical computers struggle with and also process data faster and more efficiently. Overall, Quantum Computing far surpasses classical computer ERP Systems in terms of supply-chain optimization and data processing, essentially putting any business that uses its services in the future ahead of its competitors. On the other hand, according to experts, Quantum Computing isn't projected to replace classical computing; instead, they will work together in a hybrid manner, with classical computers still completing the simple everyday tasks they're assigned while Quantum Computing would speed up any tasks its struggling with. Overall, this study highlights how Quantum Computing has the potential to beneficially impact enterprise operations once used on ERP Systems.