Abstract: Science and Engineering Fair of Houston

3100

Adaptive EMG Gaming: Real-Time Detection of Muscle Fatigue and Co-Contraction for Enhanced Motor Learning

Category: Biomedical Engineering

Arnav Kanodia

Conroe ISD /AST: Academy of Science and Technology

Stroke rehabilitation requires high doses of therapy to restore motor function, but muscle fatigue, abnormal co-contraction, and problems with selective muscle control limit recovery. This study investigated whether adaptive difficulty adjustment based on real-time electromyography feedback reduces co-contraction and enables more effective selective muscle activation compared to a fixed-difficulty system. Seven neurologically intact adults completed four 20-minute sessions of an EMG-controlled game requiring isolated biceps and triceps activation for movement control. A within-subjects counterbalanced design compared adaptive versus non-adaptive difficulty modes. The adaptive system tracked muscle fatigue through dual-metric detection requiring simultaneous amplitude increases and frequency decreases and tracked co-contraction, then it reduced difficulty by adjusting pipe speed, gap size, activation thresholds, and triggered a 20 second break if the thresholds were met. Adaptive difficulty produced significant improvements on average: 20.4% higher total scores, 73.4% reduction in time spent fatigued, 64.6% decrease in mean fatigue levels, time to sustained fatigue was delayed by 114%, and 32.2% fewer co-contraction events. The time to first fatigue did not differ significantly between the two game modes, meaning the game did not prevent fatigue but rather managed the intensity and duration of fatigue. These benefits resulted from difficulty reductions that maintained challenge while managing the user's fatigue and co-contraction. Results demonstrate that adaptive EMG systems can help improve selective activation and co-contraction of muscles through real-time physiological adaptation. While this study tested healthy adults, findings suggest potential for rehabilitation using EMG-controlled games to improve motor control while managing fatigue.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[X] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3101

Category: Biomedical Engineering

ART (Adaptive Respiratory Trainer): A Wearable Closed-Loop Biofeedback Prosthetic for Diaphragmatic Rehabilitation in MS Patients

Danielle Trinh, Alaina Van

Clear Creek ISD /Clear Lake High School

Multiple sclerosis (MS) patients often face respiratory insufficiency from diaphragmatic weakness, increasing the risk of infection. Current therapies lack real-time feedback, making effective diaphragmatic engagement difficult. This project aimed to design a wearable, waistband-style prosthetic integrating EMG and flex sensors, providing immediate tactile (vibration) and visual (LED) feedback upon meeting deep breathing thresholds. Thresholds were determined with a dynamic calibration algorithm: Threshold = Min + (k * Range), with optimized factors of k_flex=.25 and k_emg=.27. The system further incorporates heart rate and SpO2 monitoring (via iOS Health app samples) to ensure physiological stability during use. The device was tested over five sessions (9,973 samples) to evaluate the user's ability to improve breathing technique using the feedback loop. Success was defined as meeting EMG and flex thresholds while maintaining normal vitals (60-100BPM; >92% SpO2). Quantitative analysis revealed a significant learning curve: the success rate improved from 4.70% in the initial session to a peak of 25.95% by the fourth session, representing a 451.7% increase in technique mastery. The fifth session (disabled feedback) showed the success rate revert to 4.79%, confirming user dependency on the device for correct technique. SpO2 levels remained optimal (98-100%), while heart rate stabilized at a consistent mean of 71BPM by the final trials, indicating increased user comfort and respiratory efficiency without strain. Overall, the biofeedback mechanism effectively helps users identify and maintain diaphragmatic engagement. This low-cost, portable device allows MS patients to perform more effective/ independent respiratory rehabilitation, offering a scalable solution to reduce respiratory complications in MS.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[X] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

Abstract: Science and Engineering Fair of Houston

3102

Category: Biomedical Engineering

Generative Artificial Intelligence for Patient-specific Reference Model Estimation in Orthognathic Surgical Planning

Kelly Xiong

Spring Branch ISD/Spring Branch Academic Institute

Prior to the advent of artificially generated orthognatic surgical planning tools, the surgical template would be subject to each individual surgeon's experience and preferences, introducing opportunities for error and personal bias, with a surgical planning model trained on normalized data sets, possible human error can be prevented and surgical outcomes came be greatly improved. Accurate and patient-specific estimation of a normal reference jaw is essential for effective surgical planning in orthognathic procedures. In this study, I present a novel two-stage AI framework for generating personalized jaw reference models directly from the midface model. This approach offers a promising direction for AI-assisted patient-specific orthognathic surgical planning.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants   [ ] potentially hazardous biological agents

[ ] Vertebrate animals   [ ] microorganisms   [ ] rDNA   [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes   [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes   [ ] no

4. This project is a continuation of previous research.

[ ] yes   [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes   [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes   [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3103

Category: Biomedical Engineering

Computational Immunology Biomarkers in AML: Harnessing Multiplex Cytokine Profiles for Machine Learning-Driven Risk Stratification

Aarnavi Dhengane

Fort Bend ISD /Dulles High School

Acute myeloid leukemia is an aggressive hematologic cancer characterized by the rapid proliferation of myeloid blasts. It remains the most fatal type of leukemia despite therapeutic advances. This research posits that if the regulation of pro-inflammatory cytokines in acute myeloid leukemia is impaired, then cytokine signaling will be dysregulated because hematopoietic cells in AML undergo several stress factors, causing an imbalance in the microenvironment and a suppression of anti-leukemic immune responses. Additionally, it tests methods of a machine learning algorithm analyzing cytokine profiles of AML patients to classify them based on their prognosis risk. In order to contribute to patient treatment and improve recovery, cytokine profiles of AML patients from BeatAML data were investigated in Google Colab using Random Forest and SMOTE to create a machine learning algorithm that can predict prognosis and stratify risk classifications of those patients. The resulting machine learning model achieved an area under the curve of 0.82 for binary survival prediction and a concordance index of 0.665. Kaplan-Meier analysis demonstrated a log-rank p-value of 0.00029752328504038035. Feature importance analysis identified IL6, TNF, and IL1B as the primary cytokine drivers of the prognostic signature. The application of survival analysis and specific platforms such as Google Colab aided the development of preprocessed omics data and the model itself. Ultimately, this project aids the medical research field to make better decisions on personalized treatment of each patient and have more efficient diagnostic and risk stratification plans, optimal therapy, and considered expected outcomes.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3104

Category: Biomedical Engineering

NanoCleaners: Miniature Magnetic Rotating Swimmers (MMRS) for Uniform Biofilm Clearance in Urinary Catheters to Prevent Catheter -Associated Urinary Tract Infections

Dhruv Mantri, Nihika Sarada, Bella Pham

Cy-Fair ISD/Cypress Ranch - HS

INTRODUCTION: Catheter-Associated Urinary Tract Infections (CAUTIs) affect 150 million patients annually and account for ~70-80% of all urinary tract infections. These infections are driven by intraluminal biofilm formation, which obstructs urine flow and enables persistent bacterial colonization. Existing approaches rely on passive antimicrobial coatings or frequent catheter replacement, which are often ineffective at removing established biofilm, painful for patients, and costly for healthcare systems. AIM: To develop and evaluate a low-cost, non-invasive, drug-free method for active biofilm removal in urinary catheters using miniature magnetic rotating swimmers (MMRS). METHODOLOGY: 5 helical MMRS variants were engineered with bristle-like features to facilitate mechanical agitation of the inner catheter walls, while maintaining forward propulsion. Swimmers were resin printed (1 mm OD, 6 mm length) and embedded with a micromagnet. The green dyed biofilm surrogate, composed of sodium alginate, porcine mucin, and egg white, was injected into the catheter, coating the inner walls. The MMRS was inserted, and actuation was achieved using an electromagnetic cubic-field manipulator to produce predictable magnetic torque and sustained swimmer rotation along the lumen. RESULTS: Cleaning was recorded under standardized imaging and quantified. The top-performing variant of MMRS achieved and maintained 95.1% ± 2.4% surrogate removal within 20 minutes, outperforming all other variants. Axial intensity profiles and subtraction heatmaps confirmed the most uniform spatial clearance across catheter lengths. CONCLUSIONS/APPLICATIONS: The study demonstrates a novel, low-cost, non-antibiotic solution for active intraluminal removal of biofilm buildup in catheters. The result highlights strong translational potential for reducing catheter replacement frequency and mitigating CAUTI risk, particularly in resource-limited settings where frequent catheter exchange is not feasible.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3105 **Structural Performance of 3D-Printed Prosthetics** Nataly Lopez Aldine ISD/Blanson CTE HS	**Category:** **Biomedical Engineering**

A major limitation of low-cost 3D-printed prosthetics is structural weakness, which can lead to bending, cracking, or failure during everyday use. This project investigates how material choice affects the strength and durability of a 3D-printed prosthetic hand. A prosthetic hand and forearm were designed and printed using two materials: standard PLA filament for the fingers and carbon-fiber-reinforced PLA for the wrist and forearm. The prosthetic was anatomically scaled to a real human hand to improve realism and functional relevance. To evaluate material performance, identical test samples representing prosthetic finger segments were printed in both PLA and carbon-fiber-reinforced PLA. Each sample was subjected to increasing force until deformation or failure occurred. The maximum load sustained by each material was recorded and compared to determine which material provides greater structural reliability for prosthetic use. The results of this study will help identify which materials are most suitable for low-cost, 3D-printed prosthetics, with the goal of improving safety, durability, and accessibility for individuals who rely on prosthetic devices.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[X] yes [ ] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3106

Illuminating Dopamine: Engineering a CRISPR-dCas9 Yeast Biosensor for Specific and Sensitive Dopamine Detection

Yilin Guo

Conroe ISD /AST: Academy of Science and Technology

Category:

Biomedical Engineering

Every 6 minutes, someone is diagnosed with Parkinson’s disease, a neurological disorder caused by the loss of dopamine-producing neurons in the brain, which takes away their ability to control their movements and function in daily life. Developing drugs to treat dopamine-related neurological disorders, including Parkinson's disease, schizophrenia, and addiction, is an incredibly slow and expensive process, since evaluating whether a potential drug works requires measuring its effect on dopamine signaling, but current detection methods are either low-throughput, invasive, or prohibitively expensive for large-scale compound screening. To address this, I engineered a novel, yeast-based biosensor that leverages synthetic biology for quantitative dopamine detection. The system integrates a human dopamine receptor (DRD2) with a CRISPR-dCas9 transcriptional activation circuit in Saccharomyces cerevisiae, translating ligand-binding events into amplified green fluorescent protein (GFP) expression. The biosensor was successfully constructed and validated, exhibiting a dose-dependent fluorescent response to dopamine with nanomolar sensitivity and specificity. Quantitative analysis yielded a limit of detection of 2.3 nM and an EC_{50} of 47.5 nM, confirming operation within the physiologically relevant nanomolar range. Specificity tests showed a statistically significant 11.8-fold greater response to 10 µM dopamine compared to equimolar concentrations of norepinephrine, a similarly structured neurotransmitter more commonly known as noradrenaline ($p < 0.001$). This demonstrates a robust, modular platform capable of readouts of dopamine concentration with nanomolar sensitivity and specificity to dopamine. Ultimately, as a sensitive, specific, and scalable biological tool, this work could initiate the next big breakthrough in drug discovery.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [X] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [X] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year’s work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[X] yes [ ] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3107

Deep Learning-Based Denoising of Low-Dose CT Images Using Wasserstein Generative Adversarial Networks

Category: Biomedical Engineering

Sahil Mohammed

Veni Home School

Computed Tomography (CT) is essential for medical diagnosis but exposes patients to ionizing radiation linked to increased cancer risk. Low-Dose CT (LDCT) reduces radiation exposure by up to 90%, yet introduces image noise that may lower diagnostic accuracy. This research investigated whether deep learning could restore LDCT image quality while preserving important structures needed for accuracy. A Wasserstein Generative Adversarial Network with Gradient Penalty was developed using a U-Net generator architecture. The model was trained on paired Low-Dose and Normal-Dose CT images from a publicly available, de-identified dataset. The training utilized a combined loss function incorporating adversarial and reconstruction losses. The model was evaluated on 319 test images using Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM). The approach achieved significant image quality improvements. Both PSNR and SSIM metrics showed substantial gains, demonstrating preservation of structural details needed for diagnosis. Deep learning effectively restored LDCT image quality to approach Normal-Dose CT standards. This approach has potential clinical applications for reducing patient radiation exposure while maintaining diagnostic image quality, contributing to safer medical imaging practices.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3108

Period Patch

Category:

Biomedical Engineering

Christian Chen, Kevin Choi, Kevin Gao

Homeschool/CAK Pack - Homeschool

Dysmenorrhea, painful menstruation, affects 40% of humanity. To address this, we created the Period Patch, a homemade, extended-release, transdermal system. To create our custom drug reservoirs, we investigated inhibitors to the cyclooxygenase (COX) enzymes, responsible for prostaglandins synthesis, associated with menstrual cramps. Naproxen Sodium inhibits COX enzymes. Natural alternatives are ginger and colored avocado seed extract (CASE). Ginger is proven to block COX enzymes and mitigate dysmenorrhea. CASE contains glycosylated benzotropolone-containing polyphenols that have anti-inflammatory properties. However, CASE is not well established as a COX inhibitor. We created seven unique patches with different drug formulations. To test the patches, we attached them to skin-mimicking membranes on test tubes of saline for an in vitro experiment. To simulate blood flow, we shook the test tubes every hour over 32 hours and extracted samples every eight hours. Absorbance readings obtained using a spectrophotometer at 8 hours, 16 hours, 24 hours, and 32 hours were used to calculate the amount of substance diffused. We then calculated the consistency of diffusion using the R-squared of each of the patches. The Ginger-Only Patch ($P = 0.00001$), diffused the most at 855 milligrams, with the least lag time, the time when diffusion was initially detected. However, the Naproxen Sodium Patch (in Silicon-Mold) ($P = 0.00006$), diffused at the most consistent rate with an R-squared of 0.91. Although limited to in vitro testing, our Period Patch is a valuable model for pharmacologists because our statistically significant data can contribute to further research on dysmenorrhea management.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3109

CelluVent: Mold Cast Cellulose Acetate Endobronchial Valve for Accessible Emphysema Treatment

Category: Biomedical Engineering

Sirtaj Mattewal

Conroe ISD /AST: Academy of Science and Technology

Emphysema, an advanced form of COPD, causes destruction of alveolar walls, which leads to air trapping and hyperinflation. This not only reduces quality of life but also contributes to a significant portion of deaths worldwide. Endobronchial valves (EBVs) are a minimally invasive treatment that allows one-way airflow in the bronchioles to reduce hyperinflation. Unfortunately, current commercial devices are expensive, making them inaccessible in low and middle-income countries. This research investigated the feasibility of using cellulose acetate (CA) as an alternative material for low-cost endobronchial valves. A CA solution was produced and then molded into an umbrella-style geometry. Rectangular CA strips were also cast and used to evaluate mechanical properties. Tensile strength and elasticity were tested through controlled loading tests. One-way airflow was evaluated through a syringe-manometer system. Mechanical testing revealed that cellulose acetate exhibited moderate tensile strength and consistent elasticity, indicating that it possesses sufficient structural integrity while maintaining flexibility. Stress–strain examination revealed desirable stiffness across trials, indicating reliable mechanical performance despite manual fabrication. Airflow testing showed low resistance during forward flow and minimal leakage under reverse pressure, validating an effective one-way airflow function. Overall, the results demonstrate that cellulose acetate can exhibit structural stability and flexibility, as well as sufficient one-way airflow, which are key requirements for the success of an EBV. While performance did not match that of commercial valves, the material demonstrated feasibility for low-cost applications, and results support further research on cellulose acetate-based valves.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3110

Computational Optimization of Magnetic Nanoparticle Size for Tumor Hyperthermia Using Multiphysics Modeling

Deeti Modi

Katy ISD/Jordan - HS

Category:

Biomedical Engineering

When using magnetic hyperthermia to treat tumors, finding the optimal nanoparticle size for treatment is key to achieving best treatment results in terms of measuring diffusivity and volumetric heat source. Using COMSOL Multiphysics, I tested the hypothesis that medium size particles will perform best. Parameters for the tumor microenvironment were gathered from other works and TDS, Bioheat Transfer, and Laminar Flow were the coupled physics. There was a parameter sweep for the different nanoparticle diameters because that was the variable being tested. The simulation ran and the results were seen on the 3D geometry as well as the 2D cross sections and the line graphs. Overall, the 30nm, 45nm and 60nm proved to be optimal for the concentration gradient and even diffusivity (starting at 0.783 mol/m^3 at the inlet of the needle and then distributing out evenly approximately to 0.2 mol/m^3 in 2, 5, and 10 seconds). For the heating aspect, the edge of the tumor had heated significantly more (at max 60 degrees Celsius or 333 Kelvin) and after 10 seconds, much of the outer edge of the tumor had cooled down to 37 degrees Celsius. This study showed that particles in the range from 30-60 nm are ideal for magnetic nanoparticle hyperthermia treatment. Anything less than 10nm is claimed to be too small as it can be easily cleared by the kidneys. Future studies will add surface charge for further optimization and realistic tumor geometry.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

- [X] yes
- [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

- [ ] yes
- [X] no

4. This project is a continuation of previous research.

- [ ] yes
- [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

- [ ] yes
- [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

- [X] yes
- [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3111

Automated Drowning Detection Using Computer Vision Algorithms

Category: Biomedical Engineering

Katelyn Zahner

Clear Creek ISD /Clear Creek High School

This project aimed to protect children from drowning in backyard pools. An end-to-end system was designed to detect drowning using a computer vision system that, when drowning is detected, sends a notification phones alerting bystanders. The hypothesis was If the computer vision detection system correctly detects drowning from a camera and can successfully send a drowning notification to subscribed phones, then this project can successfully provide a mitigation to children drowning in their backyard pool. This was achieved by training a YOLOv11m model to detect drowning. A camera was then used to pass imagery to this model; this would detect drowning and notify a remote web server. Users would register with that server to be notified if drowning had occurred. Once the model was trained appropriately and the model variables were tuned, validation testing started. The validation cases used live streamed videos of a person simulating drowning behavior and swimming. The results showed that the end-to-end system was able to detect drowning successfully 100% of the time, it also successfully detected swimming 96% of the time. The results demonstrate that drowning can be detected and possibly prevented by using a trained vision detection system.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [X] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

- [X] yes
- [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

- [ ] yes
- [X] no

4. This project is a continuation of previous research.

- [X] yes
- [ ] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

- [X] yes
- [ ] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

- [X] yes
- [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3112

Reinventing the Medicine Container Year 2

Category: Biomedical Engineering

Ishaan Chaudhary

Fort Bend ISD /Hightower High School

Medication nonadherence is a major public health problem, contributing to an estimated $42 billion in annual global healthcare costs and accounting for nearly 30% of preventable hospital visits. Studies indicate that over half of patients fail to take medications as prescribed, often due to forgetting doses, taking them at the wrong time, or unintentionally double dosing.The goal of this project is to create a solution to the growing problem of medical non-adherence that is cost-effective, interactive, and simple. A native iOS application was developed using swift. This application used NFC tags to confirm medication adherence. The application was built with two configurations: a treatment version with reminder notifications and NFC-based dose confirmation, and a control version without these features. 18 participants were randomly assigned to either group and instructed to take a placebo medication twice daily for nine days. The application logged medication intake times, and participants completed a post-experimental satisfaction survey. Performance was evaluated using adherence rate, adherence drop-off, time elapsed between scheduled and actual intake, and satisfaction scores. Statistical analysis using p-values was conducted to compare group performance. The treatment configuration demonstrated higher adherence rates, reduced adherence drop-off, shorter intake delays, and higher satisfaction compared to the control configuration, with statistically significant differences ($p < 0.05$). These results indicate that NFC-based confirmation combined with persistent reminders can effectively improve medication adherence. This system has potential applications in reducing medication errors and enhancing patient safety.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [X] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

- [X] yes
- [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

- [ ] yes
- [X] no

4. This project is a continuation of previous research.

- [X] yes
- [ ] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

- [ ] yes
- [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

- [X] yes
- [ ] no

Abstract: Science and Engineering Fair of Houston

3113

Design and Validation of a Low-Cost Dry Heat Sterilization System Using a Multi-Channel Thermocouple Array

Category:

Biomedical Engineering

Arya Ahmadi

Fort Bend ISD /Clements High School

This project aims to develop a low-cost dry-heat sterilization system equipped with a multi-channel thermocouple array to monitor temperature distribution in real time. Many dry-heat sterilizers currently monitor temperature at only a single point, which can lead to unvalidated cold spots and incomplete sterilization. I will construct a system using an Arduino-based control unit and 16 thermocouples placed inside a sealable instrument tray to track spatial temperature variations. The system will regulate heating based on the coldest point and log temperature data for validation. I expect the device to consistently identify cold spots and ensure the coldest location maintains sterilization temperature for the required duration. This project may improve sterilization reliability in low-resource or field environments where traditional steam autoclaves are not feasible.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3114

Wearable Brain-Controlled Glove for Movement Assistance in Parkinson's Disease

Krushal Panda, Caleb Foo

Conroe ISD /AST: Academy of Science and Technology

Category:

Biomedical Engineering

Parkinson's disease is a progressive neurodegenerative disorder that affects over 10 million people worldwide, causing motor impairments which severely limit daily activities like grasping objects and performing self-care tasks. As a solution, this project introduces a non-invasive electroencephalography (EEG)-based brain-computer interface that uses EEG signals to detect motion intent and a soft robotic glove to assist and enhance finger movement for daily hand functions. Our BCI system consists of a riemannian geometry framework that utilizes covariance matrices to capture spatial and temporal features. Utilizing a transfer learning framework, the researcher was able to transfer our model trained on healthy patients to parkinson's patients as most datasets for parkinson's patients often include only 10-12 patients, making information very limited and susceptible to overgeneralization. Flexible silicone actuators in each finger inflate and deflate to simulate natural flexion and extension, achieving up to 180 degrees of motion for grasping and releasing objects. Independently controlled via solenoid valves, the actuators provide precise movement based on EEG signals. Pressure testing and reinforcement adjustments in the passive layer ensure controlled bending in order to mimic joint-like motion. This system offers a cost-effective, portable solution for individuals with motor impairments, providing non-invasive assistance with hand movements. Its adaptability and ease of use make it suitable for everyday tasks, improving quality of life without the need for bulky, expensive devices and constant caregiving attention.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3115

Mesenchymal Plasticity as a Predictor of Renal Damage in Lupus Nephritis

Category: Biomedical Engineering

Ronuk Gadamsetty

Fort Bend ISD /Dulles High School

Histopathologic evaluation of lupus nephritis (LN) relies on semi-quantitative scoring of renal biopsies and is subject to inter-observer variability. This project focuses on the quantitative computational analysis of Imaging Mass Cytometry (IMC) images to characterize spatial and single-cell features associated with LN severity, as defined by National Institutes of Health activity and chronicity indices (AI/CI). De-identified IMC images were obtained from formalin-fixed paraffin-embedded renal biopsies representing low and high AI/CI LN, along with non-LN controls. No tissue collection, handling, or experimental procedures were performed by the student; all work was conducted through image processing and data analysis. Images were processed using established computational workflows for noise reduction, channel quality control, segmentation, and single-cell feature extraction. Quantitative measurements of marker intensity, cell density, and spatial distribution were evaluated across glomerular, periglomerular, and tubulointerstitial regions. Dimensionality-reduction and clustering methods were applied to visualize differences in cellular composition across severity groups. Image-derived analysis showed that high AI/CI LN samples exhibit increased immune cell infiltration, elevated expression of antigen-presentation markers, and greater deposition of extracellular matrix proteins compared to low AI/CI and control samples. Mesenchymal markers were more broadly expressed across both resident renal cells and infiltrating immune populations in high AI/CI biopsies. In contrast, low AI/CI samples demonstrated more preserved architecture and reduced inflammatory and fibrotic signal intensity. Overall, this work demonstrates that quantitative analysis of IMC images can reproducibly capture spatial and cellular features associated with LN severity, providing detailed molecular context that complements conventional histopathologic assessment.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3116

Sound Wave–Assisted Rapid Respiratory Infectious Diseases Diagnosis

Junhao Cheng

Private/The Village School

Category:

Biomedical Engineering

Rapid diagnosis of respiratory infectious diseases is essential for timely clinical decision-making and effective public health response. However, conventional laboratory-based nucleic acid testing workflows often require several hours from sample preparation to result reporting, primarily due to time-consuming sample handling and processing steps. This project presents a sound wave–assisted microfluidic diagnostic platform designed to enable rapid diagnostic readout by significantly accelerating on-chip sample processing. The system consists of a compact polydimethylsiloxane (PDMS) microfluidic chip integrated with microscale sharp-edge structures. When actuated by a piezoelectric transducer, acoustic fields are generated within the microchannels, producing strong acoustic streaming that enables rapid and efficient mixing of human saliva samples. This acoustofluidic mixing mechanism enhances sample homogeneity and facilitates accelerated nucleic acid diagnostic workflows. The integrated design allows biological samples to be introduced, processed, and analyzed within a single microfluidic platform. All experiments were conducted in a university laboratory setting using commercially obtained, de-identified human saliva samples and synthetic viral nucleic acids, without involving live pathogens. Experimental results demonstrate that the sound wave–assisted microfluidic system enables diagnostic readout within 15 minutes when working with standard nucleic acid detection techniques, representing a substantial reduction in total diagnostic time compared to conventional laboratory workflows. By integrating acoustofluidic mixing with a compact PDMS-based microfluidic design, this work demonstrates the potential of sound wave–driven systems to support rapid and efficient respiratory infectious disease diagnostics. The proposed platform provides a scalable and time-effective engineering solution for point-of-care and time-sensitive diagnostic applications.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [X] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [X] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[X] yes [ ] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3117

Penny Monitor: A Cheap and Effective Device to Aid in ED Triage and Clinic Patient Monitoring

Category: Biomedical Engineering

Christian Ding

Conroe ISD /AST: Academy of Science and Technology

Modern hospital-grade vital sign monitors have been developed over the past six decades, with the technology growing in accuracy, capability, and ease of use. Though these devices have presented several setbacks, such as price and bulkiness, reducing the possible range of use. A possible solution to these systematic issues is wearable health monitors, which are typically more compact and cheaper. This project aimed to test different alternatives to hospital-grade vital sign monitors that could supplement current industry-grade ones. To do this, it tested several different alternatives: a Fitbit, a Pulse Oximeter, and a custom vital sign monitor named the “Penny Monitor”, against a Hilrom Welch Allyn 4400 Vital Sign monitor. These comparisons would only be for temperature (both skin and core), blood oxygen percentage, and pulse rate; blood pressure is excluded due to the difficulty in obtaining accurate readings without a blood pressure cuff. To create the “Penny Monitor,” a MAX30102 Heart Rate and Pulse Oximeter sensor and a TMP36 Analog Temperature sensor were used. To experiment, a pulse oximeter, a Fitbit, and the “Penny Monitor” were tested against the Hilrom Welch Allyn 4400 Vital Sign monitor in Pulse Rate, Blood Oxygen, and temperature readings. Blood Oxygen and Pulse Rate readings between the “Penny Monitor,” the pulse oximeter, and the Hilrom were very similar. Skin temperature readings between the “Penny Monitor” and the Fitbit were comparable, though the “Penny Monitor” could not measure core temperature like most hospital-grade monitors.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year’s work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3118

Category:

Biomedical Engineering

A Deep Learning Pipeline for Tumor Burden Extraction and Eligibility Classification in Hepatocellular Carcinoma: Engineering Robustness in Liver Transplant Eligibility

Nia Shetty

Private/ST. JOHN'S SCHOOL

The Milan criteria is widely used to determine liver transplant eligibility for patients with hepatocellular carcinoma (HCC) based on tumor size and count. As these measurements are derived from medical imaging and performed manually, small variations near Milan thresholds (1 tumor <= 5cm or 3 tumors each <= 3cm) can lead to inconsistent eligibility decisions in a high-stakes clinical process. This research developed an automated deep-learning pipeline to segment liver tumors from CT images, quantify tumor burden, and evaluate robustness of Milan-based eligibility decisions. Convolutional neural network models were trained on the Kaggle Liver Tumor Segmentation dataset (LiTS) to generate patient-level tumor measurements, including tumor count and largest diameter. Segmentation quality was evaluated using Dice coefficient, with liver segmentation achieving high and stable Dice scores (≥0.90) and tumor segmentation showing lower and more variable Dice scores (0.65–0.80), reflecting greater boundary complexity. A rule-based eligibility classifier based on Milan criteria was applied, and Monte Carlo simulations introduced realistic measurement variability to assess decision stability using eligibility flip rates. Separately, de-identified UNOS liver-transplant data was analyzed independently to examine whether tumor burden features could improve outcome predictions. A Graphical User Interface(GUI) was developed to visualize segmentation, tumor measurements and eligibility outcomes. Results showed that eligibility decisions were stable for clearly eligible and ineligible patients but highly sensitive for borderline cases near Milan thresholds, with 15–40% of classifications changing under small measurement perturbations. Findings demonstrate that automated imaging can enhance consistency in tumor burden assessment and standardize transplant eligibility decisions.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3119

Category: Biomedical Engineering

POCKET: A Multiplexing Point-of-care Kinetic Electrochemical Test using Aptamers for Accessible, Rapid Diagnostics

Sai Spoorthi Maram, Jiya Joshi

Fort Bend ISD /Travis High School

Nearly half of the world's population, 47%, has little to no access to diagnostic testing, which can delay care until conditions become critical. This gap in diagnostic access limits timely screening for common conditions and harms resource-limited settings. Current methods such as ELISA, lateral flow assays, and qPCR that attempt to bridge this gap are expensive, inaccurate, or require professional training, making them unjustifiable for patients with mild or ambiguous symptoms. To mitigate these problems, we propose POCKET, an affordable (<$30), rapid (<30 minutes) platform that delivers multiplexed diagnostics in one step. POCKET's system first begins with an FEA verified passive microfluidic module which filters whole blood to plasma in 10 minutes with the help of nano-insterices. Plasma is then led to a disposable, screen-printed sensor coated in an antifouling layer with DNA aptamers on a gold working electrode to target three biomarkers, verified through in-silico simulations. Each aptamer is attached to a distinct redox reporter to generate electrochemically separable peaks, read by a custom-made, portable PCB potentiostat. These peaks shift with signal-on/signal-off behavior of the aptamer, reflecting its conformational changes upon binding to the target biomarkers. Signals from the potentiostat are transmitted via Bluetooth to a mobile application where voltammograms are processed to generate a diagnosis that can be shared with clinicians and family members, enabling a rapid response. POCKET has the potential to revolutionize point-of-care diagnostics by serving as the first automated end-to-end system of care.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [X] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

- [X] yes
- [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

- [X] yes
- [ ] no

4. This project is a continuation of previous research.

- [ ] yes
- [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

- [ ] yes
- [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

- [X] yes
- [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3120

Neuro Hand Maker 2.0

Category:

Biomedical Engineering

Maryam Ogunbanwo, Samirah Chowdhury, Ryan Nguyen

Harmony Public Schools - South District/Harmony School of Innovation Katy

This Neuromaker 2.0 project explores the connection between neuroscience, creativity, and design thinking. Through observational studies, material experimentation, and research, the project investigates how the brain perceives form, pattern, and meaning in both natural and built environments. By combining hands-on making with reflection, this project aims to better understand how cognitive processes influence creative decision-making and spatial interpretation.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3121

Precision Analysis of Protein-protein Interactions Using AI-embedded Multimodal Biosensor Chips

Category:

Biomedical Engineering

Aetna Lin

Private/THE JOHN COOPER SCHOOL - HS

The research goal is to develop biosensing chips that can characterize protein-protein interactions (PPIs) with multimodality and high-throughput analysis. PPIs are the key element that facilitate a wide range of biological processes. Standard PPIs analysis methods, including co-immunoprecipitation and bioluminescence resonance energy transfer, require bench-top equipment such as mass spectrometers or optical spectrometers. Though these systems provide high accuracy, they are bulky, costly, labor-intensive, and incapable of parallel and efficient PPIs measurements. A miniaturized and precision PPIs device is thus in highly demanded. Procedurally, our novel PIPs sensor device was prepared by fabricating micron-scale optical waveguide assay that consisted of a nanostructured anodized alumina oxide (AAO) membrane. PPIs measurements were conducted by genomic hybridization of SARS-CoV-2 genetic targets. Finite-Difference Time-Domain (FDTD) simulation was used in the design of the waveguide assay and modeling of the PPIs detection performance. AI algorithms were implemented in the data analysis. Two orders enhancement of fluorescence and measurement accuracy corresponding to PPIs were observed because of the extremely large surface of a nanoporous AAO membrane. Multimodal detections applying (i) evanescent waveguide sensing and (ii) fluorescence sensing were also verified through the FDTD modeling as well as the PPIs analysis. In conclusion, a miniaturized and high-throughput biosensor device for rapid PPIs analysis was in high demand. It has the advantages of label free, real-time, cost-effective, and accurate detection of many specific proteins simultaneously. The developed sensor chips will accelerate exploration and prediction of complex protein functions, which are critical in new drugs developments and novel diseases treatments.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3122

A Retainer-Based Tongue Interface for Simulated Wheelchair Control

Category: Biomedical Engineering

Hibah Faheem

Conroe ISD /ASHP: Academy for Science and Health Prof

Individuals afflicted with quadriplegia strive to regain independent mobility to increase their quality of life. However, a comfortable, non-invasive system capable of sophisticated control remains an unmet necessity in today's environment. This work evaluates a non-invasive, retainer based tongue interface to determine its feasibility for controlling complex 3D navigation. A custom intraoral retainer was designed and fitted with five thin-film pressure sensors at the incisive papilla, canines, and molars to capture a range of intuitive press commands. A Support Vector Machine, a machine learning classifier, translated tongue presses into directional commands. Performance was assessed in a custom 3D simulated environment. A single subject proof of concept design was used, with the participant completing 20 standardized trials. The completion time and collision count served as key metrics against an optimal keyboard control condition. The interface allowed for the successful completion of all navigation trials with 89% real time command accuracy. Compared to the optimal benchmark, the tongue interface was 2.3 times slower and resulted in more collisions, defining the current performance gap. This interface serves as a foundation for hands-free operation of assistive technology, increasing independence for users with significant motor impairments.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

Abstract: Science and Engineering Fair of Houston

3123

Hemoguard

Category: Biomedical Engineering

Nevzat Gok

Harmony Public Schools - South District/Harmony School of Innovation Katy

Hemophilia is a blood disorder that inhibits blood clotting, because of this, it poses a significant risk to toddlers as they learn to walk. The goal of the experiment and the broader HemoGuard Project is to identify which foams work best in helping prevent intracranial hemorrhaging, and what attributes of the foam contribute to this. Using a head foam attached to a helmet shell, with a neck surrogate (PVC pipe and weights), the experiment tested various foams, recording raw data on a 9-axis IMU. After calculating peak linear acceleration, Head Injury Criterion (HIC), and impact duration, the foams were compared to determine which was most effective. The HemoGuard Project aims to identify a physically effective, cost-effective, non-invasive material to help prevent intracranial hemorrhaging among toddlers, providing a potential preventive solution to a significant health risk.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3124

Category: Biomedical Engineering

Beyond the Blood–Brain Barrier: A Decision-Based Computational Framework for Targeted Temozolomide Delivery in Glioblastoma via Extracellular Space Transport Modeling and In Silico Nanocarrier Validation

Anyulina Arias Delvaty

Alief ISD/Alief Early College

Glioblastoma (GBM) is the most aggressive form of brain cancer, where the five-year survival rate is as low as 6.9%. Temozolomide (TMZ), the standard form of chemotherapy treatment, rapidly degrades to MTIC and diffuses heterogeneously through the brain's extracellular space (ECS), resulting in insufficient drug exposure beyond the tumor core. These issues highlight the need to measure the simulated release of TMZ and its drug exposure over time and space before hydrolytic conversion to MTIC. To address these limitations, this project developed a diffusion-physics-based, in silico decision framework that models TMZ diffusion, release, and decay in the ECS by ranking nanocarrier delivery strategies based on predicted penetration radius, flux at the margin, and Area Under the Curve (AUC). To measure these outputs, three polymer-based and three lipid-based nanocarrier strategies based on TMZ-carrier studies were analyzed. Each strategy was categorized by its physicochemical properties, including particle size, gain stability factor, release half-life, zeta potential, and its transport mechanisms, serving as inputs to the framework's decision modules. PEG-PLGA demonstrated favorable simulation results under higher AUC values, delivery flux, and sustained TMZ concentrations above the defined threshold, relative to the remaining nanocarriers. Additionally, a CART-based decision tree regression model was applied to the simulation outputs to identify which delivery parameters most strongly influenced tumor drug coverage. Following, the model was evaluated by comparing docking analyses using AutoDock Vina regarding the TMZ nanocarrier interactions. Ultimately, this framework provides a scalable approach for optimizing TMZ drug delivery, allowing therapeutic intervention in invasive GBM regions.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3125

CTS Ergonomic Mouse

Category: Biomedical Engineering

Elisha Autor

Harmony Public Schools - North District/Harmony School of Advancement

Carpal Tunnel Syndrome (CTS) affects approximately 3-6% of adults worldwide, characterized by numbness, tingling, and pain in the hand caused by compression of the median nerve. This ongoing problem is exacerbated due to the prolonged use of computers in homes and workplaces. Most ergonomic mice in the market look clunky and medical, which stops many from purchasing them. I propose the "Modular Core" System, an ergonomic mouse designed to adapt to each users wrist by utilizing a 3D-Printed body. The shells are built with tilts that support the wrist in a natural position whilst being comfortable and lightweight, similar to a gaming mouse. I also incorporated breathable patterns to prevent the user's hands from becoming sweaty over long periods of time. I researched existing mouse designs and consulted users to determine which features maximize performance while minimizing wrist strain. This led me to utilize fitted designs and add-ons such as supports and wrist rests. I tested the comfort and feel of the mouse by surveying teachers and parents, focusing on their overall experience as well as the amount of wrist strain felt while using the device. The modular system is also environmentally friendly, as the outer shell is both removable from the main body and recyclable. The mouse only costs around $2 to make, making it substantially cheaper compared to other mice on the market. This project offers a practical solution that is able to prevent wrist pain from computer use.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[X] yes [ ] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

Abstract: Science and Engineering Fair of Houston

3126

Sphinx

Category: Biomedical Engineering

John Eikenburg, Grace Manuel, Haya Wishah

Private/ST. JOHN'S SCHOOL

The current standard of care for patients struggling with gastroesophageal reflux disease (GERD), a condition caused by a damaged or weakened lower esophageal sphincter (LES), is to surgically perform a fundoplication or to install a LINX implant. Studies show between 10-20% of American adults suffer from varying degrees of GERD symptoms weekly, ranging from reflux to vomiting, heartburn, and nausea. The issue with the current treatment is that, as of now, there is no exact way to determine how tight to make the fundoplication or LINX implant, and an unbalanced distensibility index (DI) may cause severe dysphagia and trouble eating or continued reflux and the associated complications. Recent studies have shown that up to 70% of patients suffer from varying degrees of dysphagia post-op and 20% of fundoplication procedures are reported as failures for persisting reflux. In order to address this issue, the team proposes an alternative akin to the LINX device, but with the added capability to monitor the patient's distensibility index (DI) continuously and the capability to increase or decrease the ALINX's maximum and minimum extension parameters, effectively allowing the patient to adjust the sizing of the device to their comfort post-operation.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[X] yes [ ] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3127

Category: Biomedical Engineering

Rational Design of a DNA Nanorobotic-Mediated Trispecific Nanobody Platform for Neutralization of Prion Aggregates in Transmissible Spongiform Encephalopathies

Sriram Susarla

Fort Bend ISD /Dulles High School

Transmissible spongiform encephalopathies (TSEs) are fatal neurodegenerative disorders driven by the conformational conversion of cellular prion protein (PrPc) into the infectious isoform (PrPsc). The TSE mortality rate is virtually 100% due to no approved treatments. Therapeutics are limited by two major challenges: ineffective blood –brain barrier (BBB) penetration and incomplete inhibition of prion propagation due to distinct conversion interfaces. This project addresses both limitations using a rationally engineered trispecific nanobody system, selected for its small size and superior tissue penetration compared to conventional antibodies. Target conversion hotspot epitopes, including the B1–a1 loop and B2–a2 loop of PrPc, and the groove terminus of PrPsc fibrils, were identified using Discotope and ElliPro and validated against literature. Immunogenicity screening against MHC I and II predicted minimal immunogenic risk across HLA alleles. Complementarity-determining regions of nanobodies were designed using RFAntibody's h-NbBCII10 framework and affinity-matured in IgDesign to optimize hydrogen bonding and electrostatic interactions. Docking and 2 ns molecular dynamics simulations confirmed strong binding, with MM/PBSA binding free energies of −456.9, −411.4, and −328.6 kcal/mol. The trispecific construct was assembled by connecting the three nanobody domains with (GGGGS)3 linkers, and 2 ns molecular dynamics confirmed that each domain maintained independent epitope engagement. The trispecific nanobody was encapsulated in a DNA nanostructure decorated with transferrin aptamers for BBB delivery and gated by a pH-responsive i-motif for targeted release at prion aggregates, demonstrated by oxDNA simulations. This is the first therapeutic strategy to integrate a trispecific nanobody with a DNA origami platform to comprehensively inhibit prion conversion.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3128

Break Buddy: The Technological Approach to Breaking The Normalized Teacher Bladder

Category: Biomedical Engineering

Keyla Salinas, Ana Segura, Kenya Ulloa

Fort Bend ISD /Willowridge High School

This project investigated how lack of breaks increased the number of UTI's infections amongst teachers over the past thirty years. It is commonly known as the "teacher bladder". We hypothesized that if we designed an app that could assist teachers by reminding them to purposely make time to take care of their needs, then this statistic would decrease. We conducted a survey with teacher in our area to see if they lacked restroom access, and we found that at least 52% did not drink enough water throughout the day to possible refrain from having to go to the restroom due to lack of having access. After this we created an app called "Break Buddy:, that can send discreet notifications via Smartphone, and Smartboard as it can assist them with having a healthier bladder schedule. These alerts are also shared with team members, so that they can assist them with their classes. Our app is under a continuous improvement, as we would like to expand its ability to provide a 31- day summary, as they self-reflect on possible improvements.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[X] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3129

Impact of Pressure on Kidney Filtration Rate

Category: Biomedical Engineering

Amina Zara

Harmony Public Schools - South District/Harmony Science Academy - Beaumont

My project is a homemade model that effectively displays the process of kidney filtration. Crucially, it also highlights the impact of different pressure conditions, visually displaying the distinct outcomes associated with increased and decreased pressure on filtration efficiency. This model utilizes household materials to illustrate how blood is filtered and waste products are removed to produce urine. My primary aim is to create an engaging tool for a better understanding of kidney function and filtration.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3130

Utilizing Helminth-Derived Factors to Subdue Hyperacute Rejection in Xenotransplantation

Category:

Biomedical Engineering

Arohi Mishra

Conroe ISD /AST: Academy of Science and Technology

Organ failure is becoming a serious issue in the medical world; only a limited supply of allografts is available for transplantation. Xenotransplantation, the process of grafting organs/tissues between different species, is a feasible solution to this issue but is limited due to hyperacute rejection (HAR) caused by a T cell-mediated immune response. To prevent HAR, this study hypothesized medics could possibly utilize helminth-derived factors (PL) from Mesocestoides Corti (M. Corti) due to their immunosuppressive properties. The premise is that helminths can survive in the human body for many years because they can actively suppress the immune response. To model rejection of liver cells (HepG2 cells), Jurkat T cells were cultured with THP1 monocytes and the antigen lipopolysaccharide (LPS). The THP1 cells recognize LPS, process it, and present the antigens to the Jurkat cells. This would trigger the T cells to secrete cytotoxic molecules that would result HepG2 cell death, mimicking HAR. To determine if helminths could prevent HAR, some experimental groups additionally contained PL. HepG2 cell death occurred if the cells secreted higher amounts of lactate dehydrogenase (LDH). In addition to an LDH assay, MTT and albumin assays were utilized to measure cell survival and functionality respectively. Two sample t tests determined that albumin secretion levels and cell viability were significantly higher in the cultures with PL, indicating that helminths could eventually be utilized to prevent HAR. Prospectively, helminth-derived factors could have the potential to be modified, mass produced and encapsulated in pills to be used as treatment.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [X] potentially hazardous biological agents
- [ ] Vertebrate animals
- [X] microorganisms
- [ ] rDNA
- [X] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

- [X] yes
- [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

- [X] yes
- [ ] no

4. This project is a continuation of previous research.

- [ ] yes
- [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

- [ ] yes
- [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

- [X] yes
- [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3131

Can sticky bacteria solve our ocean plastic pollution problems?

Category: Biomedical Engineering

Sophie Zhang

Private/Awty International School

Plastic pollution is reaching an all-time high, killing wildlife and damaging ecosystems. Because plastic is non-biodegradable and can take 5000 years to decompose, it is very urgent to find new ways to clean plastic out of ecosystems. To solve this issue, we previously engineered a tRNA/aaRS pair to incorporate a sticky non-canonical amino acid (ncAA), named DOPA, at an Amber-TAG stop codon, producing DOPA-containing proteins and bacteria that adhere to plastic. These bacteria were also designed to secrete PETase, an enzyme that breaks down polyethylene terephthalate (PET), with degradation measured by terephthalic acid (TPA) release. Our published results demonstrated the feasibility of using ncAAs to aid plastic degradation. However, ncAA incorporation remains limited by translational constraints. Based on this previous work, we proposed to improve ncAA incorporation efficiency in the coming summer of 2026. We hypothesize this efficiency is regulated by certain ribosomal proteins which can be altered to increase rate of ncAA inclusion. To test this hypothesis, we will use genome-wide knockout screening in E. coli followed by error-prone PCR to identify/create ribosomal protein variants that can enhance ncAA incorporation efficiency measured by a barcode-based Sequence Display platform. We expect to identify effective variants and will functionally validate them. The success of this new project will hopefully enhance DOPA's utility and enable a larger-scale strategy for combating plastic pollution.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [X] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3132

Multifactor Analysis of Nanoparticle Features Influencing Transport Across the Blood-Brain Barrier

Category: Biomedical Engineering

Kaitlyn Nguyen

Cypress Fairbanks ISD/Langham Creek - HS

The Blood Brain Barrier (BBB) is a physiological membrane that shields the brain from toxins and harmful chemicals. Due to its selective semipermeable nature, the BBB restricts the transport of certain drugs into the brain. This poses a challenge to therapeutic treatment of brain diseases and disorders in the Central Nervous System. The use of nanoparticles encapsulated with drugs across the BBB has potential to combat this issue. However, due to the variability and complexity of nanoparticle features, passage through the BBB remains difficult to predict and understand. To address this challenge, a novel dataset of nanoparticle physicochemical features and corresponding BBB uptake metrics was curated. Regression machine learning models are developed to identify the features that most strongly influence nanoparticle uptake across varying conditions of vitro and vivo. These features are then grouped into functional behaviors of BBB transport for further interpretability. The results provide a framework for improving nanoparticle design and drug delivery through the BBB by increasing the understanding of the influence of nanoparticle physicochemical features on the BBB uptake under varying contexts.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

Abstract: Science and Engineering Fair of Houston

3133

Virtual Screening of Natural Molecules - Blocking RBBP4 to Fight Liver Cancer

Suheyla Altunkopru

Harmony Public Schools - South District/Harmony School of Innovation - Sugar land

Category:

Biomedical Engineering

This project explored natural compounds as potential treatments for liver cancer by using computer-based molecular docking simulations. The focus was on blocking a cancer-related protein called RBBP4, which works with another protein, SALL4, to help cancer cells grow. Because SALL4 is difficult to target directly, this study aimed to find natural compounds that could attach to and inhibit RBBP4, disrupting this harmful interaction. A total of 200 natural compounds from the Selleck Chemicals database were screened using AutoDock Vina, a molecular docking software. The RBBP4 protein structure was obtained from the Protein Data Bank (PDB ID: 7M40). Custom Python scripts were used to analyze the results, rank compounds by binding strength, and visualize the most promising candidates. Several compounds showed strong binding affinity to the target protein, with Ginkgolide A (Molecule 135 with -11.60 kcal/mol best binding energy), Sennoside A (Molecule 161 with -11.50 kcal/mol best binding energy), Nystatin (Molecule 138 with -13.20 kcal/mol best binding energy), Rutin DAB10 (Molecule 121 with -11.60 kcal/mol best binding energy), Astragaloside (Molecule 128 with -11.90 kcal/mol best binding energy), and 10-Deacetylbaccatin III (Molecule 139 with -12.40 kcal/mol best binding energy) emerging as top candidates. These results suggest that certain naturally occurring molecules could serve as leads for the development of safer, plant-based cancer therapies. Future work will focus on laboratory validation to confirm the effectiveness of these compounds against RBBP4 in biological systems.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3134

GaitShift: A Wearable, Real-Time, Closed-Loop Feedback System for Gait Asymmetry Detection and Correction

Category:

Biomedical Engineering

Elaine Wang, Audrey Li

Houston ISD/Bellaire HS

Gait asymmetry affects over 50% of individuals and compromises stability, increases reinjury risk, and contributes to musculoskeletal imbalance across rehabilitation, athletic, and aging populations. Conventional clinical approaches for gait assessment, including force plates, motion capture systems, and episodic therapy, are largely confined to laboratory environments and fail to provide continuous, real-time corrective feedback. Existing wearable technologies primarily offer passive monitoring or delayed analysis, leaving a critical gap between gait assessment and actionable intervention. This project presents GaitShift, a wearable system engineered to detect gait asymmetry and deliver immediate haptic feedback to facilitate corrective adjustments. The device integrates inertial measurement units and plantar pressure sensors within a sock-based platform, coupled with embedded signal-processing algorithms to continuously quantify spatiotemporal gait parameters. Gait asymmetry is assessed using the Normalized Symmetry Index, enabling precise detection of interlimb differences, and vibration motors provide real-time biofeedback when asymmetry surpasses a 10% threshold. A companion mobile application visualizes asymmetry across multiple sessions, allowing objective monitoring and longitudinal evaluation. By combining continuous measurement with instantaneous feedback, GaitShift supports recovery, reduces compensatory movement, and promotes safer, more symmetrical gait patterns. Future studies will investigate its efficacy across athletes, post-rehabilitation patients, and older adults, with the overarching goal of advancing personalized, real-world gait rehabilitation and improving functional mobility outcomes.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3135

A Novel Computational Pipeline for Discovering Hidden Disease Subtypes from Proteomic Data Using Unsupervised Clustering

Category:

Biomedical Engineering

Shri Chada

Homeschool/Chada Homeschool

Clinical disease classifications are based on symptoms and diagnostic tests. However, patients sharing the same diagnosis often exhibit substantial underlying biological heterogeneity. As a result, treatments effective for some patients may fail in others, allowing disease progression and delaying effective care. A novel computational pipeline that uses high-dimensional proteomic data to uncover biologically meaningful patient groupings without relying on disease labels was developed to address this challenge. Proteins with similar expression profiles were grouped into modules representing coordinated biological processes by applying the Walktrap community detection algorithm. Module activity scores were then used to hierarchically cluster patients into distinct molecular subgroups. In a plasma proteomic dataset of patients with asthma and chronic obstructive pulmonary disease, the pipeline largely separated patients by diagnosis while revealing multiple molecular subtypes within each disease. Functional enrichment analysis (Reactome, GO, KEGG) showed subtype-specific differences in immune signaling, oxidative stress, cell death, and tissue remodeling. The pipeline's generalizability to a different biological context was assessed by applying it to a urine proteomic dataset containing lupus nephritis and other diseases. Patients with the same clinical diagnosis were distributed across multiple molecular groups, while patients with different diagnoses clustered together, indicating that traditional disease labels do not fully capture the underlying biology. The results demonstrate that the pipeline can uncover biologically meaningful patient groups across diseases and sample types. By revealing molecular patterns hidden by traditional classification, this approach explains why one-size-fits-all treatments often fail and supports a shift toward biology-driven personalized medicine.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

Abstract: Science and Engineering Fair of Houston

3136

Reducing the Light Dose in NICU Incubators to Improve the Developmental Outcomes of Very Preterm Infants

Category: Biomedical Engineering

Madison Mooney

Clear Creek ISD /Clear Lake High School

The high light levels premature infants receive in the Neonatal Intensive Care Unit are harmful to their heart rates, respiration rates, blood oxygen saturation rates and sleep quality. Researchers have tested various methods of light reduction for their effect on these physiological parameters, finding a positive correlation between lower light levels and improved parameters. However, few studies have investigated methods that both reduce light and maintain visibility to reduce rapidly changing light levels when the infants are visually analyzed. This project sought to test 4 window films of varying opacity, from 23% to 90%, for their effectiveness at light reduction while maintaining visibility. The 78% opaque film was predicted to be the most effective based on preliminary visual analysis. 5 Incubators were built from plexiglass, and window films (opacities of 23%, 45%, 78% and 90%) were applied to them, with one incubator acting as a control with no film. The ambient lighting was measured at each incubator position, then the light level inside each incubator was measured at each position to determine the amount of light reduction of each film. Next, 4 dolls were adapted to include breathing simulators. One doll was dyed yellow to simulate jaundice, one doll had a malfunctioning breathing simulator to represent apnea, one doll had a misplaced nasal cannula, and one doll was normal. Participants viewed a permutation of infants in incubators, so each infant was viewed in each incubator 5 times, with each participant viewing the incubators in a different order. The results demonstrated that the 23% and 45% films performed similarly to the control incubator in terms of visibility while reducing some light, and the 78% film demonstrated a moderate decrease in visibility while reducing a significant amount of light. The 90% film reduced a significant amount of light, but increased idenification time by 164%. Thus, a film with opacity between 45% and 78% is promising.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[X] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[X] yes [ ] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

Abstract: Science and Engineering Fair of Houston

3137

Automated Cardiac Vascular Network Mapping from CT Angiography Using U-NET CNN for 3D Bioprinting

Mrinal Yalageri, Angad Kumar

Katy ISD/Tompkins - HS

Category:

Biomedical Engineering

Current bioprinting cardiac tissue often fails because printed constructs don't develop a reliable network of tiny blood vessels to deliver oxygen and nutrients. Patient-specific vascular models from CT scans usually take hours of manual annotation, which takes valuable time away from medical professionals and still may miss important vessels. This issue hinders progress toward the goal of vascularized bioprinted heart tissue that could reduce dependence on donor organs and help address the transplant waitlist. We propose a deep learning pipeline that automates patient-specific cardiac vascular network extraction from CT scans for 3D bioprinting applications. While existing computational models can successfully segment cardiac anatomy, they are usually trained for diagnostic purposes and cannot generate outputs suitable for bioprinting as they lack the topological accuracy needed for usable bioprints. Our work bridges this gap by developing a framework that transforms raw DICOM volumes directly into bioprint-ready STL files. We trained around 32 million-parameter 3D U-Net on the ImageCAS dataset (N~1000 cardiac CT angiograms) using Dice loss and Hausdorff Distance for validation. A multi-scale model is then trained to recognize blood vessels ranging from major coronary arteries to smaller micro-vessels. The final outputs are converted into clean, printable 3D models using 3D Slicer, making them compatible with both standard extrusion-based and FRESH bioprinting methods. Our model produces usable STL files across most test cases without needing manual correction. By making vascular modeling faster, more consistent, and also patient-specific, this research moves bioprinting closer to on-demand bioprinting of cardiac tissues and hearts and ultimately helps address the organ shortage.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3138

Category: Biomedical Engineering

EquiliMind: A Novel Multimodal AI-EEG Fusion System for Precursor Identification and Early Warning of Ménière's Disease Attacks

Hongyi Gong

Private/The Village School

Meniere's disease is an inner-ear disorder characterized by endolymphatic hydrops and recurrent vertigo. The unpredictability of attacks creates serious safety risks in daily life. Current clinical diagnosis relies mainly on patients' subjective reports, and objective, real-time methods for identifying and warning of prodromal signs remain limited. To address this, this study designed and implemented an integrated wearable system based on multimodal AI and EEG fusion to enable automatic recognition and proactive early warning of vertigo prodromes in Meniere's disease. A synchronized multimodal acquisition protocol was established to collect 30-channel EEG and IMU motion data across resting, task-induced, and balance-challenge conditions, forming a high-quality labeled personal dataset. Algorithmically, a hybrid deep-learning architecture combining 1D-CNNs and spatiotemporal feature fusion was proposed to extract and integrate EEG features for accurate state classification. System integration produced a lightweight wearable prototype that combines EEG sensing, inertial sensing, edge computing, and haptic/auditory alerts, achieving a closed-loop workflow from real-time acquisition and preprocessing to inference and risk intervention—supporting a shift from "assisted diagnosis" to "proactive safety monitoring." It is intended to demonstrate that the model can effectively distinguish different states and that the prototype operates stably with real-time warning output. This work also provides a multimodal dataset and fusion framework that may inform vestibular neuroscience research and the development of related intelligent medical devices.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[ ] yes [X] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

Abstract: Science and Engineering Fair of Houston

3139

EDALS: An Electroencephalographic-Driven Adaptive Learning System

Neil Pawar

Conroe ISD /AST: Academy of Science and Technology

Category:

Biomedical Engineering

Brain computer interfaces (BCI's) can create communication links between neural activity and computer systems. BCI's have many applications, but their use in education is largely unexplored. Educational content today is often static and lacks flexibility for learners. However, BCI's utilizing electroencephalographic (EEG) signals could reshape education by providing adaptive content that responds to the user's neural performance data. An EEG-driven adaptive learning system (EDALS), a closed-loop neuroadaptive learning system with AI-powered training adaptations, was created to serve this purpose by using EEG data to set thresholds that the AI can utilize to create adapted content. The system allows users to input a STEM topic and the AI can generate a unique lesson consisting of 5 submodules customized to EEG metrics (stress, engagement, relaxation, etc.). When the metrics go beyond the defined threshold, the logic defined in EDALS prompts the AI to generate customized submodules. For example, adaptations for low excitement would include real-world problem solving and surprising fact insertions. After 135 attempts during development, ten trials of the system's final version were conducted and automated CSV logging recorded the number of adaptations made by the AI, performance metrics before and after the quiz as well as at the start of the submodule, and quiz scores. The results indicated that the AI model was able to implement adaptations when EEG data beyond the threshold was observed and that increased numbers of adaptations coincided with positive EEG metric and quiz score trends over the course of the lesson.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[ ] yes [X] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

Abstract: Science and Engineering Fair of Houston

3140

PinkAI: Augmenting Radiologist Performance in Screening Mammography Through AI-Assisted Detection; A Real-World Study Demonstrating AI-Human Synergy

Esha Dave, Rishaan Dave

Private/The Village School

Category:

Biomedical Engineering

Breast cancer is the second deadliest cancer for women in the US, after lung cancer. 2025 estimates include 316,950 invasive diagnoses in women (plus 2,800 in men), 59,080 DCIS cases, and 42,170 female deaths. It is well established that early detection boosts survival, with 99% five-year survival for localized cases versus lower for advanced stages, enabling less invasive treatments and reducing costs. Screening using 3D tomosynthesis mammography for breast cancer detection is critical for reducing mortality; however, effectiveness is still limited by the disparity in accessing imaging services and the worldwide deficit of skilled radiologists. Our project introduces PinkAI, a novel artificial intelligence-powered copilot that aims to enhance the radiologist's productivity in screening mammography. PinkAI was built using a hybrid convolutional neural network architecture trained on the CBIS-DDSM dataset using TensorFlow on an NVIDIA RTX 5080 GPU workstation. It processes 3D digital breast tomosynthesis images, generating risk scores (0-100%) and Grad-CAM heat-maps for abnormality detection. To demonstrate real-world efficacy, our project evaluated 250 anonymized real-world mammograms (Jan-Dec 2025) from a local hospital (50 positive BI-RADS cases, 200 negative), with IRB approval and HIPAA compliance. Three MQSA-certified radiologists (10+ years experience) interpreted cases in blinded, randomized arms: Radiologist alone, Pink AI alone, and Radiologist + AI, with informed consent and 2-week washouts. Metrics included sensitivity, specificity, NPV, PPV and AUC; statistical significance was assessed via McNemar's test ($p < 0.05$) and Cohen's kappa for inter-rater agreement. Data from the 250 mammogram cases were analyzed to compare performance, with results demonstrating that Pink AI plus human radiologist performed the best, suggesting a synergy between AI and human radiologists may maximize patient benefit and improve health care delivery.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[X] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[ ] yes [X] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3141

Assistive Technology for Dementia Patients in Underserved Populations

Subhaan Uljamil

Harmony Public Schools - South District/Harmony School of Innovation Katy

Category:

Biomedical Engineering

Over 55 million people worldwide suffer from dementia, which is a condition where many are at an increased risk of falling due to a lack of understanding. The goal of this project is to create a low-cost wearable device to improve the safety of those with dementia. To detect falls, the device has an accelerometer. There is also a GPS module to track location, and a pulse oximeter to track heart rate and blood oxygen levels. When a fall is detected based on changes in acceleration, the device asks the user to confirm within 10 seconds. If no response is received, the device sends an alert with the user's location and vital signs to a caregiver's smartphone via Bluetooth. Results showed that the device was able to detect falls, decrease the number of false positives from sudden movements, and successfully send alerts. This project shows how a low-cost, wearable safety device can assist caregivers and improve quality of life for individuals with dementia.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

[ ] Human participants [ ] potentially hazardous biological agents

[ ] Vertebrate animals [ ] microorganisms [ ] rDNA [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

[X] yes [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

[X] yes [ ] no

4. This project is a continuation of previous research.

[X] yes [ ] no

5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[ ] yes [X] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes [ ] no

APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE