# **Abstract:** Science and Engineering Fair of Houston

## 3462

## Ai Interactive Humanoid Robot

**Category:**

**Robotics and Intelligent Machines**

Victor De Leon

Harmony Public Schools - North District/Harmony School of Advancement

This project focuses on the integration of a pre-existing conversational AI into a humanoid indoor robot designed to demonstrate the possibilities of STEM education and applied engineering. The AI originally functioned as a standalone personal chatbot and was later expanded and physically embodied through this robotic system. The long-term goal of the project is to evolve the platform into a school-wide assistant capable of supporting students and educators. The system uses a friendly language-based interface with memory retention, allowing it to maintain context across interactions. Computer vision, implemented through OpenCV, enables basic visual tracking and recognition. This visual input is directly connected to coordinated motor responses, including following a user's eyes and copying simple hand gestures, demonstrating how perception can guide physical movement. The robot's body was fully designed and 3D printed to visibly showcase engineering principles such as mechanical design, calibration, modular construction, and system integration. All mechanical assembly, calibration, and system processing were completed by the student. The project draws from biomimetics by modeling aspects of human perception and interaction, making the robot more intuitive and approachable.

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[ ] Human participants    [ ] potentially hazardous biological agents

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

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# **Abstract:** Science and Engineering Fair of Houston

## 3463

## HavenPath - Navigate Beyond Signals

**Category:**

Robotics and Intelligent Machines

Melanie Lugo, Jade Abrego, Sophia Robles

Conroe ISD /ASHP: Academy for Science and Health Prof

Our project is to build a watch based off the tragic story of Geraldine Largay, a hiker that became disoriented and died after veering off the Appalachian Trail in Maine. Geraldine attempted multiple times to send distress signals through non-existent signals. Her tragedy could have been prevented if she had a solution. This project is important for lowering the number of casualties and incidents caused by getting lost off trails. Our project can improve signless technology and its impact is that it can be revolutionary for hikers that go deep into trails surrounded by miles of woods that are closed off and signalless. The project can protect many hikers. A gap in our research is the struggle of making our watch/device signaless. Throughout our research we want to achieve this by creating a safe way for hikers to enjoy trails, minimizing casualties and incidences that may occur. By the creation of the watch we can achieve our goals in our research. To retrieve our needed data we will use the watch and record the reaction time of how long it takes the watch to alert the user when going off trail. The key message is to spread awareness towards hikers getting off trails and reducing the casualties of incidents that turn into life threatening situations.

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# **Abstract:** Science and Engineering Fair of Houston

## 3464

## AI-Driven Voice Emotion and Prosody Analysis for Early Detection of Alzheimer's Disease

**Category:**

Robotics and Intelligent Machines

Pranav Pulluru

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

Alzheimer's disease (AD) affects nearly 60 million individuals worldwide, a number projected to rise significantly in the coming decades. Despite this growing prevalence, current diagnostic approaches rely heavily on subjective cognitive assessments or costly neuroimaging, often delaying early intervention. Early detection is critical, as timely treatment and lifestyle adjustments can meaningfully improve patient outcomes. Recent research suggests that subtle alterations in speech content, timing, and prosody may serve as reliable, non-invasive biomarkers of cognitive decline. This project presents an AI-driven diagnostic pipeline that leverages these speech-based indicators to predict Alzheimer's disease from natural speech recordings. Enhanced audio files are processed to isolate participant speech while preserving pauses and temporal structure relevant to cognitive function. From these recordings, complementary acoustic representations are extracted: log-mel spectrograms generated using Librosa to capture time–frequency acoustic patterns, and eGeMAPS features extracted via openSMILE to encode clinically relevant prosodic and voice quality cues. To model these features, a deep convolutional neural network (CNN) followed by a bidirectional long short-term memory (BiLSTM) network is trained on the spectrograms to learn both local and temporal speech characteristics. In parallel, a multilayer perceptron (MLP) is trained on the eGeMAPS features to capture complementary high-level statistical and prosodic information. By combining data-driven acoustic modeling with clinically informed speech features, this approach provides a scalable, non-invasive framework for early Alzheimer's disease detection, demonstrating the potential of speech analysis as a widely accessible screening tool for cognitive decline.

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# **Abstract:** Science and Engineering Fair of Houston

## 3465

## Development and Evaluation of a Predictive Machine Learning Model for Assessing Cardiac Disease Risk Using Patient Demographics and Examination Data

Sherry Gao

Conroe ISD /AST: Academy of Science and Technology

**Category:**

**Robotics and Intelligent Machines**

This project's main focus is to create a risk assessment of the potential of a person to have cardiovascular disease, based on a machine learning model based on a database of examination data, such as gender, age, cholesterol etc. Many current treatments are implemented after a sign of the disease has occurred, such as heart attack, but treatments in the later stages are more expensive and at higher risk. My goal with this model is to be able to evaluate the risk a patient is at in the earlier stages to help take preventative measures before the condition worsens.

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# **Abstract:** Science and Engineering Fair of Houston

## 3466

**ViSa Bots: A Novel Non-Invasive Hybrid Electroencephalogram and Functional Near-Infrared Spectroscopy Interface Analyzed by Machine Learning, Managing the Systematic Operations of Synchronized Collective Robotic Swarm Systems Utilizing Artificial Intellig**

Vidipsai Pitta, Satvik Maggavi

Conroe ISD /AST: Academy of Science and Technology

**Category:**

Robotics and Intelligent Machines

Robots are used in several industries today, such as medicine for nanobots drug delivery, industrial machines for mass production, and response robots that save human lives. Although these robots are vital for society, they face multiple accuracy and safety issues. Often, these issues can be mitigated through remote control and programming, but they can be challenging to implement. These difficulties can be mitigated with a hands-free interface where mechanical actions are operated through thoughts. To accomplish this, techniques including an electroencephalogram (EEG) and functional near-infrared spectroscopy (fNIRS) are utilized to track brain activity. An EEG is a non-invasive technique that reads the brain's electrical activity, but suffers from noise as the readings are very fast. The fNIRS uses spectroscopy to measure the brain's blood oxygen levels, allowing slower, but precise readings. Although modern applications of a hybrid EEG-fNIRS system consist of measuring and enhancing sleep levels, its readings can also be used to control external devices. A machine learning model, trained on several data points with high accuracy, was created to classify the thoughts of the user into robotic actions. After the model reads the brain signals, commands are sent to the robot. This interface allows numerous robots to be simultaneously controlled, creating neural-controlled swarms. This interface can be implemented in various robotic fields, with some examples being efficient nanobot drug delivery and reduced risks in manufacturing operations.

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# **Abstract:** Science and Engineering Fair of Houston

## 3467

## Coordinated Modular Truss Robots for Unstable Terrain Rescues

Andrew Yoon

Katy ISD/Tompkins - HS

**Category:**

**Robotics and Intelligent Machines**

This research proposes the use of TETRAdules, or Truss-based Extendable Triangles for Reconfigurable Architecture Modules, a modular robotic system designed to assist human operators in traversing hazardous and unstructured environments commonly encountered in search-and-rescue operations. Existing robotic platforms may struggle due to terrain variability and the difficulty of task standardization in disaster scenarios. Many Modular Self-Reconfigurable Robots (MSRs) see their adaptability limited by practical scalability with mechanical complexity and compounded failure probabilities in large assemblies. TETRAdules attempts to shift the role of robotics in rescue work from autonomous scanning to adaptive structural support, allowing human and robot operators to improve mobility. TETRAdules prioritizes geometric stability and a simplified docking mechanism, allowing it to become a “fluid architecture,” and ultimately expanding the reach of human rescuers.

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**Abstract:** Science and Engineering Fair of Houston

**3468**

## Arduino Ultrasonic Radar Using Processing Visualization

**Category:**

Robotics and Intelligent Machines

Mohamed Ashiq Basha Sathik Basha

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

This project solves the problem of easily detecting objects and measuring their distance in real time, which can help with security, safety, and navigation tasks. It uses an Arduino Uno with an ultrasonic sensor and a servo motor to scan the area and collect distance and angle data. Processing software turns this data into a live radar animation, showing objects visually. The main constraints are using only low-voltage electronics, staying within the Arduino's memory limits, and making sure the sensor and servo are connected safely.

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# **Abstract:** Science and Engineering Fair of Houston

## 3469

## TornadoVision: Using Convolutional Neural Networks for Accurate Tornado Warnings

**Category:**

Robotics and Intelligent Machines

Aditya Mandke

Spring Branch ISD/Spring Branch Academic Institute

Short-term forecasting of severe storms, including tornadoes, has remained incredibly difficult despite advances in long-term forecasting. This study investigates whether novel deep learning techniques, specifically Convolutional Neural Networks (CNN), can identify tornadic signatures in radar imagery in order to improve short-term tornado detection. Using the TorNet dataset, four CNN architectures were trained and evaluated for tornado detection, using metrics such as loss, area under the curve (AUC), probability of detection (POD), and false alarm ratio (FAR). All models displayed a POD of over 0.8, with Model 3 successfully identifying 99 percent of tornadoes. However, all models exhibited a high FAR of around 0.9, illustrating the tradeoff between sensitivity and reliability. These results show that CNNs are compelling tools for improving tornado detection, but future work is needed to reduce false alarms by incorporating attention mechanisms and temporal data.

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# **Abstract:** Science and Engineering Fair of Houston

## 3470

## Mosquito Detection using A.I.

**Category:**

**Robotics and Intelligent Machines**

Ernest Teo

Fort Bend ISD /Clements High School

Mosquitoes are the deadliest animals on Earth, killing up to one million people each year through the spread of diseases. If mosquitoes could be quickly and accurately identified in images, it could help reduce disease transmission and potentially save lives. To address this problem, I developed an artificial intelligence (A.I) model capable of recognizing and outlining mosquitoes in images. This type of technology could be used in many ways to support mosquito monitoring and control. To build this model, I collected images of mosquitoes and manually created segmentation masks, which are silhouettes showing the exact location of each mosquito. These images and masks were used to train a U-Net–based deep learning model, a method that has rarely been applied to mosquito segmentation. The model was trained multiple times and fine-tuned to improve its accuracy and reliability. In total, the model was trained using 215 labeled images across three training runs. The best-performing model achieved a Dice score of 0.8990, indicating a high level of overlap between the predicted masks and the true mosquito locations. During testing, the model performed very well when mosquitoes occupied a large portion of the image, but its performance decreased when mosquitoes were very small. These results show that image segmentation using AI can successfully detect mosquitoes. Future improvements will focus on optimizing the quality of the training masks, adding more diverse images, and further fine-tuning the model to improve accuracy, especially for detecting smaller mosquitoes.

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# **Abstract:** Science and Engineering Fair of Houston

## 3471

## Investigating Belief Strength as a Latent Variable in Depression-Related Language Modeling

**Category:**

Robotics and Intelligent Machines

Samuel Xie

Katy ISD/Seven Lakes - HS

A major aspect of human behavior captured in large language models (LLMs) is responsive to belief attribution and perspective-taking; although its existence in processing is questionable in terms of its relation to internalized information in relation to belief or being a surface-level pattern-processing task. The current project explores the extent to which belief attribution is internalized in the hidden states of a large language model and analyzes its effects in terms of its usage in belief-dependent language. Utilizing a frozen version of a Mistral-7B model, hidden-state activation was probed throughout each transformer layer using a series of ToMi and BigToM Theory of Mind theory-containing questions. Linear logistic regression probes were also trained to decode True/False belief attribution using these hidden-state responses to investigate regions in each layer where the information in belief attribution was most linear. The resulting weight vector was then used to guide activation during the task of generating a belief-dependent response to test the extent to which manipulation of the belief-related component leads to a system-wide change in responses. To generalize these results outside of structured responses to theory of mind tasks, a subset of the Dreaddit dataset was used to manually annotate belief strength using an ordinal scale. Linear regression probes were then trained to decode internal belief-strength from internal model activation responses. Finally, internalized belief-strength results were probed as a condition to guide model activation during the task of generating exploratory responses in relation to patient responses with depression. Overall, the current experiment investigates the extent to which internalized latent variables in relation to belief strength have a system-wide effect in relation to the mediation of variable effects in the task of generating a belief-dependent response to a set of ToMi or BigToM theory-containing questions.

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# **Abstract:** Science and Engineering Fair of Houston

## 3472

## Using Computer Vision to detect Phone Usage in Classrooms

**Category:**

**Robotics and Intelligent Machines**

Athan Chee

Private/THE JOHN COOPER SCHOOL - HS

This project tests the performance of a computer vision model to detect students' phone usage in a classroom environment, which minimizes disruptions while continuing to enforce a no phone usage policy. The model aims to shift the role of monitoring student behavior away from teachers, letting them focus on teaching while increasing productivity due to the reduced interruptions. A pretrained image detection model (YOLO-based object detection model) was fine-tuned with collected data of phone usage from a classroom setting. The data consists of a single participant (me) in a single classroom using the same phone. Performance was measured using both the benchmarks from training, which includes Recall, Precision and mAP@0.5, as well as true event and false event detection accuracy, where an event is counted as time intervals where a phone is used. The model achieved a true event detection accuracy of 75% while minimizing false event detection accuracy to 11% by trading recall for precision. The high precision to recall, displays how the model aims to assist through providing accurate detections while minimizing inconvenience from false positives. This project aims to show the proof of concept but can be improved on by increasing the detection rate and increasing the diversity of detections.

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# **Abstract:** Science and Engineering Fair of Houston

## 3473

**Category:** Robotics and Intelligent Machines

## PollenPilot: Autonomous, AI-Driven Pollinating Ground Robot

Xunyi Liu, Wesley Chu

Private/ST. JOHN'S SCHOOL

Global bumblebee colonies currently face environmentally unsustainable colony losses, decreasing the output of commercial crop sectors dependent on insect pollination. Tomatoes, a crop with particularly high nutritional and economic value, require a more reliable and scalable pollination system. The team has developed PollenPilot, an autonomous, vision-driven ground robot aimed towards efficient, noninvasive precision pollination inspired by biological mechanisms. The robotic system utilizes a tread-based drivetrain and a three-dimensional pathfinding algorithm to identify the best fit path between pollinating targets. Flower detection occurs via a stereoscopic vision system combined with a “You Only Look Once” convolutional neural network, trained to identify tomato flower bloom stage and orientation. The team has developed an electrostatic precision applicator for noninvasive pollen transfer directly to the flower stigma, mimicking the biological process of no-contact pollination via electrostatic attraction between insect and plant. To ensure targeted delivery, a soft, compliant gripper stabilizes flowers during the pollination process. PollenPilot will be first tested in a lab setting with 3-D printed pollinating targets, then deployed in the field with real tomato crops, and ultimately compared against real-time pollination rates in commercial greenhouse spaces. By combining robotics, computer vision, and bio-inspired engineering, PollenPilot is an environmentally impactful solution to supplement pollination during ongoing declines in bee populations.

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# **Abstract:** Science and Engineering Fair of Houston

**Category:** Robotics and Intelligent Machines

## 3474

## Breaking Bad: An Analysis on Attacking Feed-Foward Networks within Modern Day Transformers

Luca Chang

Private/ST. JOHN'S SCHOOL

Generative Pretrained Transformers (GPTs) are the behemoths of the Language Modeling world, at the cutting edge of AI research with massive interest and widespread use. However, attacks focusing on the feed forward neural-networks (FFNs) within each and every transformer are sparingly studied. In this paper, we aim to target this preprocessing stage of the model and determine whether prompts can be crafted that target the FFNs of models to elicit adversarial failure. We hypothesize that if a probe is found to pass through attention and target the first FFN, this probe would cause cascading problems for downstream parts of the model and eventual model failure. To test this hypothesis, we use several different Small Language Models (SLMs) from varying families and generate probes that pass through each model's attention, targeting the FFN within the primary encoding layer. These targeting probes were then fed into the models and their outputs were evaluated. Our results indicate that despite such a small model size, we can consistently observe a divergence in quality of writing as compared to a control, with more than 80% of models demonstrating a greater than 57% reduction in quality of writing. This approach demonstrates a novel way to attack Language Models. This probing method employs white box techniques, utilizes a small overhead (~7.5% to ~46.9%) of total model parameters, and is capable of eliciting adversarial failure. We present a new method of attack that is able to be scaled with greater compute power and more time for attacking modern-day Language Models (LMs) efficiently.

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# **Abstract:** Science and Engineering Fair of Houston

## 3475

## Identifying Potential Threats Using Weapon Detection Technology to Improve Public Safety

Daniel Blessan

Friendswood ISD /Friendswood High School

**Category:**

Robotics and Intelligent Machines

This project explores how artificial intelligence and computer vision can be used to improve public safety by detecting weapons in images and video. A Python based program was developed in Visual Studio Code using the YOLOv5 object detection model and trained with open source weapon image datasets from Roboflow and Kaggle. The goal of the project was to determine whether AI based weapon detection could accurately identify firearms and other weapons in public spaces using surveillance images. The model was trained and tested on thousands of images and evaluated using accuracy, precision, recall, and F1 score. The final results showed strong performance with weapon detection achieving a precision of 0.958 and a recall of 0.938. The overall detection performance reached an F1 score of 0.849, demonstrating that the model can reliably detect weapons. While identifying people alongside weapons was less accurate than detecting weapons alone the system still showed consistent and promising results. Overall accuracy exceeded 65%, meeting the project's performance goals. These findings suggest that AI powered weapon detection systems could be useful in real world applications by helping identify potential threats earlier and improving response time. Future improvements include enhancing detection of partially visible weapons, improving performance in complex scenes, and implementing real time detection using live surveillance footage. This research highlights the potential of machine learning technology to help prevent violent incidents and enhance public safety.

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# **Abstract:** Science and Engineering Fair of Houston

## 3476

## Sim2Real Autonomous Tumor Removal via Minimally Invasive Robotics

**Category:** Robotics and Intelligent Machines

Rayhan Papar

Conroe ISD /AST: Academy of Science and Technology

Autonomous surgical robotics have the potential to deliver unprecedented precision and dexterity, improving safety, reducing operative risk, and expanding access to high-quality care. Yet, despite advances in robotic platforms, most systems deployed in clinical settings remain fully teleoperated. Challenges including anatomical variability, tissue deformation, and constrained visual fields hinder the reliability of traditional autonomous algorithms and limit their generalizability to real procedures. Learning-based approaches such as reinforcement learning (RL) and imitation learning (IL) offer adaptive capabilities, but typically require extensive video data and lack integration with preoperative imaging, restricting their practical use. The present research proposes a simulation-to-real (Sim-to-Real) framework for autonomous minimally invasive tumor resection that addresses these limitations. This method reconstructs patient anatomy from medical imaging to generate a physics-based simulation, enabling virtual policy training and preoperative validation of the surgical plan. A hybrid learning strategy combining initial trajectory generation, behavior cloning, and reinforcement learning is used to derive an optimal control policy capable of adapting to tissue variability, while preserving the desired initial plan. The approach is evaluated on an en-bloc tumor resection task performed on simulated and physical anatomies. The system, deployed to the da Vinci Robot, achieved 100 percent extent of resection on three of the four gel phantoms it operated on. By leveraging spatial anatomical information in simulation rather than camera data alone, and learning-based methods over model-based approaches, this research demonstrates the potential to enhance precision, reduce data requirements, and improve surgical outcomes in autonomous procedures.

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APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

# **Abstract:** Science and Engineering Fair of Houston

**3477**

## Scalable Transformer-Based NLP Pipelines for Automated Patient Phenotyping from Social Media Archives

**Category:** Robotics and Intelligent Machines

Aaditya Panchal

Fort Bend ISD /Travis High School

Parkinson's disease is heterogeneous and much of the patient experience remains undocumented between infrequent clinical visits. Social media platforms offer large-scale, longitudinal archives of patient-generated content that can complement traditional clinical cohorts. In this study, disease status and age were automatically extracted from approximately 9,600 posts on the r/Parkinsons subreddit using natural language processing (NLP) pipelines. Labeled subsets of posts were manually annotated for self-disclosed Parkinson's diagnosis and age, and multiple transformer-based models were trained and evaluated using macro $F_1$ scores. The best-performing model for disease status classification was an Ensemble of RoBERTa, DeBERTa-v3-base, and BERT-base-uncased ($F_1$ = 0.94), while fine-tuned BERTweet achieved the highest performance for age extraction ($F_1$ = 0.86). Modern large language models (LLMs), such as Mistral-7B with prompt engineering, also showed strong zero-shot performance for demographic extraction. These findings demonstrate that accurate, automated phenotype extraction from online cohorts is highly feasible, enabling the construction of a robust digital cohort of people with Parkinson's disease and supporting more efficient, scalable digital research that can be extended to other conditions and demographic attributes

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# **Abstract:** Science and Engineering Fair of Houston

**3478**

**3D Printed Robotic Hand Controlled via Wireless Glove**

**Category:** Robotics and Intelligent Machines

Ali Al-Ramthan

Clear Creek ISD /Clear Lake High School

This project explores the design and fabrication of a 3D-printed robotic hand controlled via a wireless glove interface. The goal is to develop a functional prototype that accurately mimics natural human hand movements using additive manufacturing techniques. By integrating wireless control and mechanical actuation, the system demonstrates the feasibility of low-cost, customizable prosthetic and assistive technologies. The project involves CAD modeling, 3D printing, electronic integration, and performance evaluation based on movement accuracy, responsiveness, and durability. The research highlights the precision and versatility of additive manufacturing in creating biomedical and robotic devices. The findings are expected to contribute to advancements in prosthetics and human–machine interaction, offering potential improvements in accessibility and quality of life for individuals with limb differences.

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# **Abstract:** Science and Engineering Fair of Houston

## 3479

## Bioprinting In Vitro Human Muscular Tissue to Improve the Efficiency of the Medication Development Process

**Category:**

**Robotics and Intelligent Machines**

Eshaan Ahuja

Conroe ISD /AST: Academy of Science and Technology

Bioprinting is an emerging technology within regenerative medicine that enables the fabrication of three-dimensional, biologically active structures using hydrogel-based bioinks containing living cells. While modern bioprinting has advanced the creation of tissue models, its integration into the early stages of drug development remains limited. Clinical trials currently represent the primary bottleneck in medication development, with long wait times and high costs slowing innovation. This project aims to develop a low-cost, extrusion-based bioprinter and biosensing system capable of producing and analyzing in vitro tissues that can provide preliminary feedback on pharmaceutical effects before clinical trials. In the first phase, a custom bioprinter is designed and constructed using a cardboard prototype followed by a metal, temperature-controlled system equipped with a specialized toolhead for hydrogel extrusion. A Chlorella-based sodium alginate bioink serves as a safe model to optimize printing parameters, including extrusion temperature, crosslinking conditions, and cell viability. Embedded electrical leads within the printed structure allow the later application of stimulation, and a custom PCB-based sensor system is developed to measure tissue movements. Dimensional accuracy and cell survival are quantitatively evaluated and refined through iterative testing. The resulting platform establishes foundational methods for producing consistent, functional bioprinted tissues and accurately detecting their mechanical responses. This work provides the groundwork for future research involving human myoblast-based bioinks, with the long-term goal of enabling rapid, low-cost preclinical testing to accelerate the development of safe and effective medications.

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# **Abstract:** Science and Engineering Fair of Houston

## 3480

## Musical Spellcheck: Using AI to Correct Baroque Era Pieces

**Category:**

Robotics and Intelligent Machines

William Larson

Conroe ISD /ASHP: Academy for Science and Health Prof

The integration of generative artificial intelligence into music composition has advanced significantly, yet applications for correcting or editing human composed pieces has remained relatively under explored, particularly in historically rule-bound styles such as classical Baroque music. This study investigated the extent to which a Long Short-Term Memory (LSTM) neural network could assist composers in revising Baroque-era pieces by identifying and correcting deviations from stylistic conventions, including counterpoint rules, voice leading, dissonance resolution, harmonic progressions, and ornamentation. A corpus of 98 Baroque MIDI files (primarily Bach chorales) was used to train an LSTM model on symbolic event sequences (pitch, velocity, quantized duration). The model achieved a final cross-entropy loss of 1.5238 after 20 epochs, demonstrating strong capture of Baroque patterns. Short excerpts (8–16 measures) were intentionally composed with stylistic violations (e.g., parallel fifths/octaves, unresolved dissonances, improper cadences). These flawed pieces were processed through the model, which autoregressively predicted corrections based on learned probabilities. Outputs were evaluated using a Baroque Rule Matrix derived from musicological sources, measuring pre- and post-correction rule adherence quantitatively and stylistic authenticity qualitatively. These findings suggest LSTM-based systems can effectively support historical accuracy in Baroque revision while preserving expressive intent, offering potential for music education, restoration of manuscripts, and broader AI-assisted composition across genres. Limitations include dataset bias toward Bach and challenges in capturing interpretive flexibility.

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# **Abstract:** Science and Engineering Fair of Houston

**3481**

## An End-to-End Deep Learning Pipeline for Early Scoliosis Detection from Gait Silhouettes

**Category:**

Robotics and Intelligent Machines

Chanya Methaprayoon

Private/Awty International School

Early detection of scoliosis is critical for preventing long-term spinal deformities and improving patient outcomes. However, current screening methods rely on manual observation and specialized imaging, which are inaccessible to some individuals. In this study, we present an end-to-end deep learning pipeline for automated scoliosis detection from gait videos. Our system first preprocesses user-submitted RGB videos through sequential modules for person detection, segmentation, and silhouette generation, creating standardized 64x64 binary gait sequences. Following this, a convolutional neural network inspired by the ScoNet and ScoNet-MT architectures extracts spatiotemporal features from these silhouettes to classify scoliosis severity, and in the multi-task variant, estimate Cobb angles. The scoliosis predictive model is trained and evaluated on the Scoliosis1K dataset, achieving promising sensitivity in identifying scoliosis-positive subjects. These results demonstrate the potential of gait-based video analysis as a low-cost, non-invasive screening tool for early scoliosis detection.

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# **Abstract:** Science and Engineering Fair of Houston

**3482**

## Can Machines Really know your Face?

**Category:**

**Robotics and Intelligent Machines**

Derek Agosto-Liceaga

Charter/School of Science and Technology, Houston - MS

Computers are used in facial recognition technology to recognize individuals by their facial features. It is utilized in a variety of settings, including schools, phones, and airports. It can make life safer and easier, but it also raises concerns about fairness and privacy. This essay describes facial recognition's operation, applications, and potential drawbacks.

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# **Abstract:** Science and Engineering Fair of Houston

## 3483

## AI Study Buddy

**Category:** Robotics and Intelligent Machines

Talya Ahmed

Harmony Public Schools - North District/Harmony School of Advancement

Artificial intelligence has become increasingly prevalent and accessible in today's society. One main drawback of this is the use of AI by students, leading to a decrease in critical thinking by giving students a crutch to lean on for school assignments. This project aims to combat this problem by providing students with an artificial intelligence tool that is specifically designed to help with homework and studying, guiding students instead of answering questions or completing assignments for them. This AI Study Buddy uses Python run on a Raspberry Pi and an LCD screen to create a desktop device with an animated face as well as touch and voice input that responds to student questions, explains concepts, guides learning, and sets timers for productivity.

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# **Abstract:** Science and Engineering Fair of Houston

## 3484

**Category:** Robotics and Intelligent Machines

## Enhancing Endoscopic Retrograde Cholangiopancreatography Safety and Accessibility Through the Utilization of Soft Robotic Design and Model Testing

Sivang Hari Nair, Joshua Staub

Conroe ISD /AST: Academy of Science and Technology

In the United States alone, over 500,000 Endoscopic Retrograde Cholangiopancreatographic (ERCP) procedures are annually conducted. However, over 10% of procedures, or over 50,000 procedures annually, develop complications such as perforations, pancreatitis, and other effects. This stems from the external pressure exerted by a gastroenterologist due to limited operator experience and the rigidity of the traditional endoscope. Compounding the issue, only approximately 20% of patients who require the ERCP procedure receive it, rendering several million patients underserved due to the high specialization and cost of the endoscope. To address these limitations, a phantom model was developed using a silicone elastomer with an embedded tubing system to represent the geometry of the internal ducts of a patient, with a fixed obstruction to represent a gallstone. Both rigid and soft catheter prototypes were created with cheaper silicone tubing infused with stainless steel wire in order to compare the interaction on the duct walls. Piezoelectric sensors served as a quantifier to detect friction and contact events, while a sealed syringe-based air pressure system measured the effort of the operator during the procedure. Furthermore, a computer vision guidance system tracked the depth of the catheter by the use of markers and applied an AI-assisted decision rule that combined both pressure thresholds and target localization to determine the optimal stent deployment time. Experimental trials determined that the softer catheters, in combination with the use of AI-assisted guidance and pressure sensing, reduced the number of times thresholds were crossed, thereby reducing the damage to ducts.

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# **Abstract:** Science and Engineering Fair of Houston

## 3485

**Category:** Robotics and Intelligent Machines

## How Motion Approximation Models and Surface Types Affect Robot Odometry Accuracy

Don Dao, Raphael Alison

Clear Creek ISD /Clear Brook High School

Odometry is a fundamental component of mobile robotics, enabling robots to estimate their position and motion while navigating through diverse environments. Many industries rely on odometry systems, yet high-end solutions—such as those using LiDAR, vision systems, or GPS—can be prohibitively expensive for widespread use. Dead tracking wheels offer a low-cost and widely adopted alternative, but their accuracy is influenced by the surfaces on which robots operate. While theoretical models describe expected performance, there is limited experimental data quantifying how different floor materials affect tracking precision. This project investigates the performance of dead tracking wheel odometry across multiple common industrial and commercial surfaces. By systematically measuring positional error on each surface and comparing results to standard odometry models, the study aims to identify patterns, limitations, and conditions that most significantly impact accuracy. The methodology includes controlled test runs, repeated measurements, and statistical analysis to ensure reliable results. The findings contribute new empirical data to the field of mobile robotics and help validate or challenge assumptions used in current approximation models. This research may assist engineers, researchers, and automation facilities in selecting appropriate surfaces, calibrating systems, or determining when low-cost odometry solutions are sufficient. Ultimately, this project supports broader adoption of affordable robotics by improving understanding of dead tracking wheel performance in real-world conditions.

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# **Abstract:** Science and Engineering Fair of Houston

**3486**

## Fire Extinguishing Robot

**Category:**

Robotics and Intelligent Machines

Deep Rathi

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

This project created an Arduino-based robot that can detect a small flame, move toward it, and spray water to put it out. The results showed that the robot successfully identified the fire using sensors and extinguished it, demonstrating how robotics can improve safety in dangerous environments.

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# **Abstract:** Science and Engineering Fair of Houston

**3487**

## Intelligent Conveyer Automatation

**Category:**

**Robotics and Intelligent Machines**

Cesar Sanchez, Maynor Serrano, Jonathan Rodriguez

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

This project focuses on the design, construction, and programming of a VEX robot arm to explore how robotics can replicate human-like tasks in engineering and industry. The main purpose is to investigate how mechanical design and sensor-based programming can improve accuracy, efficiency, and consistency in object manipulation. Guided by the driving question, how can a VEX robot arm be engineered and programmed to maximize performance in handling tasks? The project integrates structural assembly, motor control, and sensor feedback systems. The hypothesis proposes that incorporating optimized gear ratios and sensor feedback, such as potentiometers and limit switches, will significantly enhance the robot arm's precision compared to manual control alone. Through systematic testing with standardized objects, the project aims to evaluate performance outcomes and demonstrate the broader applications of robotic arms in automation, manufacturing, and education.

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# **Abstract:** Science and Engineering Fair of Houston

## 3488

**Category:** Robotics and Intelligent Machines

## From Vision to Tactics: A Multi-Modal AI Framework for Soccer Match Analysis and Recommendation Generation for Players and Coaches

Kushagra Nagar

Katy ISD/Seven Lakes - HS

In this project I present an enhanced approach which augments data analysis in sports analytics by considering internal and external factors that impact a player's performance on the field. This innovative approach uses computer vision and video fragmentation techniques to holistically perform game analysis by tracking player, goalkeeper and referee positions on the field, ball detection, identifying ball trajectory, player's area in the game of soccer. This solution considers existing weather conditions like temperature, light conditions, players behavioral and psychological factors to analyze players performance as they directly impact the performance on field. Finally, the solution combines this analysis with players' physical data from the player's profile and uses a large language model to generate personalized recommendations which can be used by players during training and by coaches for coaching. Such a solution helps coaches to customize training plans for players, prepare players for faster decision making and maintain their mental composure during high stress situations. An Application Programming Interface for the solution was implemented and the implementation codes are available in Github repository (available on request with restrictions).

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# **Abstract:** Science and Engineering Fair of Houston

**3489**

## FluffInjector: Diagnosing Logical Consistency Failures in Chain -of-Thought Reward Models

Krishiv Ray

Cypress Fairbanks ISD/Bridgeland - HS

**Category:**

Robotics and Intelligent Machines

Large Language Models (LLMs) are increasingly used as judges and reward models in alignment pipelines, where their scores shape learned behavior. Prior work shows these judges can be manipulated by superficial openers (e.g., “Thought process:” or “Let’s solve this step by step.”), but vulnerabilities in intermediate reasoning verification remain underexplored. We identify Fluff Injection, a failure in which a logically necessary step in a chain of reasoning is replaced with plausible-sounding commentary (e.g. “Let’s slow down and check our negatives here”). To measure this failure mode, we introduce FluffInjector, a benchmark of paired minimal examples: for each problem, we generate a GOOD chain and a FLUFF chain that keeps the same step count and final answer while replacing 25-40% of steps with non-inferential filler. Evaluating frontier judges (GPT-4.1, DeepSeek-V3.1, Qwen2.5-7B-Instruct), we find they frequently validate FLUFFED chains, indicating a strong reliance on surface coherence. Using FluffInjector, we fine-tune SmartRM, a verifier trained to emphasize step-to-step logical continuity. SmartRM reduces false positives from 37.43% (GPT-4.1) to 2.68% and achieves 97.27% overall verification accuracy.

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# **Abstract:** Science and Engineering Fair of Houston

**3490**

## ML-Based Discovery of Novel Longitudinal Phenotypes An Unsupervised Framework for Data-Driven Phenotype Analysis

**Category:**

Robotics and Intelligent Machines

Aditya Chakraborty

Private/The Village School

The discovery of disease phenotypes from electronic health records (EHRs) has evolved considerably with the integration of machine learning techniques in phenotype research. Traditional approaches are strongly reliant on manually engineered features and expert intervention, limiting the ability to capture complex relationships that persist in real-world patient biomarker trajectories. As a result, many diseases without well-defined diagnostic criteria remain poorly represented, leading to subtle phenotypes going undetected. This contributes to misdiagnosis and a partial understanding of how certain conditions develop and interact over time. To address this problem, we introduce a machine learning-based framework, a promising strategy that uses self-supervised learning for longitudinal phenotype discovery. Our work uses TS2Vec, a pretrained autoencoder that generates contextual representations of time-series data. As a result of implementing this strategy, two distinct phenotypes have been revealed. Statistical analyses, using chi-squared, t-tests, and visual inspection of test results, confirmed that these discoveries were highly relevant, hence demonstrating that TS2Vec captures meaningful patient biomarker trajectory profiles. This work demonstrates a favorable future for the integration of AI in healthcare research to advance precision in medicine, early detection of potential diseases, and prediction of healthcare outcomes.

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# **Abstract:** Science and Engineering Fair of Houston

## 3491

## How Accurate Can a A.I Driven App Detect Melanoma Skin Cancer Using Images

**Category:**

**Robotics and Intelligent Machines**

Sahasra Katragadda

Conroe ISD /AST: Academy of Science and Technology

Melanoma skin cancer is a serious cancer that affects mostly women,young children, and people with light melanin. This project aspires to test the accuracy of an A.I.-based smartphone app that detects this cancer. The app was made in Xcode, Apple's software for building iPhone apps, and a Google Teachable Machine model. The app its computer vision to identify whether a lesion is benign or malignant for melanoma skin cancer. To assess the app's abilities, I uploaded hundreds of images into the model and recorded the data of accuracy, including any false positives and false negatives in a confusion matrix. The goal of this project was to see if AI apps can be a reliable tool in the future for early melanoma screening and to understand how artificial intelligence might support doctors and patients in the future, potentially improving early diagnosis and saving lives.

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

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4. This project is a continuation of previous research.

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# **Abstract:** Science and Engineering Fair of Houston

**3492**

## A Drone Mounted System for Automated Pothole Detection

**Category:**

Robotics and Intelligent Machines

Lucas Rigoulot, Richard Chen

Clear Creek ISD /Clear Lake High School

Potholes can be a huge problem in cities when reporting methods are usually slow, inconsistent, and require lots of labor and money to fix. To address this problem, we created an autonomous drone-based system that can detect potholes using consumer grade hardware and open-source software. Our goal was to create a prototype that could accurately identify potholes and provide GPS coordinates for more efficient road repairs. We trained a YOLO11 object detection model on a custom pothole dataset and refined it to improve accuracy. We then built a lightweight detection module using a Raspberry Pi Zero 2 W, an Arducam camera, a GPS module, and a custom power system that are mounted onto a Holy Stone HS900 drone. A program then analyzed the captured images and recorded the GPS location of detected potholes. During testing, the system successfully identified potholes in real-world environments while avoiding false positives on open road surfaces. It also provided GPS coordinates that allowed us to locate the potholes physically. The system struggled only on unusually small or obscured potholes, such as those covered with debris. Our results demonstrate that low cost drones combined with AI image detection can serve as an effective tool for quick, automated road monitoring. This technology has the potential to save cities hundreds of thousands of dollars in fuel, labor, and equipment usage by reducing the need for manual pothole searching. Future improvements include increasing model accuracy, building a more robust drone platform, and integrating automatic reporting to city systems.

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# **Abstract:** Science and Engineering Fair of Houston

## 3493

## Are LLMs Reliable in Mathematical Problem Solving? An Evaluation of Errors and Agreement

Andy Wang

Houston ISD/Kinder HS for the Performing and Visual Arts - HS

**Category:**

Robotics and Intelligent Machines

Large Language Models (LLMs) are increasingly used in scientific work for their ability to quickly synthesize and present information. However, the presence of false information in training data can engrain error patterns, leading to common errors in different LLMs (Kim et al. 2025). Feng et al. (2025) developed the MathOdyssey dataset, with 387 math problems spanning the high school, university, and olympiad-level. Their dataset was challenging for the tested LLMs e.g. GPT, Gemini, Claude. Boye & Moell (2025) highlighted LLM reasoning failures such as unwarranted assumptions, arithmetic errors, and disregarding question constraints. The current project aims to explore how 4 advanced LLMs: ChatGPT, Grok, Gemini, & Copilot, perform on difficult AMC12 questions, and how they agree with each other. 20 AMC12 questions were selected from 2024 and 2025, amongst the last 10 questions in each year. Each question was prompted 3 times in each LLM to test their internal consistency. Accuracy was coded as 1 for correct answers and 0 for wrong ones. Response time was recorded in seconds (s). Results show that ChatGPT answered almost immediately (M=0s), but with low accuracy (M=0.15), and 0 questions correct in all 3 trials. Grok gave answers slower (M=7.5s), with moderate accuracy (M=0.4), and 3 questions correct in all 3 trials. Gemini took more time (M=11.4s), but better accuracy (M=0.8), with15 questions correct in all 3 trials. Copilot took the longest (M=17.4s), with the best accuracy (M=0.82), and 12 questions correct in all 3 trials. The 1st trial correct rate showed big differences: Copilot 90%, Gemini 80%, Grok 30%, and ChatGPT 10%. Percentage of correct answers in all 3 trials varied: Gemini 75%, Copilot 60%, Grok 15%, and ChatGPT 0. All LLMs experienced instances of a right answer followed by a wrong one in subsequent trials, showing the inconsistency and unreliability of their responses. Current LLMs should be used with caution when applied to challenging questions.

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# **Abstract:** Science and Engineering Fair of Houston

**3494**

## Converting Vision to Haptic Feedback for the Blind

**Category:**

Robotics and Intelligent Machines

Aditya Tandon, Stephen Liu, Alex Drew

Private/Awty International School

Introduction: 45 million people worldwide are severely visually impaired and struggle to navigate unfamiliar surroundings, making everyday activities difficult and creating risk of self-injury. Electronic adaptive devices that use AI to recognize objects are exciting, but are slow, and compromise the sound sense these individuals critically rely on. Our goal is to create portable, accessible AI-based haptic devices that will radically expand the sensory ecosystem enabling real time continuous environmental detection. Research: We conducted a needs assessment by interviewing an ophthalmologist who runs a low vision clinic, to make sure the output would be optimized to patients' needs. We then designed a head mounted device for conversion of 3D visual information into haptic stimulation of the skin of the forehead. We created iterations of 3d renderings to enable the system to use a 3d printed headset housing a camera, an array of vibration nodes and housing for the electronics, all connected to a portable computer. In our first iteration, we used an AI model for object detection and an AI model for depth mapping, and implemented logging to suppress outputs from the AI models until a button press, when it would print every recognized object into the console. It became clear that an AI model that only detects relative depth was inaccurate at longer distances, so we pivoted to an Intel RealSense camera and implemented LiDAR. We then developed a output protocol to communicate object location and identity by the amplitude and duration of vibration of a 3x8 array of vibrators on the forehead. Results/ Conclusion: Our device delivers complex patterned vibro-tactile output in 2 modes. An object detection mode provides object identity and spatial location. The depth mode creates a 3d depth map on the forehead of the user. This real-time expansion of the sensory ecosystem carries potential to radically transform the lives of those with visual impairment.

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# **Abstract:** Science and Engineering Fair of Houston

## 3495

## Tracking nematode behavior using YOLO Vision

**Category:**

**Robotics and Intelligent Machines**

Mohamed Ali, Godswill Nwankpa

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

Traditional methods for analyzing Caenorhabditis elegans behavior rely heavily on manual observation, making them time-consuming, costly, and difficult to scale. This study developed an automated computer vision pipeline using YOLOv8 for detection-based instance segmentation to enable high-throughput behavioral tracking. A deep learning model was trained over 100 epochs on annotated video frames of C. elegans, with multi-object tracking implemented to maintain consistent individual identification across frames, including during partial occlusion events. The system achieved 98.3% precision, 96.8% recall, and 98.9% mAP50 detection accuracy, with an mAP50-95 score of 83.6% indicating robust localization across varying IoU thresholds. Training completed in approximately 17 minutes on an NVIDIA GeForce RTX 2070 GPU with 32GB system RAM. These results demonstrate that YOLOv8-based detection provides a reliable, scalable framework for C. elegans behavioral analysis, with applications in high-throughput phenotypic screening for neurobiology and pharmacology research.

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# **Abstract:** Science and Engineering Fair of Houston

**Category:** Robotics and Intelligent Machines

## 3496

## Translating ASL into the Natural English Language via Artificial Intelligence: Training and Application

Callie Dai, Sophie Dai

Fort Bend ISD /Clements High School

This year's project focuses on the current weaknesses and uncertainties that our AI application last year had. Several examples include the need for more diverse datasets and tweaking verbal prompts for Python calls to various LLM models to improve accuracy. However, the biggest problem was our app's camera to body ratio, whereas it was difficult for the model to properly compare live data to the data from its training. A person had to be standing exactly where the dataset videos had their own person. As a result, much time was dedicated to fixing this issue, solved by a process of code debugging and tweaking and checking accuracy. With a better model, it is much more applicable and usable outside of experimentation. As a result, the application will be able to be used by hearing-disadvantaged individuals who would like to translate what they say into the natural English language just by signing in front of a camera.

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