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

**1088**

## Leveraging AI Models to Diagnose NAFLD From Liver Ultrasounds.

Aarin Mehta Mehta, Svar Koka, Pradhyun Pola

Fort Bend ISD /Sartartia Middle School

**Category:**

Biomedical Engineering

Non-alcoholic fatty liver disease is the most common liver disorder in the world, often diagnosed by blood tests, imaging, and ultrasound studies. However, the process can be rather cumbersome, subjective, and hard to apply homogeneously to large numbers of patients. This project determines whether a pre-trained machine learning model can analyze, independent of user intervention, a database of liver ultrasound images for assisting in the more effective and consistent detection of NAFLD. For this project, a dataset of liver ultrasound images as either NAFLD or normal, was collected from Kaggle, a website with multiple types of trusted datasets. These images were processed by resizing, normalizing brightness, and removing identifying information, and then divided into training and testing sets. A CNN was used as a base, and transfer learning was used, so the model could adapt to patterns associated with NAFLD. Through training, the performance of the model was determined using metrics; accuracy, precision, recall, and confusion matrix analysis. The highest performing version of the model achieved an accuracy of approximately 80%, showing that it was able to correctly distinguish NAFLD from normal liver images the majority of the time. While some misdiagnosis occurred, results suggest that pre-trained machine learning models have strong potential to support faster and more consistent NAFLD screening using liver ultrasound data. These findings indicate that a pre-trained machine learning model can effectively support automated screening for non-alcoholic fatty liver disease from liver ultrasound images potentially improving diagnostic speed consistency.

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

## 1089

## A Smooth Stride: Optimizing trans-tibial prosthesis ankle mobility functions

Jimit Patel

Conroe ISD /Knox Junior High

**Category:**

Biomedical Engineering

In the project the researcher attempted to resolve the issue of minimum ankle movement in trans-tibial prosthesis, which has been shown through multiple researches. The researcher encountered problems such as stiffness of the ankle joint (will not spring back to rest position), structural integrity, and tension of springs used in ankle. These issues were resolved by the changing of materials through a trial and error process, sanding of ankle space to create a gap, and reinforcement of structure using strong glue. In the project the researcher used the following materials: TPU filament, CF filament, Tetrahydrofuran glue/solvent, metal compression/extension springs, hacksaw, and a comparison prosthesis. The researcher 3d designed the prosthesis parts and assembled them by use of glue, tools, and friction. For testing the researcher used a fix point on both prostheses and tilted them back and forth at a time. Then the researcher measured the tilt in degrees from fixed point in both directions. As a result of the experiment the researcher discovered that the 3d printed prosthetic had a dorsiflexion(frontal bend) of 31 to 38 degrees and a plantar flexion(backward bend) of 25 degrees maximum. The comparison prosthetic had a dorsiflexion of 20-22 degrees and a plantar flexion of 20 degrees. The researcher/3d prosthesis is designed better for the ankle flexion required in both running and day to day life. In a percentage point of few the created prosthesis has a 72% increase in dorsiflexion and a 25% increase in plantar flexion. This successfully meets the expectation mentioned in the engineering goal for dorsiflexion. In total it is 50% increase which lags right behind the expectation by 20% but is still a major improvement. In summary the 3d printed prosthesis was proven to have a better functionality. The results of this project are beneficial to the development of improved mechanisms in trans-tibial prostheses in the future.

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

## 1090

**Category:** Biomedical Engineering

### AutoDock Vina–Assisted Molecular Docking Study of Natural Compounds as Potential Inhibitors of Human MR - Mineralocorticoid Receptor (2AA2): Toward the Discovery of Heart Failure Control to Treat.

Jewel Dara-Falade, Denise Tovar, Jose Sanchez

Harmony Public Schools - South District/Harmony School Of innovation- Houston

The project aims to develop drugs to neutralize the receptor that causes a disease, which is, in our case, heart failure. We want to find the most effective chemical molecule to neutralize the receptor that causes a disease by using the AutoDock Vina program. To do this, we are using the mineralocorticoid receptor 2AA2 to combat heart disease. In this project we screened 200 organic compounds Selleck Chemical LLC against the active site of the target receptor, which was our first step in creating a minimally toxic drug to treat heart failure. This helped to identify potential inhibitors that were able to work with our receptor to combat heart failure, which in turn helped us produce candidates for a safer drug able to slow down or potentially cure heart failure.

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

## 1091

## Different Types of Hand Soaps' Effect on the Amount of Bacteria

Aarvi Maru

Private/ST. JOHN'S SCHOOL

**Category:**

Biomedical Engineering

I arrived with the idea of testing which type of soap is the most effective on bacteria removal by first knowing that I wanted to do an experiment involving bacteria. Then, I came up with a few ideas, such as bacteria on towels, but my favorite was testing hand soaps. I am interested in this topic because I have always wanted to know how efficient hand soaps are at cleaning hands, and this experiment tests which soap is the best at removing bacteria. Soap removes bacteria from hands by chemically breaking up the bacteria, and by using the water and the oil in soap, the broken up bacteria easily slips off the hands. Only using water is not effective, because the oil on hands holds onto the bacteria, and water is not able to remove the oil because oil and water do not mix. So, soap is needed because the soap molecules are able to bond and remove the water and the oil fats on the hands. Soap is used to remove any type of bacteria. If soap is less diluted, there is more soap per pump; for instance, liquid soap has more soap, while foaming soap is diluted and air is pumped in for the foam. The required chemicals in soaps are sodium lauryl sulfate, sodium coco-sulfate, sodium cocoyl isethionate, sodium alpha olefin sulfonate, caustic soda, potassium hydroxide, acetic acid, sodium hydroxide, cocamidopropyl betaine, methylchloroisothiazolinone, citric acid, sodium chloride, sodium benzoate, and benzoic acid. Most hypoallergenic soaps do have safer and less harsh ingredients, but hypoallergenic soap does not have guaranteed safe ingredients, because the FDA (Food and Drug Administration) does not label an item hypoallergenic.

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

## 1092

## Model Artificial Pancreas

**Category:**

Biomedical Engineering

Matthew Ramsey

Clear Creek ISD /Seabrook Intermediate School

Diabetes is a disease that affects people's blood glucose levels negatively. Some people with the disease don't produce enough insulin in their pancreas or any at all and this causes their blood glucose levels to be high, which can be dangerous. This project contains a model of an artificial pancreas which is what some people with diabetes have to help them monitor and maintain their blood glucose levels at a healthy level. This project was designed to test the hypothesis that if various methods for sustaining blood glucose levels are tested, then the first method (turning on and off the pump) will sustain the blood glucose levels the best. Two containers were filled up with water, one of them was filled up with tap water and the other was filled up with distilled water. The code from an Arduino board was used to program a pump to pump tap water (which represents insulin) from the tap water container into the container filled with distilled water (which represents blood sugar). Included in the distilled water container is a conductivity sensor connected to a multimeter. The conductivity sensor would measure the conductivity of the water and when the conductivity reaches a certain threshold, the pump would shut off. The experiment resulted in the first method having the shortest distance of conductivity from the pump shut off point. This means that the first method best sustained the blood glucose levels which supports the hypothesis and proves the hypothesis correct.

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

**1093**

## How material affects knee sleeve mechanics and motion

**Category:** Biomedical Engineering

Enzo Rivas

Houston ISD/BCM Academy at James D Ryan - MS

ABSTRACT My testable question is: How does changing the type of knee sleeve material (spandex, polyester, and denim) affect the free range of motion and comfort during walking and soccer practice? To conduct this trial, I used three different sleeve materials with distinct characteristics: spandex, denim, and polyester. I randomly selected ten classmates for the first group of the experiment. The second group of the experiment involved middle school kids who played soccer. Each participant tested all three sleeve types, and this process was repeated across all ten individuals. To measure knee mobility, I used a specialized protractor called a goniometer, which records the degree to which the knee can be flexed toward the body. This procedure allowed me to evaluate the impact of the sleeve material on the flexibility and range of motion. Also, I used a survey to ask how comfortable they feel while wearing the three different types of knee sleeves. The results showed that polyester performed better than the other two materials, spandex and denim. Polyester provided the greatest free range of motion, and most participants felt that it was the most comfortable and confident while wearing it. Polyester had the highest range of motion, with an average of 40 degrees, spandex had an average of 3.5 degrees, and denim had an average of 30 degrees. Most people expressed that they would wear the polyester knee sleeve during the soccer game and would recommend it to other people.

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

## 1094

**Category:** Biomedical Engineering

## PA Vascular Probe Prototype - Engineering a Specialized Probe for Helping Diagnose Vascular Malformations Using the Photoacoustic Effect

Lourdes Morales

Clear Creek ISD /Brookside Intermediate School

Photoacoustic imaging, often referred to as PA, is an advanced biomedical imaging hybrid of optical and ultrasound imaging with a promising potential for the future development of medical imaging devices. The photoacoustic effect, applied in photoacoustic imaging, occurs when a laser delivers pulses to a biological tissue or vessel, causing a light-absorbing substance like hemoglobin to heat up and expand, creating an ultrasonic wave (OPOTEK, 2025, para. 1). With the common misdiagnosis of vascular anomalies and the time-consuming process such as MRI or CT imaging, this project is a way to prevent or decrease the probability of an incorrect diagnosis for patients with a vascular anomaly by creating a specialized medical probe using the photoacoustic effect to non-invasively scan the vascular anomaly in a timely manner. This way, medical professionals could get the results of the scan to diagnose the patient quickly and express the severity of the anomaly more efficiently. To create this, a high-power laser diode and piezoelectric transducer disk was connected to an Arduino to replicate the photoacoustic effect. The results were unfortunate; while the transducer disk was working proficiently, the laser diode was not. The wiring from the laser diode's base pin accidentally touched the housing, causing it to become dysfunctional. In conclusion, if the probe prototype were to be functional in the future and were to be continued, this would be a highly innovative probe that could hopefully be turned into a full scanner to help benefit the field of medicine and biomedical engineering.

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

**1095**

## Kapiva: A proposal of a novel wearable device to aid chronic inflammatory disease management

Sumedha Yadha

Fort Bend ISD /Quail Valley Middle School

**Category:**

Biomedical Engineering

Globally, chronic diseases are the leading cause of illness, death, and disability. In the US, 3 in 4 Americans suffer from at least one chronic condition which needs continuous management. In 2030, the estimated cost of chronic disease is expected to reach $47 trillion throughout the world. Unfortunately, it is not straight-forward to proactively follow a lifestyle aimed at disease prevention and management. In this context, there is a need for technology guided proactive lifestyle management gadgets like wearable devices. Commercially available wearable devices have been popular and rely on many different biomarkers. After a detailed study of viable biomarkers based on modern and ancient medicine, it is understood that thermal biomarkers such as bodily heat distribution, heat production, and heat stabilization provide valuable insights on the balance between the sympathetic and parasympathetic nervous systems. This balance or imbalance is a primary driver for inflammation and chronic disease management related to cardiovascular diseases, cancer, and autoimmune conditions. These biomarkers have been widely used in ancient medicine and have the potential to be incorporated in wearable devices. This project proposes a novel apparatus for a wearable device which can deduce these key thermal biomarkers by measuring the body temperature of the user using commercially available thermal sensors. Data analysis, modelling and user interface has been done in Python. Numerous lifestyle management strategies can be incorporated into daily life to keep these markers in range. The deduced markers will be correlated to user experiences during the study, by collecting user feedback through a questionnaire. The aim of the project is to propose biomarkers which are not widely used currently in the wearable device industry have higher potential for chronic disease management as pointed out by ancient medical sciences and are also being investigated in modern medicine.

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

## 1096

**Category:** Biomedical Engineering

### Taking Out The Polymer: limiting the Usage of Polymers During the Production of Robotic Surgical Machines in Order to Reduce Overall Costs

Daniel Uchime

Conroe ISD /McCullough Junior High

The researcher's goal was to create a model for a robotic arm more readily accessible to hospitals in the U.S. U.S. Robotic Surgery is a minimally invasive procedure in which doctors use a robotic arm to aid them in completing the operation. The surgeon sits at the console, looks into the vision system, and uses a controller to control the arm on the patient side cart. The reason that robotic surgery is rare is because of high production cost and high maintenance of the robotic arm. The Da Vinci Robotic Surgical Machine (The industry standard Robotic Surgery Machine) can cost up to 1.2 million USD to manufacture. Maintenance can also be costly. Each individual part can be difficult to remove individually, so a lot of the time to perform a fix on one tiny part might cost hundreds of thousands because multiple parts have to be replaced.The researcher designed a 3D model depicting how the Da Vinci model can be improved to reduce production and maintenance costs. In their model, the research took out excess metals in the surgeon's console and reduced the use of polymers to reduce production costs while maintaining the effectiveness of the machine. The size of current surgeons consoles are larger than required. This increases the metal usage, and by shrinking it down metal costs can be reduced. The researcher's model prioritizes polymers on the sterile parts of the machine and removes excess polymers on the non sterile parts of the machine. The design also uses a modular system which allows for each individual part to be taken apart and replaced easily. Even though this approach is more expensive initially, it significantly decreases the cost of maintenance overtime. The result of this was creating a robotic surgery machine for 486,000 USD, which is about 60% less than current designs. What the researcher learned was that 2 issues with robotic surgery were production costs and maintenance, and the solution being a modular system and conservation.

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

**1097**

## Engineering the Future of Healing

**Category:** Biomedical Engineering

Eli Pulmano, Samir Paudyal, Lucas Zhou

Fort Bend ISD /Fort Settlement Middle School

This project explores the development of a hydrogel using polyvinyl alcohol (PVA), gelatin, and citric acid. Hydrogels are soft, water-absorbing materials that can be used in a variety of fields, especially in medicine. Our goal was to understand how different combinations of these three additives affect the hydrogel's ability to swell and allow substances to pass through. PVA provides structural support, gelatin improves biocompatibility, and citric acid acts as a crosslinker to hold the network together. By testing various formulations, we analyzed changes in swelling behavior and diffusion rates. Our findings could help improve hydrogels for use in drug delivery and wound care.

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

**1098**

**CalmAi**

**Category:**

**Biomedical Engineering**

Gangrui Hu, Chen Zhou

Katy ISD/Joe M. Adams Junior High School

Stress is a significant issue in our modern society, impacting individuals across all demographics. Stress is costing our global economy over $1 trillion annually. In the workplace alone, 77% of employees report experiencing work-related stress. To address the limitations of unreliable self-assessments and costly diagnostic equipment, we developed an affordable AI solution to predict stress and give alleviation suggestions. Our methodology utilizes an ESP32 board equipped with a MAX30102 heart rate sensor and a Seed Studio GSR (Galvanic Skin Resistance) sensor, which transmits user data via Bluetooth. Community volunteers participated by reporting their stress levels, after which we collected their physiological data. Utilizing these datasets, we trained four machine learning models: K-Nearest Neighbors (KNN), Support Vector Machine (SVM), Random Forest, and XGBoost. Using the four models, we subsequently developed a Streamlit-based web platform, enabling users to input their measured data and receive an assessment of their stress status. To enhance user experience, we integrated OpenAI's GPT-4o-mini model to offer stress management feedback. When evaluated with newly collected data, our application achieved an overall accuracy of 85%. After our work and testing, our project has proven to predict and diagnose stress.

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

## 1099

## Project Parasight: Seeing Malaria Through the Lens of AI

**Category:**

Biomedical Engineering

Parjanya Yelisetty, SaiShruti Kondeti

Conroe ISD /Irons Junior High

Malaria is a serious and potentially fatal disease caused by Plasmodium parasites and transmitted to humans through the bites of infected female mosquitoes, placing nearly half of the world's population at risk. In 2024 alone, approximately 282 million malaria cases were reported, resulting in about 610,000 deaths. Due to the widespread impact and severity of this disease, improved diagnostic methods are urgently needed. The goal of this science fair project was to design an accurate, consistent interpreter, low-cost device that helps healthcare professionals detect malaria more efficiently, allowing patients to receive treatment sooner. The hypothesis proposed that if a portable device captured microscopic images of blood samples and analyzed them using a convolutional neural network (CNN), it would accurately classify samples into four categories: healthy, low, medium, and high levels of malaria infection. To test this hypothesis, blood smear images were prepared using varying amounts of yeast to simulate each infection level and were photographed using a microscope. A CNN model was then developed and trained on these images using transfer learning techniques. Finally, a portable device was constructed to capture images of blood smears, transmit them to the trained CNN, and display the predicted classification on an OLED screen. The system correctly classified samples approximately 80% of the time, consistent with the CNN's overall accuracy of 83.33%. These results indicate that a low-cost, AI-based diagnostic device can effectively detect different levels of malaria infection. With additional training data and further improvements, this technology has the potential to enhance early malaria diagnosis and expand access to timely treatment by supporting healthcare professionals in settings where rapid, consistent analysis is needed.

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

## 1100

## SID Stopper

Charlotte Warner

Stafford SMSD/Stafford STEM Magnet Academy

**Category:**

Biomedical Engineering

I chose to do this project because I believe no baby should unexpectedly pass away in their sleep.The problem that the “SIDS Stopper” is trying to reduce is Sudden Infant Death Syndrome cases in infants under one year of age. The hope of this project is that the “SIDS Stopper” will accurately beep when the temperature of the infant has reached an unsafe temperature of 100.4 degrees Fahrenheit, and beep when the temperature of the room has reached over 75 degrees Fahrenheit. To test the "SIDS Stopper" after constructing it, use hand warmers to mimic the rising temperature of a infant and take it away to show the device's accuracy. After testing and observing the data, the "SIDS Stopper" accurately beeped when the temperature of the infant reached an unsafe temperature of 100.4 degrees Fahrenheit and beeped when the temperature of the room reached over 75 degrees Fahrenheit. Overall, my device can't solve the problem of SIDS, but it can help prevent SIDS in infants under one year of age.

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

## 1101

## Check the Backseat

**Category:**

Biomedical Engineering

Milan De Jager

Clear Creek ISD /Seabrook Intermediate School

This project was chosen because there have been many reports on babies who have been left in cars and then died due to heat exhaustion. So far since 1998 a total number of 1,040 kids have died in cars, this is called the forgotten child syndrome. The problem is that many babies are left in cars by accident and there is no way for the parents or other people to know before the baby ends up dying from heat exhaustion. The goal is to detect a baby in the car, determine if it's a forgotten baby scenario and sound an alarm to notify people around the car about the baby. For this project the temperature of a closed car in the sun was measured for 30 minutes. It was used to see how fast the temperature in a car will increase. Then an AI model was trained, and the accuracy was tested on Online images, with an accuracy of 38%, then on printed pictures that increased the accuracy to 92% and then finally to real kids that was the most accurate with a 100% accuracy. The data showed that the microcontroller was able to detect the baby and whether the car was moving or not. It also showed that the temperature in a car does rapidly increase and how Oxygen does go down but slowly. In the end my hypothesis was correct because of the ability to detect babies.

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

## 1102

## Breast cancer - CDK2 - Cyclin dependent kinase 2 4FX3_chainA

Abibat Salau

Harmony Public Schools - South District/Harmony School of Excellence - MS Sugar Land

**Category:**

Biomedical Engineering

The purpose of this experiment is to use computational screening of natural compounds against human CDK2 - cyclin dependent kinase 2 (4FX3) using AutoDock Vina to determine potential treatment of breast cancer. The frequent diagnosis and fatality of breast cancer sparked my interest in potential treatments. This experiment can be useful to anyone who has fallen victim to the tragedy that is breast cancer by providing them with a possible treatment option. My hypothesis states that "if 200 natural active organic compounds are computationally screened against human CDK2, then it is expected that new potential inhibitors will show stronger binding affinity and higher specificity, so these compounds could serve as novel, effective, and safer drugs for treating breast cancer." To perform this experiment, I identified a disease-specific receptor, performed docking studies using AutoDock Vina with a receptor obtained from the Protein Data Bank, converted it into PDBQT format, selected 200 ligands from a library of 2504, defined grid box perimeters, and analyzed results using Python scripts by ranking them. My results supported my hypothesis, as I was able to compile a list of 6 of the most effective natural compounds. Using my results, I was able to conclude that natural compounds such as molecule 43 Dioscin, molecule 84 Enoxolone, molecule 35 Urosolic acid, molecule 11 Ginkgolide B, molecule 6 KENACORT, and molecule 93 Hesperidin are the natural compounds best suited to act as inhibitors and potentially become part of treatment for breast cancer.

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.

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[ ] yes [X] no

4. This project is a continuation of previous research.

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[X] yes [ ] no

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

**1103**

**Category:** Biomedical Engineering

## Harnessing Artificial Bacterial Magnetoreception for Targeted Drug Delivery Systems Against Lymphatic and Gastrointestinal disease

Jacob Ni, Eric Xiang

Conroe ISD /McCullough Junior High

The conventional pharmaceutical treatments available to treat liver diseases and liver cancer are usually ineffective because the drugs are quickly cleared before reaching the target cells. This proposed research aims to study a magnetically directed biological system to enhance the targeted treatment of drugs. The hypothesis is that Saccharomyces cerevisiae bacteria coated with iron oxide (Fe3O4) magnetic nanoparticles can be externally navigated by magnetic fields to provide targeted treatment. In this experiment, Saccharomyces cerevisiae is grown, magnetic nanoparticles are added, and then a model drug, methylene blue, is introduced. The movement of the cells along with targeting efficiency is measured while applying controlled magnetic fields. This process is carried out in a viscous solution similar to blood. Results are compared with that of non-magnetic cells. The expected outcomes include enhanced directional control and the localization of drug release. The invention shown in this research represents a proof of concept for the development of a low-cost and controlled drug release system that could potentially lower the systemic exposure of the drug and enhance drug efficacy.

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

**1104**

## A Comparative Analysis of Machine Learning Models for Small Cell Lung Cancer Detection Using Medical Imaging

Ashlyn Arias Delvaty

Charter/School of Science and Technology Advancement -MS

**Category:**

Biomedical Engineering

Small Cell Lung Cancer (SCLC) is an aggressive form of lung cancer that is difficult to detect during early stages using standard medical imaging. This project compares three machine-learning models designed to identify early-stage SCLC patterns in CT scans and X-ray images. Each model was trained and evaluated using publicly available, de-identified imaging data, and performance was measured based on accuracy, computational efficiency, and early-stage sensitivity. The results revealed notable differences in detection performance among the models. These findings emphasize the importance of selecting appropriate machine-learning architectures for reliable early-stage cancer detection.

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

## 1105

## Access Arm is it possible to build a prosthetic arm for under a 100 dollars?

Maier Imaran

Conroe ISD /McCullough Junior High

**Category:**

Biomedical Engineering

Upper limb amputees usually face a choice between expensive medical grade prosthetics or affordable non functional alternatives. This functionality gap greatly limits the quality of life for millions of people around the world. This project highlights the need for a functional yet affordable prosthetic that is accessible to many people in bad financial situations. The design uses 3d printing to create a light weight prosthetic made for durability and functionality. To acheive natural movement the arm uses a myoelectric control system which uses EMG sensors which detect electrical impulses from the users remaining muscles which are then processed by a micro controller to control high power motors. This mechanism allows users the ability for independent finger utilization. In conclusion the prototype can successfully preform essential daily tasks such as picking up utensils and lifting up objects up to 1kg with a 90% success rate in trial testing. By using opensource hardware and additive manufacturing the total cost was reduced to a fraction of alternative options. This project successfully shows that affordable technology mixed with smart engineering can provide life changing tools to many people around the world. And greatly increase the quality of life for many people including children and cancer patients.

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

**1106**

## The Allergy Predictor

Jiayue Hu, Jun Chan

Fort Bend ISD /Quail Valley Middle School

**Category:**

Biomedical Engineering

The purpose of this project is to design and build a low-cost, real-time Allergy Predictor capable of measuring local air quality more accurately than broad regional reports. Current allergy, pollen, and spores forecasts are often unreliable because they collect data far from people's homes and only update once per day. The Allergy Predictor aims to solve this by using compact sensors to measure particulate matter (PM2.5), temperature, and humidity directly in the user's environment. The real time measurements allow the device to estimate local allergen levels more precisely, helping people understand the air they are actually breathing with a cheap and efficient predictor. This device uses an ESP32 microcontroller, PMS5003T air-quality sensor, DHT11 humidity and temperature sensor, and a 1.3-inch OLED display to collect, process, and show data. By combining environmental measurements and converting them into predicted allergy levels, the system can identify variations between different indoor or outdoor locations. The project tests whether this prototype can consistently detect meaningful differences in air quality.

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

**1107**

**Category:** Biomedical Engineering

## Enhancing Electronic Nose Specificity for Non-Invasive Disease Screening: A VOC Classification Approach via Dynamic UV-Thermal Modulation

Shubham Yadav

Conroe ISD /Knox Junior High

Lung cancer is the leading cause of cancer-related mortality worldwide, underscoring the critical need for advancements in early non-invasive detection. Traditional screening methods are expensive and invasive, creating a demand for accessible early-stage diagnosis. While volatile organic compounds (VOCs) in exhaled breath serve as biomarkers, Electronic Nose systems utilizing standard Metal-Oxide Semiconductor (MOS) sensors suffer from critical cross-sensitivity, failing to distinguish cancer biomarkers from healthy metabolic byproducts. This study investigated whether a novel Dynamic UV-Thermal Modulation technique could solve this selectivity challenge by utilizing a multi-stage activation protocol. An airtight sensing chamber was engineered containing a multi-sensor array (MQ-2, MQ-3, MQ-135) utilizing high-resolution 16-bit analog-to-digital data acquisition and external polyimide thermal regulation. Twenty trials were conducted using headspace simulants: Group A (Healthy) containing Isopropyl Alcohol, and Group B (Cancer) containing Acetone and Limonene. A 90-second detection cycle was utilized: Phase I (0-30 s) established a baseline; Phase II (30-60 s) introduced the target analyte with external heating to observe standard cross-sensitivity; and Phase III (60-90 s) activated 395 nm UV modulation to induce distinct photocatalytic oxidation profiles. Results identified the MQ-3 sensor as the optimal channel. During the UV phase, the Cancer Simulant exhibited a mean sensitivity ratio of 3.05, while the Healthy Control maintained a significantly lower mean of 1.77. A two-sample t-test yielded a p-value of $p < 0.001$, confirming that integrating dynamic thermal and UV modulation successfully differentiates lung cancer biomarkers from healthy simulants, thereby validating a low-cost framework for accessible screening.

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