

MIT THINK 2022-23 Finalists

Contrail Reduction Algorithm and Data Live E-system (CRADLE)

Edward Wu | Pittsford Sutherland High School, NY

Project: Despite the aviation industry's one billion tons of CO₂ produced annually, its biggest contributor to global warming is not CO₂ pollution but condensation trails (contrails for short)—long cloud streaks that airplanes produce at high altitudes. These artificial clouds trap infrared radiation fleeing Earth's surface and significantly contribute to the rising threat of global warming. Resolutions to reduce contrail harm lack, especially in the area of finding ways to avoid high-impact contrail airplane routes. Other approaches are either too costly or harm the environment even more such as altering engine design or adding chemicals to plane fuel. My proposal is Contrail Reduction Algorithm and Data Live E-system (CRADLE), a fully computerized program that aims to alleviate contrail airplane routes. I plan to carry out my proposal through three phases. In phase one, the program first identifies contrails from any land- or satellite-based sky image by employing state-of-the-art computer vision AI models. Then, in phase two, by matching contrail regions with flight routes and considering contrail formation conditions including temperature, humidity, and pressure, the algorithm calculates alternate flight routes that reduce contrails and is maximally fuel-efficient. Finally, to address a lack of available contrail image data, phase three focuses on creating an interactive smartphone app that allows users to take an image of contrails anywhere, which is then collected into a usable dataset to improve CRADLE's accuracy.

Bio: Eddy is a junior at Pittsford Sutherland High School who is interested in the environment and applied physics. In summer 2022, he conducted quantum physics research through the University of Rochester Research Experience for High School Students. Over the years, he has noticed how his region has been getting fewer snow days, which inspired him to read deeply about the environment. Having a fascination for planes since he was little, Eddy was motivated to solve the pressing contrails problem. He is incredibly excited to further his CRADLE project through MIT THINK. His overall goal in science is to pursue a career in physics academia to make a positive impact on the world. Outside of research, Eddy is a hockey player, saxophonist, and debater as the co-president of his school's Model UN club. He is involved in his local community as a junior hockey coach helping kids with developmental disabilities.

Escaping Synthetic Carcinogens: An Integration of Chemically-Based Testing Methods for Detecting Carcinogens in Personal Care and Cosmetic Products

Chloe Sow | The Downtown School, WA

Project: A lack of transparency and regulation in the consumer products industry, specifically in personal care and cosmetic products, makes it difficult for consumers to know what is in the products they use and their potential risks. Personal care and cosmetic products, including items such as makeup, hair care, skincare, and fragrance, may contain various chemicals and ingredients that can potentially harm human health. For instance, some of these substances, known as carcinogens, can cause cancer in humans or animals, while others may cause irritation, allergic reactions, or other adverse health effects. Thus, herein, we propose the development of an origami paper-based microfluidic device capable of simple and rapid colorimetric detection of multiple carcinogens and other harmful chemicals in personal care and cosmetic products. Origami in paper-based microfluidic devices creates 3-D paper microfluidic channels as liquid fluids wick through paper through capillary action, carrying and mixing reagents, enabling the fluid exchange between layers without the assistance of a bonding agent with a lower cost and with more straightforward fabrication. Thus, with an inexpensive, rapid, and accessible device utilizing chromatography paper, wax, and colorimetric reagents—easily customized for the desired carcinogens—the general population will moreover be able to readily identify unknown irritants and toxins that may potentially affect their well-being.

Bio: Chloe Sow is a current junior at The Downtown School in Washington, who is absolutely thrilled to be a part of MIT THINK as a finalist. Interested in pursuing engineering, ubiquitous computing, and/or synthetic epigenetics, having independently conducted research, as well as at the UbiComp Lab at the University of Washington, she has presented at a few research symposiums (being absolutely roasted by the judges, of course!). In her free time, other than spending time with family and friends, she loves to watch documentaries (+ k-dramas), translate novels, and make music. With the support and resources of MIT THINK, for her project, inspired by the Stink! documentary (which is a definite must-watch!), she hopes that the device will provide greater transparency and insights, assisting consumers in making more informed decisions about the personal care products they use.

Development of Photosensitive Cellulose Resin for Stereolithography 3D-Printing

Elliott Hirko | Gainesville High School, FL

Project: Over the past several decades, there have been huge advances in tissue recellularization, a field which involves the growth of specific tissue cells onto a porous network called a scaffold to produce a functioning organ. One of the drawbacks keeping these methods from reaching the medical field is the lack of a scaffold for the organ needed (O'Brien, 2011). Herin a potential system for producing 3 dimensional cellulose structures with extreme precision for use in tissue recellularization is presented. Cellulose, the most abundant polysaccharide on the planet, is both biocompatible and very low cost. Additionally, it's chemical properties fill the prerequisites required for being a good cell scaffold material (Encheva et al., 2004). The only issue is there is no readily available way to directly manipulate cellulose into precise 3 dimensional objects since it neither melts or dissolves in common solvents. One of the most precise 3D printing process called stereolithography typically employs a laser to solidify a photosensitive resin layer by layer until a 3 dimensional object is made (Hubs, n.d). To allow for this method to be applied to cellulose, a metal complex called tetraamine copper II hydroxide or Schweizers reagent (SWR) will be tested under the influence of a photoacid generator (PAG) called coumarin-4-ylmethyl (c4m) to generate a photosensitive cellulose solution that can be utilized with a custom made stereolithography printer to produce 3 dimensional cellulose structures.

Bio: Elliott is a junior at Gainesville High School in Florida. He has always had an interest in absorbing information from the world around him an applying it to projects he finds interesting. He puts a great emphasis on chemistry and engineering because it is with these disciplines that he can obtain the ability to create almost anything through his work. He hopes to one day apply this knowledge in a way as to aide in the energy crisis. He enjoys creating things and performing various organic synthesis projects along with long walks through nature and hanging out with his friends (when they actually manage to agree on plans)..

Wall-Climbing Robot in Disaster Zones

Emily Stanton and Anna Brusoe | University High School and Homeschool, WV

Project: Over the years, natural and man-made disasters have persisted at an alarming rate, devastating the lives of many, and leaving behind an unceasing death toll. Unfortunately, there isn't an easy way to prevent these disasters from happening. So the best we can do is help preserve the lives of those caught in disasters and those risking everything to save others. This is where the wall-climbing robot comes in. The wall-climbing robot can climb up buildings, taking 3D visuals of the damaged area and providing necessary materials to people stuck inside, such as air masks and water. To accomplish this task, we are creating a robot that can climb up and across walls using a modified suction system that can work on any type of wall, even walls with crevices and dirt. Our robot also utilizes pneumatic powered limbs for greater reach. We plan on using a Lidar sensor for the 3D mapping aspect of our design.

Bio: Emily is a student at University High School in Morgantown WV who has always had a love for creating things, whether it be robots or novels. This has led her to join Mountaineer Area RoboticS (MARS), her local FRC team, where she has learned how to work with others to build robots quickly. This last year, she has interned at the Biomedical company, Intermed Labs, where she learned more about material science and the process of researching an idea. In her free time, she also loves writing sci fi and fantasy novels and short stories, swimming, and discussing crazy ideas with Anna.

Anna is a homeschooled senior from Morgantown, West Virginia. With her goal of becoming a mechanical and aerospace engineer, she hopes to design innovative technology that can be used to help others. Anna is passionate about expanding STEM education access and resources to rural areas and has written a children's book about five women in STEM to help students learn about science and engineering. As a member of the mechanical sub-team of FIRST Robotics Competition team Mountaineer Area RoboticS(MARS), Anna has learned a lot about engineering design and fabrication of materials. She is very thankful to have been selected as a finalist for the MIT THINK Scholars Program, and she is very excited to continue collaborating with Emily to continue research on wall-climbing robots. Outside of her STEM related interests, Anna is a classically trained pianist and is learning to play the organ.

From Weed to Wheat: Seaweed as a Potential Staple in the Global Freshwater Crisis

Jun Ru Chen | Jericho High School, NY

Project: Often endearingly referred to as the elixir of life, water is an indispensable commodity required by all aspects across the biological spectrum. Yet, most of freshwater is inaccessible and locked away in glaciers or blended with salts. To conserve this declining resource for our growing population, this project will introduce and demonstrate scale model processing of novel crop and explore dietary shifts for minimizing irrigative water reliance while increasing global crop yield. I will model a scale biochemical process that will render common kelp, specifically, *Saccharina japonica* into a common grain substitute similar to rice flour. The fungal fermentation with *Paradendryphiella salina* seeds the sample with accessible nutrients; complex sugars are broken down to build protein rich mycelium. A session of solar baking sanitizes the newly enriched sample. Through another round of fermentation with lactic acid bacteria instead, free protons from lactic acid promote the formation of hydrogen iodide gas with aqueous iodine. Finally, the sample is baked by the sun for the last time— when dehydrated, remaining hydroiodic acid would reform into a dispersed gas. With the acute concentration of iodine removed, myoprotein enriched seaweed powder can easily replace consumer flour with a myriad of advantages. This iodine depressed flour would serve as a low glycemic, high nutrient, and environmentally friendly grain, grown completely past the need for any of our dwindling freshwater supplies. Seaweed as a crop holds untapped potential as a source of an enriched and sustainable diet for future capitalization.

Bio: Jun Ru Chen is a sophomore at Jericho High School in New York and a student of the science research program there. Since a brief cooking unit in middle school, food has been one of the major topics sitting on the backburner. With a fear of spicy food and salmonella, he avoids cooking protein himself— drifting into simple cooking, tasting quite bland. In pursuit of this, he researches a superior ingredient and debates on creating a club to support his ventures. Among the existing clubs that he is currently in, he competes in SciOly, Mathletes, and occasionally drops by into whatever club was running that day. Despite having no background in physics, he was placed into all three physics events by the team leader. Armed with spite, he is now lobbying his guidance counsellor to waive AP Physics I prerequisites for Physics II, a class vacant for over 20 years.

Echo: A Sound Solution For Mapping and Navigation in Firefighting

Agastya Pawate | Lynbrook High School, CA

Project: Across the western US, destructive fires are larger, hotter and more frequent every year. Their white-hot flames rise high to singe the crowns of tall redwood trees and blacken vast tracts of forest; their smoke and ash turn the skies an eerie yellow. But firefighters on the frontlines are increasingly in need of better equipment and technology in order to be more effective. Currently, they rely on thermal imaging cameras to find their ways around in these situations, but these cameras white out under the intense heat of these blazes, fail to show obstacles and lack crucial depth of field information. My proposal for overcoming these limitations is to use narrow-beam ultrasonic mapping for imaging. By scanning the surroundings of a user with repeated pulses of ultrasound and plotting the resulting distance measurements on a full field of view, my camera will not white out in extreme heat and will be able to image through plumes of smoke. Measuring distance rather than temperature will produce images with clear depth of field and a view of surrounding obstacles. An innovative capture system using a stepper and a DC motor will allow for optimum resolution and measurement quality, and a dual gyroscope system enables crucial odometry for a real-time display. Multiple sensor inputs will be threaded together for efficient operating speed and signal. With this array of sensors and motors, my proposal would provide accurate, three-dimensional mapping in firefighting situations.

Bio: Agastya is a junior at Lynbrook High School in San Jose, CA and is excited to be a THINK finalist this year! Ever since he got a Python book from the library and an Arduino for his tenth birthday from his parents, he has done numerous robotics projects using microprocessors and sensors (especially his favorite - the ultrasonic distance sensor). He is a member of his school's robotics team, where he learned and taught skills such as creating Arduino projects and using power tools for machining. Outside of academics, Agastya is an avid runner on the Lynbrook Cross Country and Track teams and plays clarinet in his school's Wind Ensemble. In his free time, he enjoys exploring new routes in the hills near his home, going on trips up and down the West Coast and reading whatever he can get his hands on.