

CONNECTICUT SCIENCE & ENGINEERING FAIR

www.ctsciencefair.org

Top Winners in the 2018 Connecticut Science & Engineering Fair

(Student information as of April 2018)

Max Coisman, Grade 7

St. Gregory the Great School, Danbury, CT

The Efficiency of Different Types of Algae in Creating Self-Sustaining Microbial Fuel Cells

Connecticut Science & Engineering Fair Awards

- * Lockheed Martin Physical Sciences Awards --- Finalist - Physical Sciences 7th Grade - CSF Medallion
- * Energize CT/eemarks Alternative/Renewable Energy Awards --- 2nd Place Middle School - \$200 Cash and Trophy
- * Future Sustainability Awards - Eversource /energizeCT --- 1st Place Middle School - \$300 Cash and Trophy
- * Alexion Biotechnology Awards --- 3rd Place- Biotechnology 7th grade- \$100 & trophy and Invitation Compete in Broadcom MASTERS
- * The Children's Museum --- 1 family 4-Pack of Admission Passes to the Children's Museum

Abstract

One of the biggest challenges facing humanity is producing enough electricity to meet the world's energy needs. The Rockefeller Foundation estimates that 16% of the world's population has little or no access to electricity. Both our current practice of burning fossil fuels and many of the green energy technologies (eg. solar, wind, and nuclear) are too expensive for this segment of the population. In this project, I tested variations of another green energy technology – fuel cells.

Many researchers have given up on fuel cells because it is too energy inefficient to produce hydrogen, the fuel that powers them. Some scientists, though, have been advancing a different type of fuel cell that is powered by microbes. These microbial fuel cells are better, but still have limitations including the need to introduce oxygen and the need to provide food for the microbes. In my project, I tested four different strains of algae used inside of the fuel cell that serve as both oxygen engines and microbial food. I built four test fuels cells and one control fuel cell and validated my hypothesis that Anabaena (a type of blue-green algae) was most effective and increased the lifespan of the fuel cell by 300%.

Microbial fuel cells may never power homes in the first world, but a farmer in the developing world could charge a cell phone or light a single LED bulb with a fuel cell the size of two five gallon buckets which costs less than \$50.

Biography

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Top Winners in the 2018 Connecticut Science & Engineering Fair

(Student information as of April 2018)

Julian Kage, Grade 8

Talcott Mountain Academy, Avon, CT

Development of rapid test for Lyme bacteria in ticks

Connecticut Science & Engineering Fair Awards

* Alexion Biotechnology Awards --- 3rd Place- Biotechnology 8th grade- \$200 & trophy and Invitation Compete in Broadcom MASTERS

Abstract

The purpose of this experiment was to develop a rapid, cost-effective, and easy to use test to detect whether Lyme disease bacteria (*Borrelia burgdorferi*) are present in ticks. Antibiotic treatment for Lyme disease transmitted by the blacklegged tick (or deer tick, *Ixodes scapularis*) is effective but can have significant side effects. As the population and percentage of infected deer ticks is rising in Connecticut, the risk of infection is also increasing. This test can help give the patient a better idea on whether they should consult a doctor and begin treatment. The principle of the test is that of a competitive lateral flow immunoassay, where positive and control lines are used to give results. A positive test is represented by the absence of a colored line at the test line, and a negative test is represented with two colored lines. The test was conducted 17 times, including several failures from dilution errors, along with errors in the length of time between adding reactants, where reactants dried out too fast, stopping the continuation of the test. All but four tests proved successful, leading to the conclusion that the test can be accurate and reliable. Future applications would require concentrations and diluents to be changed and tested for the optimal ratio, as well as tests to find what is the minimum amount of *Borrelia* that the test can detect. This test also has several possible research applications, including the surveying of the number of infected ticks in a certain area.

Biography

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Top Winners in the 2018 Connecticut Science & Engineering Fair

(Student information as of April 2018)

Kavin Kathir, Grade 8

St. Bridget School, Cheshire, CT

Transforming Trash Into Treasure: A Sustainable Approach To Oil Spill Cleanup

Connecticut Science & Engineering Fair Awards

- * Pfizer Life Sciences Awards --- 3rd Place- Life Sciences 8th grade- \$100 & trophy and Invite to Compete Broadcom MASTERS
- * Environmental Sciences Awards with CACIWC --- MS Finalist - CACIWC gifts, CSF Medallion
- * Future Sustainability Awards - Eversource /energizeCT --- 2nd Place Middle School - \$200 Cash and Trophy
- * Alexion Biotechnology Awards --- Finalist - Biotechnology 8th grade - CSF Medallion
- * Office of Naval Research- U.S. Navy / U.S. Marine Corps --- Middle School- Certificate, \$25 gift card given by CSEF
- * Ricoh Americas Corporation --- Certificate, \$25 Amazon gift card given by CSEF
- * National Oceanic and Atmospheric Administration --- Certificate and medallion, ,and \$25 Amazon gift card given by CSEF
- * Southeastern New England Marine Educators --- \$100 award and membership in SENEME - 1st Place Junior & T-Shirt
- * Air and Waste Management Association, Connecticut Chapter --- \$100 Junior, Environmental Research, waste recycling related
- * TurnKey Compliance Solutions Environmental Awards --- \$200 Cash Award Middle School- For excellence in environmental sciences

Abstract

Oil spill cleanup is a colossal and pressing problem in our world today. About 1.5 million gallons of oil are spilled each year and millions of dollars are spent to cleanup the spilled oil. These spills also harm marine animals and pollute drinking water. Due to these detrimental environmental effects, cleaning up oil spill is imperative. Finding an effective method to combat these oil spills will greatly reduce the amount of damage and the cost of oil spill cleanup. The aim of this project was to test natural sorbents' oil retention under different conditions. The plant based biodegradable sorbents such as salvinia minima and milkweed were tested. The hypothesis was that milkweed fibers would be more effective for oil spill cleanup due to its hydrophobic, oleophilic nature and its tubular structure than salvinia minima. The sorbents' retentions were tested and compared in fresh water and salt water. In addition, milkweed was tested for recovery and reusability by recovering the adsorbed oil using a vacuum filter unit. Results from this study indicate that milkweed was a more effective sorbent than salvinia minima and could be reused multiple times. Milkweed is a biomass that has 'super power' of cleaning up oil spill up to 40 times of its weight. Hopefully, the results from this study will help to find an eco-friendly and cost effective solution for oil spill cleanup using natural, biodegradable sorbents that can preserve the world.

Biography

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Top Winners in the 2018 Connecticut Science & Engineering Fair

(Student information as of April 2018)

Khushi Parikh, Grade 8

Westside Middle School Academy, Danbury, CT

Image Recognition to Diagnose Lyme Disease

Connecticut Science & Engineering Fair Awards

- * Lockheed Martin Physical Sciences Awards --- 1st Place- Physical Sciences 8th Grade Ind.- \$300 & trophy, invite to compete Broadcom MASTERS
- * People's United Bank Mathematics Awards - with ATOMIC --- 1st Place Middle School- \$150 from ATOMIC, and Trophy, \$300 from People's United Bank
- * Petit Family Foundation Women in Science & Engineering Awards --- 1st Place- Middle School \$300 / trophy
- * CASE • PepsiCo Urban School Challenge Awards with IBM --- 1st Place Middle School - \$300 and Trophy, Medallion
- * Computer Science Awards --- 2nd Place Middle School - \$200, Trophy and Medallion
- * United Technologies Corporation Awards --- \$500 in UTC Common Stock, Plaque, Backpack, and Annual Report
- * Connecticut Academy of Science and Engineering Middle School Urban School Challenge Award --- Urban School Challenge 1st MS- \$250 Cash Award, Invite to attend CASE's Annual Meeting
- * Connecticut Science Teachers Association's Marty Tafel Student Research Award --- Physical Sciences 8th Grade - \$500 and invite to CSTA Award Banquet
- * Urban School Challenge 1st Place Middle School Awards --- Highest Placing 8th grader- GENIUS-Olympiad Competition -\$500 travel stipend
- * Maplesoft Awards for Applied Mathematics and Modeling --- Maple software - For Excellence in Mathematics

Abstract

The application of convolutional neural networks to detect the bullseye rash present after contraction of lyme pathogen B. Burgdorferi, is inspired by the 200% increase in reported Lyme Disease cases from the year 2015 to 2017. Using fine tuning procedures, vgg16, a deep learning network, was fine tuned through replacement of its fully connected layers and retraining of terminal neurons. The convolutional neural network was construed and overwritten in the language Python to achieve image recognition. Five variations of fine-tuned models were fabricated, each trained using a batch size differing by two units, to explore the effects of batch size on progressional validation accuracy. It was accurately postulated that a specific range of batch sizes would best distribute weights when faced with a linear regression problem. Batch sizes exceeding and preceding this range would be subject to variation surpassing boundaries of an optimization algorithm, in case of the former, or overfitting of weights in the case of the latter. Using 35 images per category for training, the number of backpropagation initializations range from 175 to 35 iterations. Batch sizes 2, 4, 6, or 175-59 weight updates, yield the greatest accuracy, 93.75%, 96.66% and 90.00% respectively. The effects of batch size on accuracy will vary depending on method of transfer learning, epoch size, and derivative of the loss curve. This model's interactions with images of clear skin and lyme rashes is a large epidemiologic and public health advancement; furthermore, promising potential translation to a software application distinctly accessible via phones.

Biography

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Top Winners in the 2018 Connecticut Science & Engineering Fair

(Student information as of April 2018)

Emma Ruccio, Grade 8

Talcott Mountain Academy, Avon, CT

Got Your Back

Connecticut Science & Engineering Fair Awards

- * UTC Aerospace Systems Engineering Awards --- 3rd Place- Engineering MS \$100 & trophy and Invitation Compete in Broadcom MASTERS
- * Alexion Biotechnology Awards --- 2nd Place- Biotechnology 8th grade- \$300 & trophy and Invitation Compete in Broadcom MASTERS
- * Henderson Award --- Certificate and \$25 Amazon Gift Card given by CSF
- * Robotics And Beyond Award for Excellence in Physics- High School and Engineering Design- Middle School --- Middle School- For Excellence in Engineering Design- \$200 for Robotics And Beyond STEM Design Academy

Abstract

Scoliosis is a condition wherein the spine curves, rotates, or collapses, affecting three out of every one hundred people worldwide. In many scoliosis cases X-rays are taken of the patient's spine with as little as three months between each, exposing the patient to enormous amounts of potentially harmful radiation. The other options for treatment, surgery and bracing, are just as, if not more costly. To help solve this issue, I started looking at other technologies to detect and monitor scoliosis curvature. Infrared radiation is a technology that is able to reveal soft tissue. I theorized that it might allow me to view an outline of the soft tissue surrounding the spine, which would have curved with it as the scoliosis developed. In order to conduct the experiment, I borrowed a Near Infrared ("NIR") camera from my school, and tested different variables with it. Reflectors of some sort can be used to reduce scattering and focus the Infrared, so I tried using mirrors and different types of tape, along with a NIR heating lamp. The results were better than I had expected, as the camera I used was not built specifically to reduce scattering. With different combinations and individual isolation of variables I was able to achieve effective results. In several cases a vague outline of the spine was present in my images. In the future, this could be applied to an invention I am working on that will use non-invasive and harmless technology in order to detect scoliosis curvature.

Biography