SPRING ENGINEERING + COMPUTING SHOWCASE
DUKE ENGINEERING

JANUARY 23, 2019

Student Projects

NanoMine: Online Platform of Materials Genome Prediction for Polymer Nanocomposites

Claire Lin	PhD	August 2021	Mechanical Engineering & Materials Science
Bingyin Hu	PhD	August 2021	Mechanical Engineering & Materials Science

Due to the complex mechanisms involved in nanocomposite formation and response, and the isolation of data sets from each other, both the fundamental understanding and the discovery of new nanocomposites is Edisonian and excruciatingly slow. We address this issue by the creation of a living, open-source data resource for nanocomposites. NanoMine is built on both a schema and an ontology to provide a robustness to the FAIR (findable, accessible, interoperable and reusable) principles. Nanomine also allows for the registration of materials resources, bridging the gap between existing resources and the end users and making those existing resources available for research to material community. The data framework together with the module tools like microstructure characterization and the FEA simulation tools forms the nanocomposite data resource. Searching and visualization tools are being developed for user to query, visualize, and compare their data with the existing data in our system for design purposes. Tools and models utilizing data sciences and optimization concepts are being developed with the goal of data-driven materials design.

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Field-driven Odor Modulation

Mariana Vasquex PhD May 2021 Electrical & Computer Engineering

There is an urgent human and environmental need to increase access to improved sanitation in developing countries. Effective sanitation systems and technologies need to be accessible, sustainable, and affordable. However, even when they are present, malodor nuisance remains a major risk factor in user adoption. Currently activated carbon or air fresheners are used to address the issue. These approaches have limited effectiveness as they try to mask or hide the smell and they do not apply to all malodor molecules. Here, we introduce Electrosmell™, an alternative solution using electrochemistry. Electrosmell™ focuses on the mitigation of the most common and prevalent odorant molecules in human waste. These molecules consist mainly of volatile, small carbon chains ending with functional groups such as carboxylic acids, aldehydes, alcohols, or ketones. A change in the molecular structure can significantly modify olfactory perception. Butyric acid, which has a rancid cheesy smell, and p-cresol, which has a phenolic tar smell, were used as case studies. For both molecules their corresponding more pleasant-smelling homologs were identified: butanal, and 4-hydroxybenzaldehyde. Electrochemical characterization and treatment results suggest that butyric acid, p-cresol solutions could be modified to more pleasant odorous compositions.

Biogenic Refinery Energy Analysis

August Frechette PhD May 2023 Mechanical Engineering & Materials Science

With funding from the Bill and Melinda Gates Foundation, Biomass Controls has created a biogenic refinery that has a primary function of converting fecal sludge to biochar. The funding for the refinery requires that the refinery be energy neutral or positive during steady state operation. Unfortunately, the refinery is incapable of meeting this requirement due to the high energy demand of external drying systems, which are required by the refinery to reduce the moisture content of incoming fecal sludge. In order to reduce energy required by the refinery, it is necessary to determine the optimal method for drying fecal sludge internal to the refinery. The analysis used in this case study, while specific to the refinery created by Biomass Controls, can be extrapolated to other biogenic waste processors.

Improving Visualization of Lesions in Cardiac Tissue by Increasing Ultrasound Elasticity Image Quality

Souhaila Noor Master May 2019 Biomedical Engineering

Acoustic Radiation Force Impulse (ARFI) ultrasound imaging creates 2-D images of tissue elasticity. The radiation force emitted by the ultrasound transducer acts on the tissue and causes a tissue displacement, which is inversely related with tissue elasticity. ARFI is used during cardiac interventional procedures such catheter-based radiofrequency ablation to determine whether the affected tissue region was completely necrotized. The complete necrosis of affected tissue is critical for the success of treatments of heart conditions such as atrial fibrillation and atrial flutter. The purpose of this project is to improve the quality of tissue elasticity imaging to allow for better visualization of lesions in heart tissue.

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Bundled CHEST Health App

Aparna Mohan Master December 2019 Master of Engineering Management

This project was done as a class project in the Software Quality Management Class. To build any software product that meets customer expectation of quality, the first phase which is of utmost importance in the software development lifecycle (SDLC) is requirements development. Elementos, an NGO working to improve child health in rural Mexico, needs to develop a mobile app CHEST (Child Health and Surveillance Tool) to provide child health data to health workers and help them manage their visits. In this project, broad and vaguely defined expectations of the customer were converted into a structured business requirement document consisting of user stories and detailed requirements; to serve as a starting point for the app development. Implementable suggestions to improve the impact and usability of the App were included.

Omnimoji – a Versatile and Cool Emoticon Generator

Ting Chen Master December 2019 Electrical & Computer Engineering

People use various prebuilt emoticons or animations in WeChat, SnapChat, Facebook, and more. Apple provided a feature called Memoji/Animoji which is customizable. Even with that, you sometimes cannot find the exact sticker that expresses your exact mood. Or let's say, you've seen a funny sticker somewhere before, and really want to find it again this time - it could be a long search before you get there. Sometimes you have an idea that you want to present in an unique way, but you really do not want to take out your drawing tablet or Photoshop. That is what I want to tackle in this project. Omnimoji APP has several major submodules, including but not limited to:

- GIF/APNG Viewer: allows you to playback those two animated graphic format on iOS
- Textimoji: get ruthless with Texticons in an emoticon fight
- Pickymoji: a collection of well-needed, one-touch emoticon modification features
- Pandamoji: Asian's trending 'pandaman' emoticons in your palm
- Animoji Converter: convert Apple's Animoji to a WeChat-friendly format

Command Shell

Yue Tu	Master	May 2020	Electrical & Computer Engineering
Yuefan Yu	Master	May 2020	Electrical & Computer Engineering
Jiaran Zhou	Master	May 2020	Electrical & Computer Engineering

This is a simplified version of a command shell developed in C++. It can accomplish the basic bash-like operation like prompt, exit, running programs by relative path, absolute path or command. It has built-in functions like cd, set, inc and export with variables. In addition, it supports pipes and redirection.

Online Ads Search Platform

Hanyu Xie	Master	December 2019	Electrical & Computer Engineering
Xu Zheng	Master	May 2020	Electrical & Computer Engineering

Search advertising is a method of placing online advertisements on web pages that show results to users from their search engine queries. Every website and application with a search engine can do search advertisement business. Inspired by Google Ads, we built an ad searching platform that takes thousands of product data as ads, selects ads for a given query and returns sorted ads based on ranking criteria.

We first developed a web crawler to scrape product data from Amazon using Java. We built query understanding model by applying Apache Lucene analyzer to remove redundant info and to tokenize the query. Then, we implemented query rewrite by word2vector using Spark to expand candidate ads pool. To choose the right ads for each user, we used simulated search log to train logistic regression model and gradient boosted trees to predict click-through-rate (CTR).

Data Analysis Pipeline for Review System

Ming Yang	Master	May 2019	Electrical & Computer Engineering
Naixin Yu	Master	May 2019	Electrical & Computer Engineering

Effectively analyzing customer review data is important. But it is not always an easy task for small businesses because of their lack of professional tools and specially trained staff. Our Review Data Analysis Pipeline was created to help them. It is designed as a web application so that users do not need to do any setup or install a package on their computers. By uploading JSON format review data and specifying the information they want to work on, we created a review database for them, which allow users to search for records and perform statistical analysis on the dataset. This project will be demoed with Yelp's review dataset.

Detection of Drivable Areas in Car Images

Ashwin Shankar Master May 2019 Electrical & Computer Engineering

This project is about the detection of drivable areas using Mask R-CNN. This can be used in conjunction with object detection algorithms for autonomous driving. The two types of drivable areas are direct lanes and alternate lanes. The dataset used for this was the Berkeley Deep Drive dataset.

Parallel Real-Time Path Planning using RRA* Algorithm

Steven Hua Master May 2019 Mechanical Engineering & Materials Science
Zhiwei Kang Master May 2019 Biomedical Engineering

We introduced a novel real-time path-planning algorithms RRA* with two parallel processing method to solve a robot evacuation problem and to achieve reasonable speed up. The robot evacuation problem describes a simulation scenario where all the robots are required to evacuate from the simulation domain within a set time. To achieve reasonable speedup running this simulation, two parallelism method domain decomposition and robot supervision were implemented for two versions of the simulation. Performance and scalability results are presented for Stampede, a petascale supercomputer. The parallelism method respectively achieved maximum around 50 and six times speed up running on up to 256 tasks on the Stampede supercomputer. Also, good weak scaling is achieved for both the parallelism method.

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Shared Parking System

Qing Lu	Master	May 2020	Electrical & Computer Engineering
Ziqi Pei	Master	May 2020	Electrical & Computer Engineering

Due to the difficulty of finding a convenient and cheap parking space, our group designed a system that parking's owners can share their private parking space with people in need to get profit. We designed an App and parking locker, which can turn off when the car comes in and out when car out. It is also equipped with reservation, navigation and charging functions.

Deep Learning Microscopes for Efficient Malaria Detection

Amey Chaware	Master	May 2020	Electrical & Computer Engineering

This project presents an imaging system that simultaneously captures multiple images and automatically classifies their content to increase detection throughput. The optical design consists of a set of multiple lenses that each image a unique field-of-view onto a single image sensor. The resulting "overlapped" image exhibits reduced contrast, but includes measurements from across a proportionally larger viewing area. This overlapped image is then post-processed with a deep convolutional neural network to classify the presence or absence of certain features of interest. We examine the specific case of detecting the malaria parasite within overlapped microscope images of blood smears. It is demonstrated that it is possible to overlap 7 unique images onto a common sensor while still offering accurate classification of the presence or absence of the parasite, thus offering a 7x potential speed-up for automated disease diagnosis with microscope image data.

Simulation of Command Shell in C++

Jingru Gao Master May 2020 Electrical & Computer Engineering

The command shell project is a course project which can act as a bash. The shell can take arguments separated by arbitrary white space, and also treat with relative or absolute path. It has built in commands such as “cd”, “set”, and “inc”, which works as real shell and can set a new variable, increase the value of variable. The shell can have redirection as well, including input, output and error redirection. Making use of function abstraction was good for me to keep a clear mind of the entire process. I realized the basic function first and then went into different small pieces to improve the details. To test with different functionalities of the program, I wrote test cases for each part in order, which also helped for fixing bugs and handling errors.

Resiliency

Deyang Wang Master May 2019 Electrical & Computer Engineering
Zhizhou Zhang Master May 2019 Electrical & Computer Engineering

Currently, at Duke, seminars on resilience and burnout are offered to medical practitioners. We need an app to help the practitioners access the newest information that can help them combat with burnout. Thus, we build a Twitter-like app where the coach can provide instructions to group members, and members can post and share their thoughts.

Design and Implementation of Numerical Methods in C++

Burak Gunay Master December 2019 Electrical & Computer Engineering

This project has been done as the final project of a course I've taken last term, Programming, Data Structures and Algorithms in C++. I developed various numerical methods to create a 'calculator from the command line', where the user has the flexibility to create convoluted functions, save them and use them inside other functions as well. The first part of the project was to implement creating new functions and testing values. Major part of the work has gone into parsing the functions and ensuring sensible inputs were provided. Afterwards, the second task was to engineer a 'numerical method integration', where the integral value of a given curve is calculated by thousands of tiny trapezoids. The caveat here was that it does not have to be a single variable, as it can be 10, 100 or even 1000. Final part of the project was to implement Monte Carlo integration, where the integration is calculated pseudo-randomly over many iterations, then the average is taken.

Autonomous Battery Hot-swapping Station

Cheng Lyu	Bachelor	May 2019	Computer Science Statistical Science Electrical & Computer Engineering
Yao Yuan	Bachelor/Master	May 2020	Electrical & Computer Engineering Computer Science

In this project, we created a mechanism that makes swapping of battery easier for automation and doesn't cut power during the process, which is very useful for digital systems. We built a prototype of the swapping mechanism and proved that the mechanism worked. Then we automated the swapping process with a CNC framework and computer vision as a proof of concept of autonomous swapping.

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Hydrogen Drone

Bataung Mohapi	Bachelor	May 2019	Mechanical Engineering
Yao Yuan	Bachelor/Master	May 2020	Electrical & Computer Engineering Computer Science

In this project, we are building one of the world's first prototype of a small-scale drone powered by hydrogen cell. There are many challenges in terms of hydrogen storage, power regulation and limited power budget. We hope to prove that this is possible at small-scale by building a working prototype. By gathering experimental data, we also want to extrapolate and study the practicality of hydrogen-powered drone at larger scales.

Synterface: Efficient Chip-to-World Interfacing for Flow-Based Microfluidic Biochips

Aditya Sridhar	Bachelor	May 2019	Electrical & Computer Engineering Computer Science

Flow-based microfluidic biochips can be used to perform bioassays by manipulating a large number of on-chip valves. The work addresses chip-to-world interfacing, which requires the use of off-chip control equipment to provide control signals for the on-chip valves. As chips get more complex, the number of valves increases, and off-chip overhead overwhelms the biochips due to the required additional control. To address the interfacing problem, I present my research on an efficient pin-count minimization synthesis solution which uses on-chip microfluidic logic gates and optimization based on concepts from linear algebra.

Collaborative Augmented Reality

Michael Glushakov Bachelor May 2021 Electrical & Computer Engineering
Computer Science

The aim of the project is to allow collaboration between multiple users when placing virtual objects on the screen. The project consists of two parts: an Android application and a server that stores virtual objects created by users in the cloud.

3D Printing Custom Pads for Athletics

Clark Bulleit Bachelor May 2019 Biomedical Engineering
Kevin Gehsmann Bachelor May 2019 Mechanical Engineering
Tim Skapek Bachelor May 2020 Mechanical Engineering

This season, when one of our teammates on the Duke Football team broke his collarbone, we were approached by our athletic trainer to see if we could apply the 3D printing technology we had been working with to create a custom-fit pad unique to this injury. We went through an iterative design process that included a 3D scan, reverse engineering to create a suitable CAD model, prototyping of the pad (custom molded to the torso), and finally a print using quality material on the Innovation CoLab's Polyjet printer. Our teammate wore this clavicle pad for the rest of the season- practice and games- and has remained uninjured ever since. We have applied the process to other injuries and pad location and are continuing our research to include a layer of energy absorption, with either a lattice structure or cutting-edge foams.

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Duke Electric Vehicles

Gerry Chen	Bachelor	May 2019	Electrical & Computer Engineering Mechanical Engineering
Yukai Qian	Bachelor	May 2021	Mechanical Engineering
Will Smith	Bachelor	May 2021	Mechanical Engineering & Materials Science
Jiwoo Song	Bachelor	May 2020	Mechanical Engineering & Materials Science
Shomik Verma	Bachelor	May 2019	Mechanical Engineering

The Duke EV team recently broke the world record for world's most fuel-efficient vehicle. We will showcase some of the innovations that led us to break the record, as well as the improvements we're currently pursuing.

Autonomous Underwater Vehicle - Duke Robotics Club

Neil Dhar	Bachelor	May 2020	Electrical & Computer Engineering
David Miron	Bachelor	May 2021	Electrical & Computer Engineering Computer Science
Samuel Rabinowitz	Bachelor	May 2021	Electrical & Computer Engineering Computer Science
Joseph Saldutti	Bachelor	May 2020	Electrical & Computer Engineering

The Duke Robotics Club is a student-run organization in the Pratt School of Engineering. Our mission is to provide Duke undergraduate and graduate students a place to pursue their interest in robotics by working on high-impact, large-scale robotics projects and competitions. We currently primarily focus on designing and building an autonomous underwater vehicle that is capable of completing an obstacle course without any human input as an entry in the International Robosub Competition