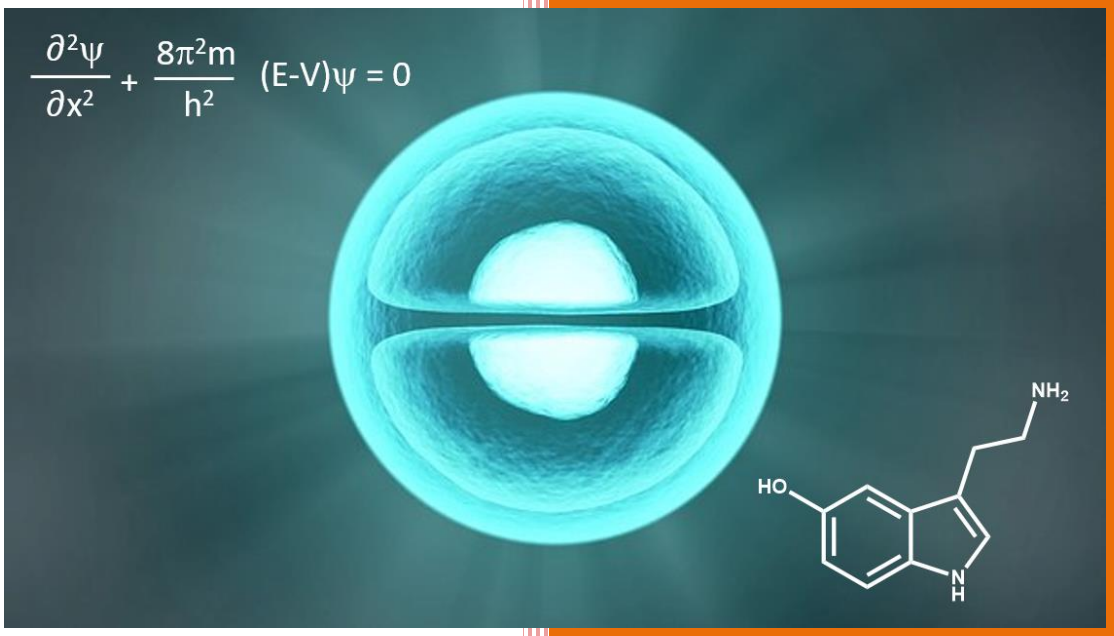
AUBURN
MONTGOMERY

2019

Undergraduate Research Symposium



Hosted by: College of Sciences

Auburn University at Montgomery
College of Sciences
Undergraduate Research Symposium

April 5, 2019

Table of Contents

Abstracts

The Auburn Montgomery College of Sciences

Presents

The 2019 Undergraduate Research Symposium

On behalf of the students, their parents, staff and faculty of the College of Sciences, we welcome you to the annual Undergraduate Research Symposium! Science is the art of producing new knowledge and scientists are the people who pursue that knowledge. The purpose of research at an educational institution is to convert students of science into scientists and scholars. That challenge is often hard and painstaking but if it were easy, we would call the process of creating new knowledge *search* instead of ***re****search*. The students we are celebrating today have taken it upon themselves to undertake that conversion. I hope you will join me in congratulating these students and that you enjoy what they have produced.

Dr. Robert M. Granger, II
Dean of the College of Sciences

Undergraduate Research Committee

Ann Marie O'Neill – Biology
John Hutchison – Chemistry
Eunyoung Kim – Communication & Theatre
Jerome Goddard II – Mathematics & Computer Science
Greg Ciesielski – Chemistry

Schedule of Events

11:45 am – 12:15 pm	Registration Goodwyn Hall Lobby
12:15 pm – 12:30 pm	Opening Remarks Goodwyn Hall 109
12:30 pm – 1:00 pm	Lunch (provided) Goodwyn Hall Lobby
1:00 pm – 2:00 pm	Poster Session I (lunch continued) Goodwyn Hall Lobby
2:00 pm – 3:00 pm	Oral Presentation Session Goodwyn Hall 109
3:00 pm – 4:00 pm	Poster Session II Goodwyn Hall Lobby
4:30 pm	Awards Ceremony and Closing Remarks Goodwyn Hall 109

Poster Session I

1. Cloning, expression and purification of human mitochondrial molecular chaperone Tid1

   Thinh Truong Mentor: Greg Ciesielski
   Department: Chemistry

2. A GPU Based Circle Detection Algorithm in 2D Space

   Alexander Mears Mentor: Semih Dinc
   Department: Mathematics and Computer Science

3. Investigating the role of insulin resistant adipocytes in the proliferation of cancer cells

   Martin Eastwold Mentor: Ann Marie O'Neill
   Department: Biology and Environmental Science

4. Comparative Production of Biomass-Hydrolyzing Enzymes of Trichoderma SG2 by Submerged and Solid-Substrate Fermentation

   Hydenia Boswell and Crystal Murry Mentors: Benedict Okeke and Yi Wang (AU)
   Department: Biology and Environmental Science

5. GPU Based Hyperspectral Image Classification

   Eddie Lindsey Mentor: Semih Dinc
   Department: Mathematics and Computer Science

6. Scalable Reusable Adsorption Matrix Assemblage (S-RAMA) for Water Purification

   Jada Mack and Kennedy Smith Mentor: Benedict Okeke
   Department: Biology and Environmental Science

Oral Presentation Session

2:00 pm Obesity may lead to increased survivin levels in tumors

Elizabeth Smith

Mentor: Ann Marie O'Neill
Department: Biology and Environmental Science

2:20 pm Cloning, expression and purification of human mitochondrial molecular chaperone Tid1

Emily Morgan

Mentor: Greg Ciesielski
Department: Chemistry

2:40 pm Don't blow out the candles – preventing transmission of bacteria to birthday cakes

Natalie Donohoe and Caitlyn James

Mentors: Ann Marie O'Neill and Clark Danderson
Department: Biology and Environmental Science

Poster Session II

1. A GPU Based 2D Point Triangulation Algorithm

   Brandon Litzinger Mentor: Semih Dinc
   Department: Mathematics and Computer Science

2. Aqueous Reduction of Divalent Mercury with Hydroquinone

   Skyler Chandler Mentor: Emma Si
   Department: Chemistry

3. Math Promotion Through AR Gaming Environment by using Google's TensorFlow

   Matthew Little and Ali Yildirim Mentor: Enoch Lee
   Department: Mathematics and Computer Science

4. GPU Based Gradient Descent Minimization

   Surya Chigurupati Mentors: Semih Dinc and Tianran Chen
   Department: Mathematics and Computer Science

5. Preliminary Evaluation of Bacillus species M13 and T21 for Degradation of Macromolecules

   Ryan Loomis and Chyna Woods Mentor: Benedict Okeke
   Department: Biology and Environmental Science

6. A Dynamic Programming based Outlier Rejection Algorithm for Image Mosaicing Problem

   Christopher Smith Mentor: Semih Dinc
   Department: Mathematics and Computer Science

7. The Diels-Alder reaction between anthracene and maleic anhydride: Use of NMR for the analysis

   JaVirous Grant Mentor: Daniel Kim
   Department: Chemistry

Abstracts

Poster 1 (session I)

Cloning, expression and purification of human mitochondrial molecular chaperone Tid1

Lead Presenter: Thinh Truong

Other Authors/Presenters: Emily Morgan, LaQuandra Buckhannon, and Carolina De Bovi Pontes

Mentor: Grzegorz Ciesielski

Department: Chemistry

Molecular chaperones play an important role in the folding and maintenance of the cellular proteome. Tid1 is a mitochondrial Hsp40 chaperone involved in mitochondrial import and folding of proteins within the mitochondrial matrix. Additionally, Tid1 has been found to co-localize with mitochondrial nucleoids and to interact directly with the catalytic subunit of mitochondrial DNA polymerase gamma (Pol γ), which facilitates the mitochondrial DNA replication process. Homologous Hsp40 chaperones have been found relevant for DNA replication processes in prokaryotes and viruses. The goal of our research is to investigate the putative role of Tid1 in the human mitochondrial DNA replication process.

Here we present results of cloning, expression and purification of Tid1. We amplified two splice variants of Tid1, Tid1S and Tid1L, using PCR. Next, we inserted the target sequences into the pETite N-His SUMO vector applying the Expresso® T7 SUMO cloning and expression system. Target proteins were produced in Escherichia coli Hi-Control BL21 (DE3) cells and purified using nickel (NiNTA) affinity chromatography. In the future, we will evaluate the direct interaction of Tid1 isoforms with the subunits of the Pol γ holoenzyme, as well as test whether the presence of Tid1 isoforms affects the catalytic properties of Pol γ.

Poster 2 (session I)

A GPU Based Circle Detection Algorithm in 2D Space

Lead Presenter: Alexander Mears

Other Authors/Presenters: Eric Graham and Sundeep Penkay

Mentor: Semih Dinc

Department: Mathematics and Computer Science

Shape detection is an important problem of image processing applications. Real life objects are usually recognized by their particular shapes or a set of shapes, such as lines, squares, circles, or ellipses. In such a problem, keypoints (2D image coordinates) of a parametric shape in the image is extracted. Then using detection algorithms, these points are matched with an exact size of shape parameters. In a typical application, there may be hundreds or thousands of points, which may not be suitable solution for a single processor implementation.

In this study, we plan to solve this problem with a GPU, where thousands of concurrent threads can significantly reduce the processing time. Finally, although this idea can be applied to any parametric shape, in this poster, we study of detection of circular shapes. Since our focus is the detection algorithm, we simplify the problem to only detection part. We assume there are a set of 2D points in 2D Cartesian space, and we target to detect the circular shape using our GPU based algorithm.

Poster 3 (session I)

Investigating the role of insulin resistant adipocytes in the proliferation of cancer cells.

Lead Presenter: Martin Eastwold

Other Authors/Presenters: Bulbul Ahmed

Mentor: Ann Marie O'Neill

Department: Biology and Environmental Science

While convincing epidemiological evidence links obesity to increased cancer growth, the underlying molecular mechanisms remain elusive. Metabolic dysfunction, characterized by insulin resistance, frequently accompanies obesity. In adipocytes, this causes altered cell secretions and increased inflammation. Changes in the secretions from such adipocytes may push cancer cells to a more aggressive phenotype. Recent studies have investigated the role of adipocyte secretions as potential mediators of accelerated growth. The goal of this project is to investigate if secretions from insulin resistant adipocytes leads to increased proliferation of cancer cells, and if this proliferation is, in part, attributable to changes in fatty acid oxidation (FAO) pathways.

The cell line 3T3-L1 was differentiated and rendered insulin resistant by the addition of TNF-α and subjecting the cells to hypoxic conditions for 24 hours, and media collected. Canine melanoma (CML10) and mammary tumor (CMT28) cell lines were incubated in the presence of conditioned media obtained from normal adipocyte cultures or insulin resistant adipocyte cultures. After 24 hours, cell viability was assessed and quantitative PCR performed to determine expression of Ki67 and PCNA as markers of proliferation, and the genes CPT1, ACOX, ASCL1, SLC27A4 and CD36 to investigate potential differences in FAO. The mammary tumor cell line CMT28 showed increased proliferation in response to insulin resistant media by both cell count and increased expression of Ki67 and PCNA. Also, expression of CPT1, ACOX, ASCL and CD36 was increased in these cells in response to media obtained from insulin resistant adipocytes.

These results indicated that secretion from insulin resistant adipocytes increased tumor cell proliferation and resulted in upregulation of genes in the FAO pathway. This suggests the cells are using fatty acids as source of fuel, and this may contribute to increased proliferation.

Poster 4 (session I)

Comparative Production of Biomass-Hydrolyzing Enzymes of Trichoderma SG2 by Submerged and Solid-Substrate Fermentation

Lead Presenters: Hydenia Boswell and Crystal Murry

Other Authors/Presenters: None

Mentors: Benedict Okeke and Yi Wang (AU)

Department: Biology and Environmental Science

Solid State or Solid Substrate Fermentation (SSF) is a "low moisture" fermentation process conducted at near absence of free water in organic substrates; thus simulating natural soil environment for organisms such as fungi. There are advantages of SSF over conventional submerged fermentation (SF) process. SSF has been used traditionally in the manufacture of foods and has been gaining attention as a simple and cost-efficient fermentation technology for producing important bioproducts including enzymes, food and biochemicals. SSF has other biotechnological advantages such as large-scale fermentation capacity, higher end-product stability, lower catabolic repression, less complex process control of parameters, reduced fermentation waste water, absence of foam nuisance and lower energy requirement. SSF has the potential to reduce the cost of bioethanol production from lignocellulose biomass.

This study compared production of biomass hydrolyzing enzymes by SF and SSF of mixtures of switchgrass and waste copy paper. In SF, a combination waste paper powder and pulverized switch grass powder proved most efficient for production of cellulase, xylanase, beta-glucosidase and beta-xylosidase. SSF using combinations of switchgrass and waste copy paper is in progress.

Poster 5 (session I)

GPU Based Hyperspectral Image Classification

Lead Presenter: Eddie Lindsey

Other Authors/Presenters: Jared Jordan and Lyle Hodnett

Mentor: Semih Dinc

Department: Mathematics and Computer Science

Conventional color cameras can capture limited portion (visible light) of the electromagnetic radiation. The output of these cameras is a digital image having three major color bands RGB (red, green, and blue). This means, every pixel in the image contains three values (or spectral features) that could be utilized in detection or classification problems. Having only three spectral features for a pixel may not be sufficient for accurate classification, therefore, spatial features (rather than spectral features) of the pixels (edges, corners, lines, etc.) are preferred in traditional image processing applications.

Using Hyperspectral images, exploiting the spectral features of the scene is a powerful alternative for classification problems. Spectral imaging sensors (or Hyperspectral cameras) can capture a much larger portion on the spectrum with higher spectral resolution (or number of spectral bands), when compared to the conventional cameras. A pixel on the image can be represented by hundreds of features, which are collected from different wavelengths or material reflectance. This naturally yields a large size data, which is not very practical for single processor implementations.

In this poster, we study Hyperspectral image classification with the KNN (K-nearest neighbor) model using GPUs, which allows to process large size of data with thousands of threads running simultaneously. With this study, we target to achieve much smaller processing time compared to CPU implementation.

Poster 6 (session I)

Scalable Reusable Adsorption Matrix Assemblage (S-RAMA) for Water Purification

Lead Presenters: Jada M. Mack and Kennedy A. Smith

Other Authors/Presenters: Ryan Loomis, Thinh Truong, Daniel Warren, Chyna Woods, Jasmine Walker, and Daveenyah A. Primm

Mentor: Benedict Okeke

Department: Biology and Environmental Science

Lack of potable water is a world-wide problem, especially in developing countries and some rural areas of developed countries. Available water can be impaired by microbial and chemical contamination and hence not fit for drinking. Outbreaks of water-borne diseases due to poor water sanitation is high. Many schools across the globe lack access to safe water exposing vulnerable young children to water-borne diseases. Hence there is urgent need to develop affordable water purification devices that would be useful to local communities and for emergency situations in the field.

Our study focused on the initial steps of developing and constructing a reusable adsorption matrix assemblage that can be deployed for water purification in the field or in an emergency situation; and scalable for large volume water purification. The prototype water filter consists of four layers of media in ordered array: rocks, gravel, fine sand and charcoal. Initial study on its potential pathogen removal capacity using Colilert revealed major removal of indicator organisms from heavily polluted pond water and suggests the filter can be optimized for efficient water purification. The device is unique in that it is cost effective, reusable, scalable, easy to use and field deployable. Furthermore, the prototype water filter provides a unique method of assessing pathogen removal efficiency of different media in ordered array. Further studies will focus on improving pathogen removal efficiency, scale up and a biosensor method for testing effluent water purity in real time.

Talk 1 (oral presentation)

Obesity may lead to increased survivin levels in tumors

Lead Presenter: Elizabeth Smith
Other Authors/Presenters: None
Mentor: Ann Marie O'Neill
Department: Biology and Environmental Science

Currently in the US, obesity is at epidemic levels with two thirds of the adult population overweight or obese. Obesity is associated with an increased risk of developing a number of diseases, including cardiovascular disease and type 2 diabetes. What is now known is that obesity increases the risk of a number of cancers, including colon, prostate, breast and ovarian. Obesity often results in aggressive tumor growth, reduced efficacy of chemotherapy and increased growth of drug resistant tumors. Previous research has indicated that the anti-apoptotic protein survivin that is not expressed in differentiated tissues is present in tumor cells and fat from obese patients. The goal of this project was to investigate if the expression of Birc5, the gene that codes for survivin, is increased in tumors grown in fatty animals.

cDNA obtained from a previous study, where HT29 human colon cancer tumors were orthotopically implanted and grown in both lean mice that were fed a high fat western diet or mice rendered obese by a high fat diet, was used for these experiments. The relative expression of PCNA, as a marker of proliferation, and Birc5 was compared between the two groups using quantitative PCR. Initial indicate that while PCNA expression was increased in the tumors from the obese group, this was not significant however, expression of Birc5 was significantly increased in tumor tissue from obese mice compared to lean.

These results indicated that Birc5 expression is increased in HT29 colon cancer cells, and obesity results in increased expression. This data suggests that the subsequent higher levels of the anti-apoptotic protein survivin may to the more aggressive growth of tumors observed in the obese.

Talk 2 (oral presentation)

Cloning, expression and purification of human mitochondrial molecular chaperone Tid1

Lead Presenter: Emily Morgan

Other Authors/Presenters: LaQuandra Buckhannon, Carolina De Bovi Pontes, and Thinh Truong

Mentor: Grzegorz Ciesielski

Department: Chemistry

Molecular chaperones play an important role in the folding and maintenance of the cellular proteome. Tid1 is a mitochondrial Hsp40 chaperone involved in mitochondrial import and folding of proteins within the mitochondrial matrix. Additionally, Tid1 has been found to co-localize with mitochondrial nucleoids and to interact directly with the catalytic subunit of mitochondrial DNA polymerase gamma (Pol γ), which facilitates the mitochondrial DNA replication process. Homologous Hsp40 chaperones have been found relevant for DNA replication processes in prokaryotes and viruses. The goal of our research is to investigate the putative role of Tid1 in the human mitochondrial DNA replication process.

Here we present results of cloning, expression and purification of Tid1. We amplified two splice variants of Tid1, Tid1S and Tid1L, using PCR. Next, we inserted the target sequences into the pETite N-His SUMO vector applying the Expresso® T7 SUMO cloning and expression system. Target proteins were produced in Escherichia coli Hi-Control BL21 (DE3) cells and purified using nickel (NiNTA) affinity chromatography. In the future, we will evaluate the direct interaction of Tid1 isoforms with the subunits of the Pol γ holoenzyme, as well as test whether the presence of Tid1 isoforms affects the catalytic properties of Pol γ.

Talk 3 (oral presentation)

Don’t blow out the candles – preventing transmission of bacteria to birthday cakes

Lead Presenters: Natalie Donohoe and Caitlyn James

Other Authors/Presenters: Autumn Jones and Omar Brito-Estrada

Mentors: Ann Marie O’Neill and Clark Danderson

Department: Biology and Environmental Science

A previous study demonstrated that blowing out candles on a birthday cake can transfer bacteria to the surface of the cake. An engineer developed a child-friendly device that included a filter and would allow a child to blow through it onto a birthday cake but prevent the transfer of bacteria. We were approached to develop a series of experiments to evaluate the performance of the device.

Using tryptic soy agar plates, we observed the amount of bacteria that was transferred from the mouth by mimicking blowing out birthday candles directly onto an agar plate, through a device without a filter and through a device fitted with a filter. For all 3 conditions, plates were held approximately 10 – 15 cm away from the mouth. We then further tested the stringency of the device by using an aerosol of E coli suspension, which was blown through the device and then air blown through for 3-4 seconds with the air source approximately 12 -15 cm from the tryptic soy agar plates. To determine if the device would perform with repeated uses, they were washed in hot, soapy water and the tests repeated.

The results of these tests confirmed that bacteria are transferred from the mouth to a surface when it is blown on. However, using the filtered device almost eliminated this transfer, while use of the unfiltered device substantially reduced and, in some cases, eliminated the transfer. When using an aerosol of E coli, the transfer of bacteria through the filtered device was also reduced to approximately 8% of that transferred through an unfiltered device. These results suggest that the filtered device substantially blocked the transfer of E coli, and when used to mimic blowing out birthday candles by mouth both the filter and the design of the device contribute to the reduction of transferred bacteria.

Poster 1 (session II)

A GPU Based 2D Point Triangulation Algorithm

Lead Presenter: Brandon Litzinger

Other Authors/Presenters: None

Mentor: Semih Dinc

Department: Mathematics and Computer Science

The point triangulation is the process of generation of a set of triangles using a set points in the Cartesian coordinate space. Although this is originally part of a computational geometry problem, it is mostly known in the computer graphics applications, where a set of 3D points of an object is triangulated to create faces (surfaces) of that object in 3D space. Today the triangulation is a major step of computer games and 3D visualizations. And it is a challenging problem since a typical 3D model has thousands of key points. Finding the triangular surfaces of that high-resolution model is a very time-consuming task for a single processor implementation.

In this poster, we plan to solve a simplified version of the triangulation problem in 2D space, where all input points are two dimensional. We study a GPU based algorithm to generate triangles from a set of 2D points. Using the GPU implementation, we target to solve the problem in more efficient way compared to a single processor CPU implementation.

Poster 2 (session II)

Aqueous Reduction of Divalent Mercury with Hydroquinone

Lead Presenter: Skyler Chandler

Other Authors/Presenters: None

Mentor: Emma Si

Department: Chemistry

Mercury is one of most toxic metals of global importance because methylmercury could bioaccumulate and biomagnify through the aquatic food web. Previous studies suggested that many divalent mercury (Hg(II)) compounds can be decomposed in the presence of sunlight, in the gaseous and aqueous phase. Quinone moieties are common in in aquatic systems and have been studied in the reduction of other metals such as Fe(III). However, no systematic experimental study has been performed on the aqueous chemical reaction of Hg(II) with hydroquinone at near environmental conditions.

We hereby propose the first kinetic and product study on the photochemistry of oxidized mercury species with hydroquinone in aqueous phase. UV-vis and Fluorescence spectroscopy will be used to study the kinetics of the reactions. The amount of gaseous mercury, Hg(0), produced by the reaction will be measured by cold vapor atomic spectroscopy (CVAFS). The effect of pH, light, presence of dissolved oxygen, and concentration of chloride ion (Cl-) on the reaction rates will be investigated using fluorescence spectroscopy and CVAFS.

We herein present our preliminary results on the complexation between Hg(II) and hydroquinone using UV-vis spectrophotometer as well as the reaction kinetics in the dark using fluorescence spectroscopy.

Poster 3 (session II)

Math Promotion Through AR Gaming Environment by using Google's TensorFlow

Lead Presenters: Matthew Little and Ali Yildirim

Other Authors/Presenters: Zane Blume-Babcock, Jordan Johnson, and Eddie Lindsey

Mentor: Enoch Lee

Department: Mathematics and Computer Science

Machine learning can be used to automate many tasks. From search engine recommendations to gadgets like amazon echo, to self-driving cars we can see their uses in many different aspects of our daily lives.

This presentation will showcase a math game targeted towards elementary to middle school students. This game is meant to dissuade the aversions most kids seem to have towards math, by promoting an immersive experience through the use of augmented reality (AR) via artificial intelligence (AI) based object detection. The project was designed to incorporate object detection to a game using Google TensorFlow. Using deep learning, we create a model to recognize hands by training it with a sample set of more than 13000 images. This object detection model allows a computer to track human hands using a camera and uses hand positioning to control a game interface in a simple and intuitive way.

To illustrate our approach, we implement a “24 game.” The game uses a camera, and the player uses their hand to select a number or operator and solve the problem. By creating such an experience, students should be inspired to actively hone their mathematical skills in the game the same way they would seek to level up their character's skills in a traditional game.

Poster 4 (session II)

GPU Based Gradient Descent Minimization

Lead Presenter: Surya Chigurupati

Other Authors/Presenters: Emily Cosgrove and Ronald Atwell

Mentors: Semih Dinc and Tianran Chen

Department: Mathematics and Computer Science

Minimization problems --- the type of mathematical questions involving making certain quantities as small as possible --- is the theoretical underpinning of many concrete problems in machine learning. A simple yet powerful method for solving minimization problems is the "gradient descent" method. It is the mathematical equivalence of an excitement seeking skier descending from a mountain, always finding the steepest slopes. One disadvantage is its inefficiency. However, recent developments in massively parallel computing architectures unleashed new possibilities. In this study we combine new tools from GPU-computing with this classical method and apply them to real world problems.

Poster 5 (session II)

Preliminary Evaluation of Bacillus species M13 and T21 for Degradation of Macromolecules

Lead Presenter: Ryan Loomis and Chyna Woods

Other Authors/Presenters: Felix Toussaint, Daniel Warren, Jada M. Mack, Kennedy A. Smith, Thinh Truong, Jasmine Walker, and Daveenyah A. Primm

Mentor: Benedict Okeke

Department: Biology and Environmental Science

Microbial biocatalysts such as cellulase, xylanase (a hemicellulase), protease, amylase and lipase have numerous biotech applications. In the past decade there has been increasing application of microbial biocatalysts as cleaning agents for breakdown of macromolecules to monomers. Currently, microbial cleaning products are being used in domestic, commercial, industrial, and recreational settings. When used as additives in chemical cleaning products such as detergents, the quantity of chemicals can be reduced. Microbial biocatalysts are benign to the environment, biodegradable, and renewable. We had screened over 50 microbial isolates from soil and selected two strains for production of mixtures of biocatalysts for degradation of macromolecules and for potential application in cleaning. Interestingly Bacillus species M13 and T21 produced a wide range of biotechnologically useful biocatalysts. This study presents preliminary evaluation of degradation of macromolecules by Bacillus species M13 and T21 biocatalysts.

Poster 6 (session II)

A Dynamic Programming based Outlier Rejection Algorithm for Image Mosaicing Problem

Lead Presenter: Christopher Smith

Other Authors/Presenters: Jared Jordan and Lyle Hodnett

Mentor: Semih Dinc

Department: Mathematics and Computer Science

Image mosaicing is a challenging problem when there is one (or more) corrupted image in the input sequence. Since the transformation of later images rely on the previous transformation calculations, one miscalculation error caused by the corrupted image propagates to other image transformations, which fails the process.

It is not a trivial task to detect and remove these corrupted images (outliers). We propose an outlier rejection algorithm based on dynamic programming which can identify and remove the corrupted image(s) from the sequence and generate correct mosaic image. Inspired by the dynamic programming approach, our algorithm stores previously calculated transformations in a 2D array and selects the values of composite transformations by applying our decision criteria. These criteria identify the transformations derived from corrupted images by comparing the values of a new composite transformation with an equivalent transformation calculated by matrix multiplication of pre-existing transformations from the 2D array.

Our experiments on both synthetic and real datasets show that the proposed algorithm is an efficient tool for the mosaicing problem. Our algorithm successfully rejects solitary corrupted images in a set, multiple corrupted images (either adjacent or non-adjacent), and alternating corrupted (corrupted, non-corrupted, corrupted) images. The output mosaic image of our algorithm on synthetic dataset is compared with the ground truth image. Visually satisfactory results are achieved with a high PSNR (Peak Signal-to-Noise Ratio).

Poster 7 (session II)

The Diels-Alder reaction between anthracene and maleic anhydride: Use of NMR for the analysis

Lead Presenter: JaVirous Grant

Other Authors/Presenters: None

Mentor: Daniel Kim

Department: Chemistry

The Diels-alder reaction takes place between electron rich 1,3-diene and electron poor dienophile. The result of the Diels-alder reaction is the formation of a six-membered cyclic ring through a cyclic transition state. A reaction was run with a mixture of anthracene and maleic anhydride. The clean reaction product was proven the result of the Diels-Alder reaction. The NMR results of proton NMR, C-13 NMR, and 2-D COSY NMR will be presented with the explanation of background pi molecular orbit theory.