Mechanical Engineering Mentored Research

PROJECT TITLE:

Inverted Droplet Ejection via Electrowetting

NAME OF THE LAB:

The Discrete Microfluidics Laboratory (DMFL)

DESCRIPTION OF THE RESEARCH LAB OR RESEARCH GROUP:

In the DMFL, we study microscale droplets. Physics at this scale is a little different than in larger systems, because area forces such as surface tension tend to dominate over body forces. Within a single droplet the interactions among the fluid, suspended particles, the surface beneath, and the surrounding environment are highly coupled and complex. Our goal is to understand these interactions and leverage the physics of microdroplets to develop innovative microfluidic solutions for a variety of applications. Current focuses include using electric fields to control particle deposition in evaporating droplets, developing digital microfluidic (DMF) devices to assemble protein chains for DNA synthesis, and developing 3D DMF devices capable of complex routing operations.

DESCRIPTION OF THE RESEARCH PROJECT:

This project seeks to examine how droplet ejection via electrowetting is impacted by orientation. This process is critical for 3D DMF devices, as it allows droplets to be transferred between opposite plates. Previous experiments in the DMFL have examined ejection of a droplet upward into the air from a device. Here, pendant droplets will be ejected downward. The student will have the opportunity to develop a modified experimental setup for inverted actuation and then use it to eject droplets. Results will then be compared previously collected non-inverted data.

SKILLS NEEDED

General skills: Communication, critical thinking, curiosity
Major(s): Any

SKILLS TO BE DEVELOPED

This project will allow students to experience firsthand what working in an academic research lab is like. In addition to designing and performing experiments, students will also be able to improve their technical writing and speaking as they report on their progress and ultimately present their findings.

CONTACTS

PhD Mentor – Xi Li, xl1832@mail.rit.edu
Faculty Sponsor – Dr. Michael Schertzer, mjseme@rit.edu

Mechanical Engineering Mentored Research

PROJECT TITLE:

Digital DNA Synthesis (Digital Microfluidic Lab on a Chip)

NAME OF THE LAB:

The Discrete Microfluidics Laboratory (DMFL)

DESCRIPTION OF THE RESEARCH LAB OR RESEARCH GROUP:

In the DMFL, we study microscale droplets. Physics at this scale is a little different than in larger systems, because area forces such as surface tension tend to dominate over body forces. Within a single droplet the interactions among the fluid, suspended particles, the surface beneath, and the surrounding environment are highly coupled and complex. Our goal is to understand these interactions and leverage the physics of microdroplets to develop innovative microfluidic solutions for a variety of applications. Current focuses include using electric fields to control particle deposition in evaporating droplets, developing digital microfluidic (DMF) devices to assemble protein chains for DNA synthesis, and developing 3D DMF devices capable of complex routing operations.

DESCRIPTION OF THE RESEARCH PROJECT:

This research project will contribute to the development of DMF devices that miniaturize and automate biological protocols to reduce health care costs while delivering health care services at the point of care. The focus of this project will be to continue the work we've begun in automating the creation of DNA products on digital microfluidic systems. The student will work with a PhD mentor to help "functionalize" small particles so target molecules stick to the surface. They can also help design improvements to our process for "filling" devices with silicon oil prior to droplet manipulation. They can also help automate our existing facility to control motion of droplets on the device.

SKILLS NEEDED

General skills: Communication, critical thinking, curiosity
Major(s): Any

SKILLS TO BE DEVELOPED

This project will allow students to experience firsthand what working in an academic research lab is like. In addition to designing and performing experiments, students will also be able to improve their technical writing and speaking as they report on their progress and ultimately present their findings.

CONTACTS

PhD Mentor – Xi Li, xl1832@mail.rit.edu
Faculty Sponsor – Dr. Michael Schertzer, mjseme@rit.edu

RIT | Kate Gleason College of Engineering
Department of Mechanical Engineering

RESPIRATORY TECHNOLOGIES LABORATORY
R·I·T | Kate Gleason College of Engineering

Mechanical Engineering Mentored Research

PROJECT TITLE:

Characterization of the Power Management of Electronic Nicotine Delivery System (ENDS) Devices

NAME OF THE LAB:

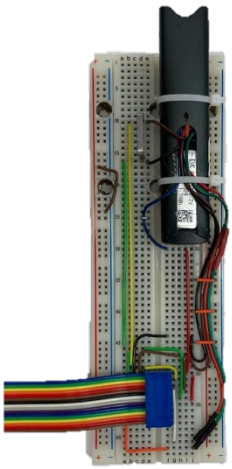
Respiratory Technology Lab

DESCRIPTION OF THE RESEARCH LAB OR RESEARCH GROUP:

The Respiratory Technology Lab (RTL) conducts research related to inhaled aerosols, including analyzing emissions, monitoring behavior, and assessing the health impacts in support of basic science and regulatory science. The lab develops technologies in support of these research activities including programmable emissions systems, lung deposition models, topography monitoring systems and mobile device apps.

Our overall research question is "are products being advertised as safer, *actually safer*?" To answer this question, we study the influence of tobacco product characteristics, such as flavor and nicotine concentration and other design features on instantaneous behavior (e.g. puff flow rate, duration, volume), on emissions produced (e.g. how much aerosol is produced and it's chemical composition), on consumption behavior (e.g. cumulative volume, cigarettes per day, vaping sessions per day), and ultimately how all these factors impact health outcomes of the tobacco product user. We have developed personal use monitors (wPUM™) that can capture instantaneous puffing behavior in the user's natural environment. We also developed phone application to collect data about users' behaviors, emotions, bio-signals, and their environments. Using this data and the puffing machines developed at RTL, we are able to emulate the user's smoking or vaping sessions and capture the emissions for chemical analysis. From this we can know how much nicotine and other harmful or potentially harmful constituents are inhaled by the user.

DESCRIPTION OF THE RESEARCH PROJECT



E-cigarettes are gaining increasing attraction by tobacco users. Manufacturers advertise these devices as a safer option or a way to quit smoking. However, understanding the full scope of their health effects is still part of ongoing research supported with nationwide efforts. Unlike conventional tobacco products, e-cigarettes are equipped with sophisticated embedded system controllers which utilize microprocessors. Power and thermal management operations are performed to control the generated inhalant (vape). Understanding these operations is critical to evaluate the health effects of these devices. It also reveals vital information to make educated legislative decisions. In this project, E-cigarette devices are opened to expose the internal electronics to access all desired connection points to collect electrical signals. The collected data will be analyzed to for power analysis. This project is part of an ongoing project that is been conducted at RTL.

SKILLS NEEDED

Students with experience and/or interest in electrical circuits. Coding skills would be helpful.

SKILLS TO BE DEVELOPED

Students will develop their skills in power and voltage analysis of electronic circuits and Reverse engineering. They will learn basics of engineering research and experiment design. They will also practice data collection, analysis, and documentation.

CONTACT PERSON (PHD MENTOR AND FACULTY SPONSOR)

PhD Mentor: Qutaiba Saleh, qms7252@rit.edu
Faculty Sponsor: Dr. Edward Hensel, echeme@rit.edu

RIT Kate Gleason College of Engineering Department of Mechanical Engineering

Mechanical Engineering Mentored Research Program

Project Description to be Used for Recruiting *(maximum 1 page)*

PROJECT TITLE:

Wearable Respiratory Monitor Calibration Methods for Ambulatory Lung Volume Observation

NAME OF THE LAB:

Respiratory Technologies Laboratory (RTL) under Dr. Risa Robinson

DESCRIPTION OF THE RESEARCH LAB OR RESEARCH GROUP: ***(300 WORDS)***

At RTL, we study the influence of tobacco product characteristics (e.g. flavor, nicotine concentration) on instantaneous smoking behavior (e.g. puff flow rate, duration, volume), on emissions produced (e.g. amount of smoke), on consumption behavior (e.g. cumulative volume, cigarettes per day), and ultimately how all these factors impact health outcomes of the tobacco user. We have developed personal use monitors (wPUM™) that can capture instantaneous puffing behavior as the user smokes in their natural environment. Using the collected data and the smoking machines we have developed, we are able to emulate the user's smoking sessions and capture the generated smoke for chemical analysis. From this we are able to obtain the quantity of nicotine and other harmful or potentially harmful constituents inhaled by the tobacco user.

DESCRIPTION OF THE RESEARCH PROJECT: ***(300 WORDS)***

We are currently using a Hexoskin Smart Garment to measure ambulatory chest motion which we then use to infer the lung volume waveform. For this we need to perform a calibration to obtain the calibration factors that convert the chest motion to lung volume according to a pre-described model. The aim of this project is to evaluate the current calibration method and investigate other novel calibration methods. Calibration methods will be evaluated using a multifactor study design approach. A study will also be conducted to evaluate the validity of the calibration coefficients over the course of the observation period. The results of these investigations will inform which calibration method is most suitable for ongoing and future natural environment tobacco use observation studies.

CREDIT HOURS

This is a 1 to 3 credit hour project. The expected workload will be adjusted according to the desired credit hours with each credit comprising of 3 to 5 hours of commitment per week for 15 weeks.

SKILLS NEEDED

Basic MATLAB knowledge is desired. An understanding of linear regression. Basic fluid dynamics.

SKILLS TO BE DEVELOPED

They will obtain the Collaborative Institutional Training Initiative (CITI Program) for human subjects training. They will obtain knowledge in analyzing real and noisy data. They will also obtain MATLAB knowledge in terms of loading, processing, plotting, and tabulating data. The student will be expected to give a powerpoint and/or poster presentation so they will get experience with presenting. They will also be asked to read and review relevant journal papers.

CONTACT PERSON (PHD MENTOR AND FACULTY SPONSOR)

PhD Mentor: Shehan Jayasekera (gbj6142@rit.edu)

Advisor: Risa J Robinson (rjreme@rit.edu)

RIT Kate Gleason College of Engineering Department of Mechanical Engineering

Mechanical Engineering Mentored Research Program

Project Description to be Used for Recruiting *(maximum 1 page)*

PROJECT TITLE:

Automation of an Infrared Imaging Acquisition System for Breast Cancer Detection

NAME OF THE LAB:

Lab: Thermal Analysis, Microfluidics, and Fuel Cell Lab (TAMFL) Faculty: Dr. Satish Kandlikar

DESCRIPTION OF THE RESEARCH LAB OR RESEARCH GROUP: *(300 WORDS)*

For the past 30 years, the TAμFL has focused on researching heat transfer and fluid transport phenomena at RIT. Presently, the active area of research consists of multiphase heat transfer and breast cancer detection. The research outcome of the lab has led to improved server cooling, efficient fuel cell, and rapid breast cancer diagnosis.

DESCRIPTION OF THE RESEARCH PROJECT: *(300 WORDS)*

Breast cancer is currently the most prevalent form of cancer in women with over 266,000 new diagnoses every year. Early detection through breast cancer screening has helped reduced mortality rates. The TAμFL lab has created a breast cancer screening method to find the location and size of a tumor within a breast through infrared imaging and a detection algorithm. The next phase of this breast cancer research project is to improve the image acquisition system, improve patient comfort, and conduct further studies through phantom models. In this project, the infrared imaging acquisition system will be automated through Computer Vision and Remote Sensing techniques. Designs for potential user-interfaces will be studied in conjunction with another project working on improving patient comfort. The overall aim for this research project is to come up with a final product and research tool by integrating all three projects. Students are expected to complete a final report and presentation on the end of the project.

CREDIT HOURS

Students have the option of taking 1-3 credit hours for this project.

SKILLS NEEDED

Some knowledge in CAD and Engineering Design, Computer Vision, and Remote Sensing will be helpful but is not required.

SKILLS TO BE DEVELOPED

Students will develop skills in the Computer Vision and Remote Sensing domains, which will be integrated with engineering methodologies for robust problem solving and engineering design. Students will also develop programming organizational skills and best practices implemented in industry. Last, students will develop skills in technical presentation and technical writing to prepare them for industry and academic research career paths.

CONTACT PERSON (PHD MENTOR AND FACULTY SPONSOR)

PhD Mentor: Carlos Gutierrez, cg9804@rit.edu

Faculty Sponsor: Dr. Satish Kandlikar, sgkeme@rit.edu

RIT Kate Gleason College of Engineering Department of Mechanical Engineering

Mechanical Engineering Mentored Research Program

Project Description to be Used for Recruiting *(maximum 1 page)*

PROJECT TITLE:

Enhancing Patient Care for Breast Cancer Screening through Engineering Design

NAME OF THE LAB:

Lab: Thermal Analysis, Microfluidics, and Fuel Cell Lab (TAMFL)

Faculty: Dr. Satish Kandlikar

DESCRIPTION OF THE RESEARCH LAB OR RESEARCH GROUP: *(300 WORDS)*

For the past 30 years, the TAμFL has focused on researching heat transfer and fluid transport phenomena at RIT. Presently, the active area of research consists of multiphase heat transfer and breast cancer detection. The research outcome of the lab has led to improved server cooling, efficient fuel cell, and rapid breast cancer diagnosis.

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CREDIT HOURS

Students have the option of taking 1-3 credit hours for this project.

SKILLS NEEDED

Some knowledge of CAD and Engineering Design, Marketing, and Product Development will be helpful but not required.

SKILLS TO BE DEVELOPED

Students will develop skills in designing systems based on consumer needs through market surveys. Students will also develop best practices for market and research surveying especially in the clinical and medical field. Last, students will develop skills in technical presentation and technical writing to prepare them for industry and academic research career paths.

CONTACT PERSON (PHD MENTOR AND FACULTY SPONSOR)

PhD Mentor: Carlos Gutierrez, cg9804@rit.edu

Faculty Sponsor: Dr. Satish Kandlikar, sgkeme@rit.edu

RIT Kate Gleason College of Engineering Department of Mechanical Engineering

Mechanical Engineering Mentored Research Program

Project Description to be Used for Recruiting *(maximum 1 page)*

PROJECT TITLE:

Experimental and Numerical Simulations of Breast Cancer of Phantom Models

NAME OF THE LAB:

Lab: Thermal Analysis, Microfluidics, and Fuel Cell Lab (TAμFL) Faculty: Dr. Satish Kandlikar

DESCRIPTION OF THE RESEARCH LAB OR RESEARCH GROUP: *(300 WORDS)*

For the past 30 years, the TAμFL has focused on researching heat transfer and fluid transport phenomena at RIT. Presently, the active area of research consists of multiphase heat transfer and breast cancer detection. The research outcome of the lab has led to improved server cooling, efficient fuel cell, and rapid breast cancer diagnosis.

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CREDIT HOURS

Students have the option of taking 1-3 credit hours for this project.

SKILLS NEEDED

Some basic knowledge in CAD and Engineering design, Computational Fluid Dynamics, or Heat Transfer will be helpful but not required. Skills in setting up experimental measurement acquisition systems will also be helpful but not required.

SKILLS TO BE DEVELOPED

Students will develop skills in understanding and utilizing numerical models in conjunction with experimental data. Students will also develop skills that utilize and enhance their critical thinking abilities in engineering through real-world application. Last, students will develop skills in technical presentation and technical writing to prepare them for industry and academic research career paths.

CONTACT PERSON (PHD MENTOR AND FACULTY SPONSOR)

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