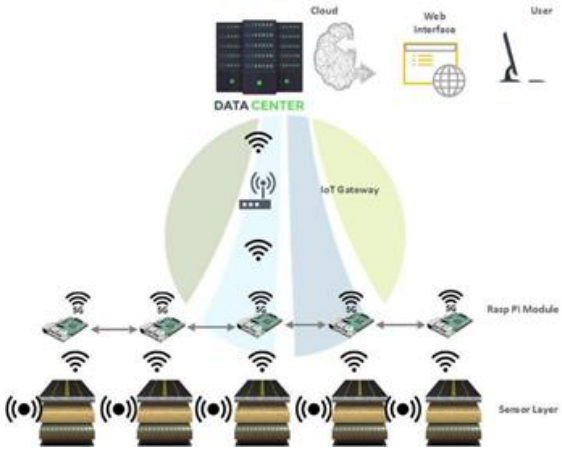
Descriptions of 2020 SURP Positions available with Utica Faculty

Faculty: Korkut Bekiroglu (korkut.bekiroglu@sunypoly.edu)
Program: Electrical Engineering Technology

1. **Internet of Things (IoT) based Pavement Monitoring System (VTRC Project)**



The proposed innovation is a low-cost IoT based wireless online structural monitoring systems of asphalt that allows engineers to continuously monitor the structural health of the asphalt/roads and develop/organize required treatment on time. The recent IoT technologies will allow us to collect intensive data (pressure, temperature, etc.) and transfer it wirelessly to the cloud for detailed analysis of time series data. The availability of intensive asphalt data will help to improve the quality of the asphalt with new findings by using this intensive data set and well know machine learning/modeling methods. Meanwhile, a low-cost solution, a customized multi-layered strain sensor, is provided to overcome the challenge (high temperature, high pressure) in asphalt pavement installation.

Student Skills: Python, IoT devices, Cloud computing, data analysis

2. **Machine Learning/Mathematical Modeling in Intrusion Detection**

The design of an anomaly/outlier/novelty detection system, for a given application, fundamentally requires, on the one hand, the construction of a numerical score from available datasets, to rank data points as to their closeness to being normal, and on the other hand, the statement of a policy, based on the score, for declaring anomalies. The task of designing an anomaly score is challenging because the probability distribution of what may be considered normal cannot always be assumed a priori, especially in dynamic environments like monitoring a computing system. Hence, most anomaly scores in use presently are based on some form of a direct distance between the data points. We need students to use our recently developed methods and the available anomaly detection methods to compare the performances. A provided benchmark dataset should be used for performance analysis.

Student Skills: Python, familiar with anomaly detection, good article writing skills

Descriptions of 2020 SURP Positions available with Utica Faculty

Faculty: Kristina Boylan (boylank@sunypoly.edu)

Program: Communications and Humanities

**Only accepting SUNY Poly students*

1. **Graphic History of Jovita Valdovinos Medina: Explorations of Historiographic and Illustration Possibilities**

The student(s) will work with the faculty member to develop digital illustrations (and, if possible, additional components, e.g. audio captioning), expanding the script of a graphic history of the life of Jovita Valdovinos Medina and the meaning of her participation in Mexico's Cristero Rebellion, Golden Age entrepreneurial activity, and transnational migration contexts. The students' visual and textual contributions will include discussions of Mexican and U.S. history, historiographical issues such as how to represent history in art and how choices are made in the comic/graphic writing genre, and innovations in layered drawing and shared illustration work. While the short-term goal for the summer will be to elaborate an article-length segment of the script for publication in peer-reviewed, interdisciplinary journals accepting graphic narrative content (e.g. Chiricú and Sequential Art Narrative in Education), with author and illustration credit appropriate to the student's contributions, longer-term goals can include planning for contributions (with authorial/illustrator credit as appropriate) to a book-length project on Valdovinos Medina, and the student developing their own proposals for graphic historical work (article/feature or book-length), particularly in Latin American/Latinx/other modern history areas, with faculty consultation, research guidance, and/or additional participation of the faculty member as the student deems appropriate.

Student Skills: Knowledge/interest in history and historiography, digital illustration (GIMP/Adobe Illustrator) and manuscript preparation skills, ability to read and write in Spanish, comfort with collaboration on and discussion of translations, is a significant plus, interest in/practice of analog drawing/inking/illustrating interest a plus

Descriptions of 2020 SURP Positions available with Utica Faculty

Faculty: Mark Bremer (bremerm@sunypoly.edu)

Program: Biology

1. **Green Building Certification**

   Student researchers will work with faculty and facilities staff to support applied learning courses focused on certifying existing campus green buildings. Tasks include compiling building energy and water data, working with building plans and other site documents, and conducting indoor air quality sampling and analysis. Additionally, student researchers have an opportunity to earn a green building industry-specific credential, such as LEED Green Associate.

   Student Skills: Interest in sustainability principles, such as water & energy efficiency, renewable energy, waste reduction, indoor air quality, occupant health, and green cleaning. Background in science and/or engineering is a plus.

Faculty: Andrea Dziubek (dziubea@sunypoly.edu)

Program: Mathematics and Physics

1. **Structure Preserving Numerical Methods for Partial Differential Equations on Curved Surfaces**

   Exterior calculus, developed by Cartan several decades ago, has become the standard language of differential geometry and has gradually been gaining acceptance as the superior formulation of vector calculus in scientific and engineering community. Building on the foundation of modern differential geometry and in particular exterior calculus, geometric mechanics reformulates mechanics, in particular Lagrangian and Hamiltonian mechanics, in the language of geometry. Formulating the problems in the language of geometrical mechanics has enabled researchers to develop new numerical methods, which preserve geometrical structures.

   Students will work with faculty on one or more of the following:

   a) Comparing Discrete Exterior Calculus and Finite Elements for exemplary problems.

   b) Understanding the discrete divergence operator and other operators of the basic equations of fluids, mechanics, and electromagnetism.

   c) Implementing discrete exterior calculus routines for problems on curved surfaces.

   Student Skills: Student Skills: Preference will be given to students who mastered multivariate calculus, linear algebra, differential equations, and a programming language, preferably Python.

2. **Mathematical Modeling of Blood Flow in the Retina of the Eye**

   The Mathematical Modelling Lab at SUNY Poly, Utica, specializes in the development, analysis and verification of mathematical models and the current focus is on modelling the blood flow

in the retina of the eye. For example, our physically based modelling, based on first principles, coupled with the most advanced analytical and numerical solution techniques, has predicted that changes in the curvature of the retina of the eye lead to significant changes in the blood flow, which in turn may play a significant role in primary open- angle glaucoma. http://people.sunyit.edu/~edmond/EyeDEC/

The blood flow in the retina of the eye is modelled as a Darcy flow through a hierarchical porous medium and is described by the parameterized Darcy equation. This equation is similar to the traditional Darcy equation, which can be used for example to model the flow of water or oil through sand, but it is extended by an additional variable, which represents the various blood vessels: large arteries, small arteries, arterioles, capillaries, and the various size veins. In other words, the model describes not only the spatial flow, but also the hierarchical flow, from arteries, through capillaries, to veins.

Student Skills: The student will have the opportunity to participate and to contribute to all aspects of the project and to focus on one particular area of their choice, appropriate to their level. The prerequisites are a solid background in mathematics, minimally at the level of calculus, and preferably including linear algebra, differential equations and multi-variable calculus, familiarity with a programming language, preferably Python, and an interest in applied mathematics, including mathematical modelling and scientific programming.

Faculty: Lauren Endres (endresl@sunypoly.edu)

Program: Biology

1. **Microbial source tracking in the Mohawk valley watershed**

   This research project is a joint effort between biology and civil engineering to develop techniques for genomic DNA isolation and quantitative real-time polymerase chain reaction (qRT-PCR) for an analysis of microbes isolated from water samples taken at various points along the Mohawk Valley watershed. The research will take place at the Utica site within the collaborative research group of Dr. Endres (Supervisor) and Dr. Rodak.

   Student Skills: Proficiency in micro-volume pipetting is a must, and previous experience in qRT-PCR is desirable.

Faculty: Sivapalan Gajan (gajans@sunypoly.edu)

Program: Civil Engineering

**Only accepting SUNY Poly students*

1. **Development of Predictive Algorithms for the Performance of Foundations during Extreme Lateral Cyclic Loading**

   The accurate prediction of nonlinear-cyclic stress-strain behavior of foundations during lateral cyclic loading (e.g., earthquakes, wind, and wave loading) is an essential component

of sustainable design of foundations for buildings and bridges. A database, consisting of results obtained from centrifuge and shaking table experiments conducted in several universities, has been created and is available at https://datacenterhub.org/. The objective of this summer project is to extract valuable experimental data on key capacity, demand, and performance parameters of foundations during extreme lateral cyclic loading. This also includes data processing to obtain meaningful processed data from raw experimental data. The processed data will be used to obtain correlations among foundation performance parameters, soil-foundation system properties, and loading conditions.

Student Skills: Junior or senior standing in civil engineering, basic math background, basic skill in computer programming (e.g., Matlab or Mathcad), and proficiency in Excel.

Faculty: Iulian Gherasoiu (gherasi@sunypoly.edu)

Program: Electrical Engineering Technology

1. **Electrodeposition of Diamond-Like Carbon (DLC) Films**

   Diamond is a wide band gap semiconductor with outstanding properties, suitable for electronic and optoelectronic applications that can withstand harsh operating demands and environmental conditions. Students will use electrodeposition method and equipment to deposit the DLC films on various substrates (quartz, silicon, steel) and optimize the material properties and the deposition parameters. The materials will be characterized using multiple methods such as the scanning electron microscope (SEM), the atomic force microscope (AFM), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR) and Raman spectroscopy.

   Student Skills: Background in electrical engineering, physics, chemistry or materials science preferred. Electrodeposition experience strongly preferred.

2. **Current Leakage Passivation for InGaN Semiconductor Alloys**

   InGaN semiconductor alloys are suitable for full spectrum solar cells. However, the material suffers from the formation of extended defects during the growth that diminish drastically their efficiency. Ex-situ defect passivation could provide a method to suppress the current leakage along these defects and improve the solar cell efficiency. Students will use sol-gel deposition/electrodeposition and annealing methods to deposit and diffuse at different temperatures, the passivation elements in the volume of InGaN films. The results of the passivation process will be evaluated using Conductive Atomic Force Microscope (C-AFM), and current-voltage measurements under dark and solar AM1.5 illumination conditions.

   Student Skills: Background in electrical engineering, physics, chemistry or materials science preferred.

Descriptions of 2020 SURP Positions available with Utica Faculty

Faculty: Ana Jofre (jofrea@sunypoly.edu)

Program: Communications and Humanities

1. **A public web-based resource exploring the faces of Time magazine**

   I'm looking for help on a research project that data mines Time magazine. Specifically, we are examining images of faces in Time magazine. Here is a link to the project page: https://magazineproject.org/TIME/(this page is a little outdated - we've had more results and publications since the last update, but it gives a good overview of the scope and goals of the project). For this particular job, we need a student to help design a public web resource where we will be presenting our research results through interactive visualizations and digital narratives.

   Student Skills: web development skills, strong graphic design skills, strong UX design skills

Faculty: Daniel Jones (dkjones@sunypoly.edu)

Program: Engineering Technology

1. **Analysis of Electroencephalography (EEG) Data**

EEG is used to measure and evaluate the electrical activity in the brain using electrodes placed on the scalp. We have collected EEG data from dozens of participants in the modern EEG laboratory at SUNY Poly in Utica. Signals were measured with 256 sensors at 1,000 Hz while participants viewed images and provided push-button responses. This project aims to analyze the data in order to understand the spontaneous neural activity of the brain in response to the images.

Student Skills: General computer skills for analyzing data, particularly in MATLAB or related programming environments.

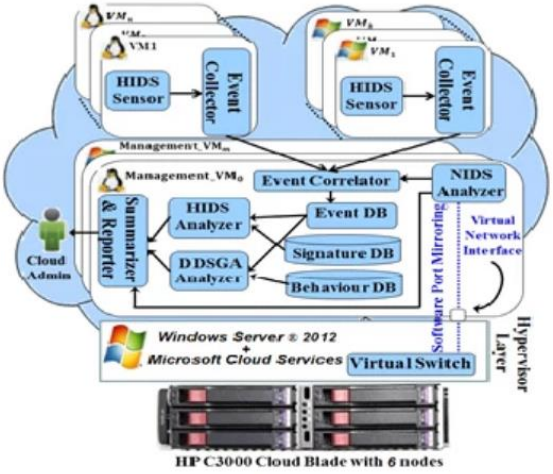
Descriptions of 2020 SURP Positions available with Utica Faculty

Faculty: Hisham Kholidy (kholidh@sunypoly.edu)

Program: Network and Computer Security

1. **Building a Cybersecurity Framework for Cloud Computing Systems**

   Security is a top concern which still solidly in first place in the field of cloud computing. Thus we needed research on cloud computing security. Modern cloud service providers often provide security during unwanted traffic over cloud systems. The main goal of this project is to practically employ some machine learning techniques that students have studied to classify intrusions and to select the suitable responses against cloud network attacks. Among the goals also is to build a small cloud testbed for research purposes and to deploy the security framework components in this testbed.



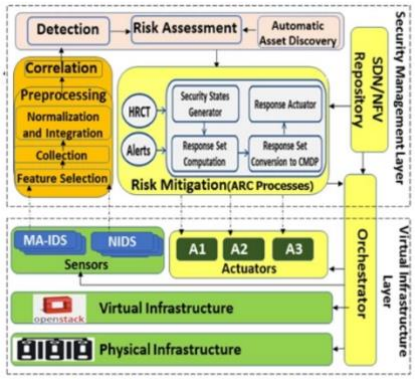
The proposed Security Framework Architecture.

   <u>Student Skills:</u> Required: (1) Programming Skills (Java, PHP, and/or Python). (2) Virtual Machine setup and tools testing.

2. **Towards a Secure 5G Systems**

   This project specifically contributes toward the need of advanced security system to identify, assess, and respond against the attacks across the new standard 5G systems in a scalable and autonomous way with or without human intervention based on the criticality of the 5G asset that can be protected.

   <u>Student Skills:</u> Required: (1) Programming Skills (Java, PHP, and/or Python). (2) Virtual Machine setup and tools testing.



The Proposed 5G Cybersecurity Framework Architecture

3. **Harnessing the Machine Learning and AI in the Self Protection Domain**

   Artificial intelligence (AI) and machine learning are now considered to be among the biggest innovations and hot research topics. AI used to be a fanciful concept from science fiction, but now it's becoming a daily reality. Neural networks and deep learning are important techniques that can improve the cybersecurity domain. In this project, we will implement such techniques to improve the Intrusion response systems in large scales systems.

   <u>Student Skills:</u> Required: (1) Programming Skills (Java, PHP, and/or Python). (2) Virtual Machine setup and tools testing.

Descriptions of 2020 SURP Positions available with Utica Faculty

Faculty: Vijay Ramalingam (ramaliv@sunypoly.edu)

Program: Biology and Chemistry

1. **UV-light assisted synthesis of rotaxane**

   Rotaxanes are a class of mechanically interlocked molecules, composed of a linear long chain molecule that threads a macrocyclic cavitand, which is sterically hindered on the terminal to keep the cavitand inside. These molecules have potential applications in the design of molecular switches, machines and nanomuscles because of their dynamic nature and capability to maintain permanent interlocking without covalent linkages. Many novel synthetic routes have been demonstrated for the synthesis of these structures involving classical organic transformations, few methods exist that involve aqueous media. Synthesizing and the estabilishing the function of rotaxanes in aqueous media plays an important role in realizing biological application of the machines. We have designed an efficient method for the synthesis of rotaxanes in an aqueous medium involving the use of 2+2 photocycloaddition of alkenes. The design strategy involves taking advantage of large cavitand's (CB8 or gamma-CD) ability to form a ternary complex to encapsulate two long chained alkenes simultaneously, which upon photoexcitation would yield a covalently-fused cyclobutane structure with threads on either side. This would prove to be an efficient one-step synthetic route for accessing a wide range of rotaxanes via a unique, inexpensive approach.

   Student Skills: organic chemistry or chemistry course

Faculty: Michael J. Reale (realemj@sunypoly.edu)

Program: Computer Science

1. **Deep Learning for Automatic Facial Expression Analysis on 2D and 3D Dynamic Data**

   Automatic machine understanding of facial expression behavior has many applications in a wide variety of fields, including education (e.g., automatic tutoring), industry (e.g., advertising, gaming), medicine (e.g., pain detection, human-computer interfaces), and military/law enforcement (e.g., airport security, lie detection). However, there are also many challenges to overcome, including unpredictable lighting conditions, non-frontal head pose, occlusion issues, and "micro-expression" behavior. In this project, we propose to utilize deep learning approaches on dynamic 2D and 3D face data to automatically analyze expressive behavior.

   Student Skills: Required: Python programming experience. Preferred: machine learning experience, computer vision experience, C++ programming experience

2. **Fundus image segmentation and analysis**

   The goals of the project are to perform image segmentation on the arteries and veins from fundus (back of the eye) images, build a 3D mesh of aforementioned vascular structures, and

perform analysis as well as simulations from this information. We will explore deep learning approaches to accomplish some of these goals.

Student Skills: Required: C++ and Python programming experience. Preferred: machine learning experience, computer vision experience.

Faculty: Carolyn Rodak (rodakc@sunypoly.edu)

Program: Civil (Environmental) Engineering

1. **Statistical analysis of water quality in the Mohawk River**

   The overall goal of the work is to identify baseline and augmented water quality conditions within the Mohawk River in the Utica / Rome NY region. Over the past four summers, water samples have been collected and analyzed for fecal indicator bacteria and general water quality parameters. The primary goal for the summer of 2020 is to analyze the current data and prepare it for publication(s). Therefore a significant portion of the work will be conducted on the computer including literature searches, data analysis and prediction tools, and scientific writing. The student will also have the opportunity to participate in laboratory work related to the use of quantitative polymerase chain reaction (qPCR) for microbial source tracking, a joint project between Dr. Rodak and Dr. Endres (Biology).

   Student Skills: Experience with excel, MATLAB, SPSS, or GIS a plus.

Faculty: Edmond Rusjan (edmond@sunypoly.edu)

Program: Mathematics and Physics

1. **Structure Preserving Numerical Methods for Partial Differential Equations on Curved Surfaces**

   Exterior calculus, developed by Cartan several decades ago, has become the standard language of differential geometry and has gradually been gaining acceptance as the superior formulation of vector calculus in scientific and engineering community. Building on the foundation of modern differential geometry and in particular exterior calculus, geometric mechanics reformulates mechanics, in particular Lagrangian and Hamiltonian mechanics, in the language of geometry. Formulating the problems in the language of geometrical mechanics has enabled researchers to develop new numerical methods, which preserve geometrical structures.

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   c) Implementing discrete exterior calculus routines for problems on curved surfaces.

Student Skills: Student Skills: Preference will be given to students who mastered multivariate calculus, linear algebra, differential equations, and a programming language, preferably Python.

2. **Mathematical Modeling of Blood Flow in the Retina of the Eye**

The Mathematical Modelling Lab at SUNY Poly, Utica, specializes in the development, analysis and verification of mathematical models and the current focus is on modelling the blood flow in the retina of the eye. For example, our physically based modelling, based on first principles, coupled with the most advanced analytical and numerical solution techniques, has predicted that changes in the curvature of the retina of the eye lead to significant changes in the blood flow, which in turn may play a significant role in primary open- angle glaucoma. http://people.sunyit.edu/~edmond/EyeDEC/

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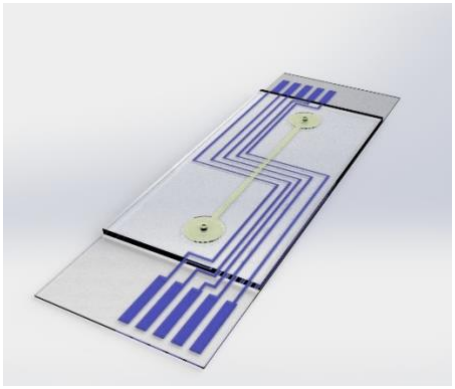
Student Skills: The student will have the opportunity to participate and to contribute to all aspects of the project and to focus on one particular area of their choice, appropriate to their level. The prerequisites are a solid background in mathematics, minimally at the level of calculus, and preferably including linear algebra, differential equations and multi-variable calculus, familiarity with a programming language, preferably Python, and an interest in applied mathematics, including mathematical modelling and scientific programming.

Faculty: Jiayue (Joyce) Shen (shenj@sunypoly.edu)

Program: Mechanical Engineering Technology

1. **3D Printed microfluidic-based sensors**

This project would require a student to direct print a microfluidic-based force sensor via the bioprinter in the CGAM. by using the bio-printer on the Utica Campus. Ultimately, the goal of this project will be to develop a process that can be used to manufacture similar sensor.



Student Skills: No experience necessary, but preferred experience in 3D printing, soft material, and chemistry. Rising sophomores welcome.

2. **Wireless stain gauge/thermocouple characterization and calibration**
   This project would require the student to conduct testing for characterizing and calibrating a few identical wireless strain gauges and thermocouples. Ultimately, the student needs to process and analysis of the collected data.
   Student Skills: Background in Mechanical engineering/engineering tech or Civil Engineering/engineering tech, preferred experience in MATLAB/Python/LabView

Faculty: Shuang Tang (tangs1@sunypoly.edu)

Program: Mechanical Engineering

**Only accepting SUNY Poly students*

1. **Crystalline and Atomic Structure Research of Nanomaterials**
   We want to make portable electricity generators e.g. by the temperature difference between your skin and the cold air. We also want to make cooling devices in satellites. To realized this, we are exploring transport and band structure properties of novel nanomaterials. Study the crystalline and atomic structures are the most basic step. This summer project will help the student find one or multiple materials candidates to make such thermoelectric devices by examining the relation between the microscopic structures and the macroscopic properties.
   Student Skills: Knowledge in materials science, physics and chemistry.

2. **Force Sensors for "Magic Gloves"**
   We are interested to develop magic gloves for doctors, especially surgeons, to record realtime medical information of each patient, based on the modern progress of materials science, electrical engineering and mechanical engineering. Sensors of force, temperature, chemical, and velocity will be embedded on surface of the glove, while the doctor is doing examinations, treatments and operations. This project will focus on searching for materials candidates to build force sensors at the proper scale. Different than traditional force sensors, this sensor has to be capable of measuring intrinsic force under tiny change of external forces, e.g. the pulse strength detected by finger will actually change with the force exerted onto the skin or the organ surface, which reflects more health information than just heart beating rate.
   Student Skills: Knowledge of materials science and electrical engineering

Faculty: Jagannath Upadhyay (upadhyj@sunypoly.edu)

Program: Mechanical Engineering Technology

1. **3D Printing of Real Soils: Evaluation of the Seasonal Variation of Soil Pore Structures**
   This project is in collaboration with Asif Ahmed, Assistant Professor, SUNY Poly.
   Structure of soil changes with the seasons of the year resulting variation of the mechanical and hydraulic properties of soil. Studying of the 3D microstructure of soil will enhance the

understanding of varying soil behavior in various climatic conditions and its effects on soil-water dynamics. The purpose of the study is to analyze 3D soil sample and its pore structures under different environmental conditions. In New York state, soil undergoes significant structural changes during freezing and subsequent thawing season. As all of the infrastructures ultimately rest on soil, the condition of the ground is very critical. Evaluating the soil-structure condition in different climatic environment will assist to undertake ground improvement techniques.

This proposal will address understanding and characterization of 3D microstructure of soil at different environmental conditions, fluid flow and transport of nano structures through the porous network of the soil-based microporous media. List are the objective of the research plan

1. Using state-of-art microscale imaging technique, micro-structure of the soil sample collected from the onsite field to obtain fundamental porous structure of the soil.
2. Leveraging current polymer based 3D additive manufacturing technique to fabricate scale up, cheap and economical 3D micro-structure of the soil on a chip for experimental study.
3. Perform a series of flow experiments using a thermosetting neutrally buoyant micro/nano particles to understand transport behavior of those nanostructures through the porous network of the soil-based microporous media.

Student Skills: The summer intern should have strong foundation of Solidworks modeling, Image processing using MATLAB, statistical data analysis and enthusiastic in 3D additive manufacturing.

2. Parametric study of Polymer Based Microfluidic Device

This project is in collaboration with Nathaniel Cady, Professor, SUNY POLY CNSE.

The field of microfluidics involves the miniaturization of analytical tools that allows for low cost, rapid, and portable chemical and biochemical analysis resulting in minute controlled chemical waste. Microfluidics devices have potential applications in drug delivery, drug screening, bio detection, DNA analysis, protein assays, to study multiphase fluid transport mechanism, chemical analysis, and clinical diagnostics. The material and design used to produce microfluidic devices is very important in terms of cost, ease of fabrication, useable temperature ranges, chemical and biochemical inertness, surface stability, and surface properties. It also offers numerous advantages to integrate commercially available traditional assays into one platform for point-of-care application. This proposed study includes:

1. Design and fabrication of polymer based microfluidic device by using state-of-art 3D additive manufacturing techniques and replication-based tradition manufacturing (hot embossing and plastic injection molding).
2. Quantitative analysis of transport mechanism at capillary based valve for the point-of-care application.

Student Skills: The summer intern should have strong foundation of Solidworks modeling, Image processing using MATLAB, statistical data analysis and enthusiastic in 3D additive manufacturing.

Faculty: Rebecca Weldon (weldonr@sunypoly.edu)

Program: Psychology

1. **Putting the Brakes on an Automatic Response: The Neural Mechanisms of Braking Successfully**

   Humans tend to have difficulty adhering to long-term health goals like quitting smoking or sticking to a diet. Cognitive neuroscience research has focused on how the brain is involved in inhibiting an automatic response (e.g., refraining from eating more of a tasty but unhealthy food) and why putting the brakes on that behavior may be difficult. In the spring of 2020, we will pilot an electroencephalogram (EEG) study in which participants will complete a computerized task that requires "stopping" before making a response while a net of electrodes records activity in the brain. In the summer of 2020, we will analyze our data to help us understand which part of successful inhibition actually results in devaluing stimuli (e.g., is it a cognitive or motor process that allows us to successfully withhold an automatic response to rewarding stimuli?). The ultimate goal of our research is to use what we learn to design interventions to reduce risky health behaviors and improve health outcomes.

   Student Skills: We anticipate that the SURP student will be largely involved in behavioral and EEG data analysis during the summer of 2020. The successful student will be enthusiastic about learning and problem solving, have a positive attitude, have initiative (i.e., willing to troubleshoot on their own and also willing to approach team members when there is a problem), and work well on a team. Familiarity with any of the following is useful but not required: Microsoft Excel, SPSS, EEG.

Faculty: Yu Zhou (zhouy2@sunypoly.edu)

Program: Mechanical Engineering

1. **Mobile robot localization**

   The participant will 1) tune up an indoor localization system which consists of onboard infrared cameras attached to mobile robots and environment-attached infrared landmarks, 2) program the onboard sensory data receiver to track the position and orientation of each robot continuously, 3) program each robot for movement, 4) combine the localization program and movement program for localization-based robot movement control.

   Student Skills: familiar with C++ programming

2. **Programming an Integrated Robotic Composite Material Layup Process**
   The participant will 1) program a composite prepreg layup process controlled based on a continuous feedback of contact force, 2) program a complete demo process which consists of supplying, picking, placing, and laying prepreg tapes several times.
   Student Skills: Familiar with Python programming