CIAN INTEGRATED OPTICS FOR UNDERGRADUATE NATIVE AMERICANS (IOU-NA)

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	**ISRAEL ARAGON** *Computer Modeling of a Diffractive Optical Switch* Fort Lewis College, Engineering Mentor: Pierre-Alexandre Blanche and Colton Bigler **Abstract** An optical diffraction switch for telecommunications was analyzed through computer simulations during this project. An optical switch works by redirecting the output of a fiber optic cable to the input of another cable allowing communication between the tw o cables. This eliminates the step of converting the optical signal to an electrical signal once the light has reached a data center for routing and vice versa once it is ready to be transmitted. The switch analyzed consisted of a Fresnel grating as well as a blazed grating as possible solutions for redirecting the incident light. The goal was to computationally generate these gratings and determine their corresponding diffraction efficiencies using Fraunhofer diffraction in Matlab 2016a. The omputational simulations were done to accurately represent an experimental system consisting of a liquid crystal on silicon (LCoS) spatial light modulator (SLM), infrared light detectors, an infrared laser and an oscilloscope. Results are not yet conclusive as the computational simulations as well as experimental tests are still being conducted. However, both gratings were successfully generated and the simulation was tested on several other steps providing successful results. Although the overall goal has not been com pleted, early estimations point toward the blazed grating being a more viable option for this system compared to the Fresnel grating.
	**LEO BIA** *The effects of increasing temperatures on photochemical smog in the Phoenix Metropolitan area 1984- 2016* University of Arizona, Engineering and Math Mentor: Chris Castro **Abstract** The most ideal conditions for formation of photochemical smog in urban areas are elevated temperatures, sunny skies, low wind, and precursor nitrous oxides and volatile compounds produced mainly by automobiles. In Phoenix, Arizona, temperatures commonly exceed 110 Fahrenheit and, as an urban area in the Southwest, has a substantial ozone pollution problem. The goal in this study is to find how the increasing temperatures in Phoenix affect the levels of photochemical smog .Looking specifically at ozone, data from the Maricopa County Public Health Clinic and Phoenix International Sky Harbor Airport are collected for ozone levels, wind, and temperatures. By MATLAB software, the data are analyzed for excessive heat warning days, the highest 5% of temperatures, during the summer months of May 1st to August 31st during 1984 to 2016. Significance in trends within the data are then evaluated. Temperatures during the excessive heat days are significantly increasing at the

	rate of 0.032 degrees F per year. These increasing temperatures appear to be 'rising the floor' for ozone levels during excessive heat warning days, though the number of days exceeding an unsafe level of ozone by National Ambient Air Quality Standards during the excessive heat warning days is not significantly increasing. These changes may be interpreted as the change in the shape of the distribution of maximum temperature and ozone during the excessive heat warning days, with both exhibiting a more narrow, peaked distribution in the recent period.
	**CRAIG DRAPER** *An Optical Ising Machine Based on Multi-core Fiber Lasers* University of Arizona, Optical Engineering Mentor: Pierre-Alexandre Blanche and Lichuan Liu **Abstract** With the observation of Moore's Law where standard computers are approaching a plateau of computational speed, an optical computer may be the future. An optical sing machine has been in development using multi-core fiber lasers. The purpose of this project was to collimate the mcfl that operates in the infrared range at 1030 nm wavelength for the ising machine. The method used was to locate a lens array at its focal point from the 19-core laser. By putting the lens array at its designed focal point and magnifying it with the system described, an optical image forms of what might be 1 collimated core laser. To determine this, an aperture needed to be placed between the mcfl and the lens array. If the optical image disappears when the aperture is used then the lens array is adequate rather than losing intensity where the mcfl would have diverged into each other. Difficulties included working with a fiber laser in the micron scale, fabrication of the lens array and to determine whether a different lens array would be needed. These were overcome by using translation stages and use of silicone molds for a pmma lens array. The expected results are to find that the lens array has collimated the laser and can then be applied to progress the ising machine to completion. The results from these have not proven or disproven that this lens array is adequate because the system and aperture caused aberrations in the image quality where further research is required.

REFREENO HARVEY

Hydrology: Understanding Streamflow Infiltration in Semi-arid Regions

Fort Lewis College, Engineering
Mentor: Pieter Hazenberg

Abstract

Streamflow infiltration in semi-arid regions are an important hydrological process that supplies moisture to the surface and subsurface soil, which enables biodiversity to survive in these dry areas. High-resolution models have been developed to better understand atmosphere and hydrological processes for semi-arid regions, but some processes, such as streamflow infiltration, are currently not represented. To gain an improved insight in whether the representation of streamflow infiltration will aid in the development of these models, the primary purpose of this research is to focus specifically on Walnut Gulch Experimental Watershed (WGEW). This evaluation of streamflow infiltration was done with data and statistical analyses procedures, such as percentiles. The hydrology concept of hydrograph theory was used to determine the valid data information and determine the statistical analysis procedure. The Horton's potential infiltration rate concept was used to understand the behavior of streamflow infiltration based on the statistical results. The outcome of these procedures and concepts showed that the volume of water loss is higher upstream than downstream. Also the variable of temporal variation has an impact on streamflow infiltration, more specifically, when focusing on the summer months when the region is affected by the North American Monsoon (NAM).

ANTONIA JIM

Assessing the ability of Landscape Evolution Observatory soil to support plant growth

Fort Lewis College, Environmental Studies
Mentor: Aditi Sengupta and Lydia Jennings

Abstract

Intense agricultural practices combined with growing population rates make it necessary to evaluate and improve the capacity of marginal soils to support plant growth. In this study, lithogenic basalt soil gathered from Merriam Crater in Northern Arizona was utilized as a parent soil material to test its capacity in supporting plant growth with or without soil amendments. The objective was to conduct a short (30 days) experiment to determine the growth response in three seed types (Panic Grass, Mesquite and the Common Bean) in LEO soil with or without amendments of the soil to the point that it will support plant growth. These seed types typically grow in arid to semi-arid environments, are very heat tolerant and can retain water. In a greenhouse study, 3 treatments were established; parent material, parent material + 20% compost, and potting soil. In each treatment, there were 3 replicates of each seed type (n=27) with irrigation increments set at 8:30 a.m., 12:00 p.m., and 4:30 p.m .(720 ml per pot per day). Plant-growth supporting capacity was evaluated by parameters like percentage germination, plant height, and dry/wet aboveground biomass, and gravimetric

	soil moisture content. Results determined that potting soil significantly supported plant growth over the other two treatments, irrespective of seed type.Compost-amended soil slightly supported plant growth than the parent Material alone, with greater percent germination and plant height, although no significant biomass difference was observed. This study determined that LEO soil is capable of plant growth.
	**JASMINE LOPEZ** *Water Quality in The Southern United States & Navajo Nation* Tohono O'Odham Community College, Life Science Mentor: Paloma Beamer, Yoshira Ornelas van Horne, Nathan Lothrop **Abstract** August 5th, 2015 nearly 3 million gallons of contaminated acid mine drainage containing lead and arsenic leaked into the Cement Creek in the state of Colorado. Ultimately it descended into the Animas and San Juan Rivers. Concerns regarding the quality of water on the Navajo Nation arose in the wake of the Gold King Mine Spill. The water quality reports from the year 2015 to 2016 within UT, NM, CO, AZ, Tohono O'odham Nation & 3 chapters on the Navajo Nation were compiled and summarized individually for lead and arsenic. Additionally, peer-reviewed literature pertaining to arsenic and lead in water systems, and health related articles were obtained. A summary table containing data on concentrations of lead and arsenic in the water systems, and exceedances of the MCL (Maximum Contaminant Level) was compiled. The data from the four states was compared to water samples from Navajo homes collected after the Gold King Mine Spill. The water samples from the four states did not exceed the maximum contaminant level of 15 ppb for lead and 10 ppb for arsenic. A total of 5/76 samples from the Navajo Nation exceeded the MCL for arsenic 10 ppb but did not exceed for lead. Overall the water systems from all water quality reports met water regulation standards.

MICAH MANN

Fluorescent Anisotropy Measurements of Fluorescein

University of Arizona, Optical Engineering
Mentor: Leilei Peng, Dustin Tran, Dongli Xu

Abstract

Fluorescent anisotropy is a method used primarily in biology and chemistry for detecting the average angular displacement of a molecule in the time between the absorption and emission of a photon. This method requires polarized excitation light and polarization sensitive emission detection. Anisotropy values range from -0.2 to 0.4. The values provide information about a molecule's size, shape, and its interaction with the environment. My task was to modify a confocal microscope. By adding an excitation and emission polarizer, the microscope gained the ability to perform polarization analysis on fluorescent emission under linear polarized excitation light. The confocal system was tested for accuracy by performing anisotropy measurements of fluorescein in mixtures of water and glycerol. Four different polarizer configurations produce four intensity values that are used to calculate the anisotropy of each sample through a MATLAB program. The final results show that the anisotropy increases when the solution's viscosity is increased by a higher glycerol percentage in the mixture. The results match the theory of fluorescent anisotropy and concludes that the confocal microscope is working properly. In the future, the confocal setup will be used for biological studies.

NATASHA MANYGOATS

Membrane distillation for power plant brine treatment

University of Arizona, Pre-Neuroscience and Cognitive Science
Mentor: Vasiliki Karanikola, Bob Arnold, Chris Yazzie

Abstract

As environmental regulations increase, power plants are in need of improved methods of handling their brine, which can have high concentrations of salts and metals. A proposed solution that is still under research is membrane distillation (MD) which aims to use the heat generated at a power plant to run the system. MD is a thermally driven process that utilizes a hydrophobic membrane that has small pores which allows water molecules to pass through the membrane on the permeate side while keeping the ions and particles on the feed side of the membrane. MD has theoretical rejection of 100% and if it is coupled with waste heat it can become a very promising technology. Fouling is one of the main drawbacks of MD which in turn decreases the permeability of the membrane often leading to complete hindrance of permeate flow. The aim of this research is to determine the impact of centrifuging the brine solution has on the effectiveness of the MD purification process.

MADISON MCMILLEN

Dietary Patterns Pre- and Post- the Gold King Mine Spill

University of Arkansas, Biological Engineering
Mentor: Paloma Beamer Yoshira Ornelas van Horne, Nathan Lothrop

Abstract

In early August of 2015, 3 million gallons of contaminated acid mine drainage were accidentally released into Cement Creek during an Environmental Protection Agency investigation. Cement Creek is a subsidiary of the Animas and San Juan Rivers. The contaminated drainage contained high levels of lead and arsenic. The GKMS potentially affects the waterways of 6 states and 12 tribes, one of the largest being Navajo Nation. Due to concerns over the safety of the water, Navajo farmers were forced to stop farming, leading to devastating impacts to local society and economy. The purpose of this project was to analyze the potential dietary changes following the GKMS. A food frequency questionnaire (FFQ) was administered to 3 chapters within Navajo Nation, Aneth, UT, Shiprock, NM, Upper Fruitland, NM. The FFQ was developed to assess potential dietary exposure to arsenic as well as how the spill affected the Navajo people culturally. The quantified responses from the FFQ were analyzed in RStudio to understand the average use, after spill use, and source of food for the participants. Most participants consume the selected food items 3 – 5x a week. The post-spill use for the majority of participants is the same as pre-spill use. The lack of change in post-spill use despite community concerns for contamination is representative of the food desert on Navajo Nation.

HARRISETTA SANDOVAL

Assembling and Operating a Direct Write Photolithography System using a 405 nm Laser Diode

Fort Lewis College, Engineering, Electro/Mechanical Concentration
Mentor: Sasaan Showghi

Abstract

Due to the time-consuming and costly machinery used in the field of microfabrication, the primary objective of this study was to design a direct write photolithography system any person could reproduce and build upon. Using the open-sourced Arduino platform, a linear actuator, and a 405nm laser diode, different intensities of pulse width modulation (PWM) were observed using photolithography. Direct writing included refocusing the beam, changing the PWM of the laser diode, and decreasing the speed of the linear actuator. A total of two resists were used, one positive and negative. Traveling at a speed of 1 mm/s, positive resist S1813 created lines 31 µm and 9.67 µm wide while operating at 50% and 75%, respectively. Furthermore at 0.5 mm/s, lines 34.07 µm, 107.15 µm, and 210.71 µm wide were created using 25%, 50%, and 75% PWM, respectively. However, despite operating at 100%, reducing the speed, and spot size, no lines were developed using the negative resist (Su8), which concluded a higher-powered laser was needed.

JESSE TOLEDO

Raindrop Size Distribution using Parsivel2 Disdrometers

University of California, Los Angeles, Chemical Engineering

Mentor: Pieter Hazenberg

Abstract

The goal of this research is to study the raindrop size distribution (DSD) in Southern Arizona. More specifically, this work will focus on comparing observations of a Parsivel2 disdrometer operated at roof of the Physics and Atmospheric Sciences building (ROOF) and one operated by USDA Agricultural Research Service in the Walnut Gulch Experimental Watershed (WGEW) near Tombstone, AZ. As the performance of the latter instrument is potentially flawed, this study aims to identify whether this is the case by statistically comparing observations between both locations. Results reveal that the rainfall between the two sites is similar but the WGEW disdrometer does not efficiently read high intensities. Our analysis in the Walnut Gulch Experimental Watershed will help us further understand the arid environment.

LEON TOLEDO

Adaptation of plants against damage by insects and pathogens

Southwestern Indian Polytechnic Institute, pre-engineering

Mentor: Betsy Arnold

Abstract

This project investigates presence of detectable volatiles related to plant protection against damage caused by insects and pathogens. We hypothesized that plants with detectable volatiles will have less damage from both insects and pathogens than plants without detectable volatiles. Three leaves with visible signs of insect and/or pathogen damage were collected and identified from 30 different types of plants from the Campus Arboretum (n=90). Signs of insect damage include scratches, holes, or bite marks. Signs of pathogens include spots or discoloring of yellow or brown on the leaves. The method we used to calculate how much damage a plant suffered was by calculating the area of each leaf which was then measured on graph paper. Once the ratio of damage to leaf area was determined, the next step was to determine which leaves had detectable volatiles to protect against damage. The leaf samples were crushed to indicate whether an odor (indicating a volatile) was produced. Overall, the results indicated leaves suffered more damage from pathogens than from insects, leaves with volatiles suffered somewhat less insect damage than leaves without volatiles, and leaves with volatiles suffered much less pathogen damage than leaves without volatiles. We conclude that volatile compounds seem more important for anti-pathogen defense than anti-insect defense. Helping plants grow in settings that increase their volatile content might help protect plants against disease.