PO-0907 (Track: Energy, Renewable, and Sustainability)

Micro Fuel Cell for Eye Pressure Regulator

Diego A Rios (New Jersey Institute of Technology)

Glaucoma is one if the leading cause of blindness in the world. There are ways to prevent and regulate glaucoma, but majority of these techniques are not noninvasive. The research objective is to determine what the power output would be of a micro fuel cell using previous data acquired from fuel cells.

The fuel cell that we are using gives off energy from oxidation and reduction reactions with glucose and oxygen, using catalysts that are enzymes attached to the tips of carbon nano tubules. The first stage in improving the fuel cell is to study the process in which the enzymes are deposited, called cyclic voltammetry. From this study, data obtained can be used for the production and planning of micro fuel cells.

Using MatLab, the data was plotted and graphed. From this graph, the area under the peak of the cyclic voltammetry was obtained. Cyclic voltammetry is the process in which the enzymes are deposited into the fuel cell. This peak would give the power output by the fuel cell and whether or not a micro fuel cell would function. Using a line and its slope to find the peak, a total power output of 2.1259 * 10-6 Watts was found for this specific cyclic voltammetry.

With the help of other data, the power output of a micro fuel cell was found. With this power, a design can be made for an eye pressure regulator that is noninvasive, unlike the eye pressure regulator on the market at the moment. This design has to incorporate and take into account the power outputted by the micro fuel cell. Otherwise the eye pressure regulator may not function properly.

PO-0692 (Track: Energy, Renewable, and Sustainability)

Ferroelectric BTO on Silicon (001) for high-efficiency solar cell heterostructures

Emma Kaeli (Northeastern University)

MgO is grown on Si (001) substrates in an ultrahigh vacuum (UHV) environment using a number of growth methods including molecular beam epitaxy (MBE) and sputtering. In comparing differences in surface structure using reflection high-energy electron diffraction (RHEED) and surface chemistry using X-ray photoelectron spectroscopy (XPS), we can understand surface interactions between Si, Mg, and O. By understanding the relationship between atomic level interactions and ultimate film characteristics, we can engineer the most effective process for BTO integration on Si. The substrates are cleaned using wet chemicals to create a hydrogen-terminated surface that resists contamination from laboratory exposure. XPS and RHEED are used to verify the lack of contamination on the surface and proper crystallographic orientation. XPS and RHEED will serve to confirm proper growth of MgO (001) on Si and determine thickness of the MgO film. BTO is then grown on the correctly-oriented MgO film using MBE, as has already been demonstrated on MgO/SiC substrates.

PO-4367 (Track: Energy, Renewable, and Sustainability)

An experimental analysis of right-sizing algorithms for power-proportional data centers

George Sarkar, Christine Chung (Connecticut College)

Due to the rising cost of energy at data centers, there is an increasing demand for making data centers more energy efficient and more environmentally friendly. One method of achieving better energy efficiency is "rightsizing" the data center by switching off unused servers during periods of predictably low loads. This paper provides an experimental analysis of the performance of a number of algorithms recently proposed in the data and communication networks, learning theory, and algorithms communities.

In our problem, data centers are modeled as a collection of homogenous servers and each of the algorithms determine the number of servers that should be active at time t. The input data used in the analysis of this work are two data center load traces (one from Hotmail and the other from Microsoft research, Cambridge) used in the paper by Lin et. al [1].

The first algorithm of Bansal et al. [1] is a randomized algorithm that maintains a probability distribution over all possible states, x, which represents the number of active servers. Since in data centers, there are "sufficiently many servers" [1], the variable x is modeled as a continuous variable. At each time t, given the work-load L_t, the algorithm evaluates the value of x_t, the number of servers that should be active to handle load L_t and calculates the cost of switching on and switching off servers and the cost of processing the load.

The second algorithm of Bansal et al. [1] is a memoryless algorithm. This algorithm does not maintain a probability distribution over all states like the first Bansal et al. [1] algorithm, however, it is based on a similar idea as the first. For the given load L_t at time t, the algorithm evaluates x_t, the number of servers that should be active to handle the load L_t, the hit cost H_t (the cost of processing the load), and the move cost M_t, cost of switching on and switching off servers.

The Lazy Cost Provisioning (LCP) Algorithm [2] uses convex optimization to compute the optimal solution for the work-load that have arrived thus far. Given the load L_t at time t, the algorithm calculates an upper bound and a lower bound based on the optimal solution up to time t for the variable x_t, which represents the number of active servers. The output of the algorithm moves "lazily" within these bounds. The operating cost for this algorithm is calculated as a sum of delay cost (the loss in income for delay d and load L), the energy cost (the cost of processing load L_t) and the cost of switching on and switching off servers.

The Randomly Biased Greedy (RBG) algorithm of [3] is the first to obtain simultaneous bounds on regret and competitive ratio. The strategy of the algorithm is to minimize the work function greedily with a randomized bias.

One of the challenges of this study is that the cost function of the LCP algorithm is defined differently from the cost function for the algorithms from Bansal et al. [1]. We have implemented the algorithms from Bansal et al. [1], but must now redesign and implement the LCP algorithm in terms of the cost function of Bansal et al. [1], complete implementation of the RBG algorithm, and evaluate their performances against both the optimal solution as well as against one another.

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PO-2228 (Track: Computer and Information Technology)

A Combinatorial Approach to Evaluating Streaming Algorithm Performance

James Evans (Princeton University)

As the need to process large, continuous streams of data becomes more universal, data streaming and the design of streaming algorithms has become a flourishing field. To date, the field has blended theoretical and practical results, but little work has been done to formalize testing approaches to rigorously evaluate new algorithms. We mostly identify three broad classes of inputs used in testing: streams drawn from a uniform distribution ("random streams"), those drawn from a distribution intended to simulate real-world data (such as Zipf distributions used to model natural language), or real data, itself. Because of the vast number of applications some of these streaming algorithms may encounter, it is not clear that looking at average-case behavior provides a sufficient picture of algorithmic performance. We argue it is important to identify which properties characterize problematic inputs, as well as the likelihood of these types of inputs occurring in a (perhaps constrained) input model. To this end, our approach relies on modeling inputs as combinatorial objects, allowing us to leverage techniques from analytic combinatorics to (a) exhaustively generate and probabilistically sample to test algorithms with specific inputs, and (b) correlate performance with specific combinatorial characteristics while using asymptotic analysis to reason about the prevalence of these characteristics. To substantiate the method, we analyze the "AMS Sketch," due to Alon, Matias, and Szegedy, for computing the second frequency moment F_2 of a stream. The testing procedure (often functioning as feedback loop) involves the following. 1) Select a combinatorial object to model the input to the algorithm being tested, with the goal of collapsing together inputs identical from the perspective of the algorithm. 2) Find an estimator of "performance" (either accuracy or resource usage). This estimator can be a function of the input, or a measurement on the algorithm itself. 3) Exhaustively generate (for small N) or randomly sample (for larger N, likely using a class of algorithms known as Boltzmann Samplers) inputs to assess the behavior of the algorithm across a wide variety of inputs. 4) Finally, correlate characteristics of classes of inputs with "performance," to both isolate factors critical to the operation of the algorithm and predict the behavior of the algorithm on unseen inputs. In the case of the AMS sketch, we choose an integer partition input model, exponentially reducing our sample space from the space of permutations by eliminating notions of element identity and ordering. Our "performance" estimator is chosen to be the theoretical variance of the random variable representing the error of the AMS sketch. We then identify an incidence metric due to Hwang (a mapping from multisets to sets) as a driver of the sketch's accuracy. This finding makes precise our intuition that the algorithm performs well on streams containing heavy hitters, and allows us to assess, in an online fashion, whether the sketch is likely to be accurate using nothing more than a bit string to approximate the Hwang metric.

PO-8507 (Track: Computer and Information Technology)

Multimodal Brain Computer Interface for Binary Communication with Locked-in Patients in the Intensive Care Unit

James McLean, Wyatt Bertorelli, Laurel McCallister, Samuel Rendall, Fernando Quivira (Northeastern University)

Delirium is a mental health condition characterized by disorganized thinking, inattention, and in some cases, hallucinations. Its occurrence has a direct correlation with mortality rate in the intensive care unit (ICU). Screening for this affliction involves asking a series of unambiguous yes or no questions to assess the patient's awareness. Unfortunately, some patients are disabled so severely that they are unable to communicate through conventional means. While some patients can manage basic communication with hand squeezes or small eye motions, many are unable to perform even these rudimentary actions. Brain computer interfaces (BCIs) provide a robust platform for doctor-patient communication by utilizing non-invasive physiological signals such as electroencephalography (EEG) to detect a subjects' intent without having to rely on any physical response. Our group proposes a multi-sensory BCI system specially designed for delirium assessment in the ICU. This device will be equipped to communicate with patients through the visual, auditory, and tactile modalities to accommodate the myriad of patient conditions encountered in the ICU. Additionally, the device will conform to all ICU standards for electronic devices and utilize a novel machine learning pipeline for high accuracy classification.

PO-9047 (Track: Humanity and Social Development)

Learning Subject-specific Fixation Patterns in Unconstrained Natural Environments

Jing Lin, Matt Peterson, Nancy Kanwisher (MIT)

The human visual system is remarkably adept at transforming visual signals from the external world into neural and cognitive representations. These representations must retain accurate task-specific information to form appropriate action plans and update world knowledge to create accurate models of the world. This implies that the brain has likely developed an information-processing structure tuned to the statistical properties of the visual world. This is especially true for facial recognition where people regularly outperform the state of the art computer vision algorithms at recognizing a diverse set of signals, from detection to identity and intent, from small samples in unconstrained environments. Human face recognition ability remains robust across increasingly unconstrained viewing environments, where uncertainty in pose, illumination, expression, occlusion, etc. create significant computational challenges. A complete understanding of these mechanisms requires a comprehensive statistical estimate of the visual input we encounter every day, determined by a combination of the surrounding visual environment and our eye movements. Here, we use a recently developed mobile eye tracking framework to gather and analyze an unprecedented large data set of the fixation patterns of thirty subjects as they walk about in natural, unconstrained real world environments. We develop machine learning models to answer two questions. First, do people enact distinct and reliable gaze patterns during everyday vision? To answer this, we attempt to classify our subjects based on each individual's fixation pattern. Second, what are the visual features that predict where we look next in the real world? Using the Caffe Deep Learning Framework on our fixation points, we develop a new real world saliency model. A more accurate saliency model would provide a more complete understanding of the computations and representations that underlie human perception. Furthermore, computer vision algorithms that combine a saliency model trained on real world natural image statistics with an object detection model may be more proficient and robust than object detection models alone.

PO-3912 (Track: Humanity and Social Development)

Spectral Anomaly Detection with Machine Learning for Wilderness Search and Rescue

Julia Proft (Connecticut College); Jesus Suarez, Robin Murphy (Texas A&M University)

In wilderness search and rescue missions, unmanned aerial vehicles (UAVs) may be deployed to collect high-resolution imagery which is later reviewed by a first responder. The volume of images and the altitude from which they are taken makes manually identifying potential items of interest, like clothing or other man-made material, a difficult task. For this reason, we created a program that automatically detects unusually-colored objects in aerial imagery in order to assist responders in locating signs of missing persons. The program uses the Reed-Xiaoli (RX) spectral anomaly detection algorithm to determine which pixels in an image are anomalous and then generates an "anomaly map" where brighter pixels signify greater abnormality. While the RX algorithm has previously been proposed for search and rescue missions, up until now it has not been evaluated in a high-fidelity setting with real responders and real equipment. We tested the program on 150 aerial images taken over the Blanco River area in Hays County, Texas after the May 2015 flooding and demonstrated the results at a workshop on flooding hosted by Texas A&M's Center for Emergency Informatics. Early feedback from responders suggests that RX spectral anomaly detection is a valuable tool for quickly locating atypically-colored objects in images taken with UAVs for wilderness search and rescue.

PO-0233 (Track: Humanity and Social Development)

Developing an Integrated Mobile Medical Platform for Rural India –Powering the System and Using Signal Compression to Reduce Sensor Power Requirements

Manting Lao (MIT)

Although technological advancement has all but eradicated numerous deadly diseases that have plagued humanity for generations, rural areas worldwide are still struggling to catch up to modern-day levels of basic healthcare. This is especially true in rural India, where official healthcare is provided through tiers of health centers from local to regional levels. However, the lack of medical staff and technological support has led to an alarmingly large patient-to-provider ratio. This has in turn led to the dissemination of many monitorable and curable illnesses such as anemia and heart disease in rural communities. While portable medical sensors and mobile medical apps have been designed, there has yet to be a complete, system-wide mobile solution. The goal of my project is to develop and test a complete mobile health suite, which will include a mobile app, portable medical sensors for medical screening, and a reliable self-contained power system for use in rural areas. My main focus is to analyze and engineer the power system behind our mobile medical suite and research different signal compression algorithms over Bluetooth Low Energy for electrocardiogram. The goal is to minimize the amount of data that needs to be processed and sent from the electrocardiogram sensor to the mobile phone so that minimal power is used.

PO-0694 (Track: Computer and Information Technology)

Fully Hardware Neural Network with Arduino Nodes Implemented with Backpropagation on a Remote Controlled Car

Mohammad Khan(Connecticut College), James Meyers (US Coast Guard Academy)

The goal is to develop a fully hardware neural network utilizing Arduino microprocessors functioning as nodes that will be able to learn live decision making utilizing the backpropagation algorithm. In this implementation, each of a set of Arduino microprocessors, will act as a single neuron with learning capabilities. This mechanism will be applied to a small model car, equipped with sonar sensors for distance detection, that will learn to drive without collisions in a colony space by observing control inputs by a human driver performing the same task. Instances of previous research were considered in this implementation. Although a few described using neural networks for similar tasks, none used ones that were fully implemented in hardware with individual microprocessors performing the task of a single neuron. The most similar previous work was in optimizing a neural network driven car that utilized image processing done by Hadik et al. from Brown University. They developed a robust neural network running on an iPhone that learned decisions from pictures. Publications on other neural network implementations were studied. The ALVINN (An Autonomous Land Vehicle In a Neural Network) by Pomerleau from Carnegie Mellon University was studied for adaptive approaches to neural network testing. An overview of two decades of practise in applications of neural networks by Misra et al. from the Institute of Engineering and Technology, India was studied to get a grasp on neural network applications. There are no results at this time; the research is ongoing. Focus is currently being given to producing optimal communication between single chips in order to determine how to build the network. We will test the implementation on learning logic gates. We are experimenting with wiring and simulations of remote control signals to optimize communication. Coding is done in Arduino.

PO-6949 (Track: Computer and Information Technology)

Software development for multi-wavelength image correlation

Samantha Miller (St. Joseph's College)

The National Synchrotron Light Source II (NSLS-II) at Brookhaven National Laboratory offers a large variety of synchrotron based imaging techniques that provide users with structural and chemical information of materials at the nanoscale. Multiple imaging techniques such as light microscopy, infrared imaging and X-ray fluorescence microscopy are commonly used to correlate information from the same sample. Correlating the important information in images presents a large technological challenge because the various imaging techniques generate images of different sizes and spatial resolutions. To overcome this challenge, there are two goals involving software development. The first is to identify a method for using fiducial markers to correlate visible light images with X-ray fluorescence microscope images at the micro- to nanoscale and secondly to develop software for fusion(i.e. overlap) and correlation of these images. Numerous programs were identified to complete this project, such as Matlab, Python, Photoshop, ImageJ and Fiji. After doing much research and testing a variety of these programs, it was clear that Fiji is the best and most efficient program for solving these challenges. It has the capability to align images automatically by converting the image to 8-bit gray scale, finding the maxima (darkest points), and stacking/and/or/corresponding these max points to perfectly align images. Moreover, it has the capability to use manually chosen fiducial point markers where the user inputs landmarks or fiducial points on the image and the program triangulates the points to align them. In addition, I wrote a user manual so that other synchrotron users can benefit from this methodology as well. Overall, this process will prove to be very useful in the future of the laboratory in cases where image correlation is vital. The majority of photon sciences involve correlating images and analyzing the data that come out.

PO-8658 (Track: Computer and Information Technology)

SUNglass: An Infrastructure for the Understanding of Physical Contexts

Pallavi Koppol (Princeton University)

The modern technology landscape has been seeing an influx of intelligent systems designed with the intention of understanding user needs and responding to them without prompt. While these systems are largely successful — they are capable of automatically updating our calendars with flight information or of learning our accents — they are hampered by an inability to relate to the physical world. They do not know when a user is looking at a famous painting that he wants to take a picture of, or at a poster for a film he wants to see.

Consider that on most mobile devices, a camera is the technological equivalent of a human being's eyes, with the added ability to retain information accurately and without alteration. However, on many of those mobile devices, cameras are reserved solely for capturing images and videos that are of particular interest to the user. In addition, there are a wide range of applications that are created especially for the purpose of editing, touching up and sharing these images. Furthermore, there is an entire subset of journaling applications that similarly encourage the capturing of images of interest as a means of documenting a person's life.

People are increasingly choosing to document and annotate their life with pictures. The sudden emergence and incredible popularity of applications such as Instagram, which revolves solely around the sharing of images, is evidence of this. However, because cameras on most mobile devices require the user to actively decide to take a picture, it is simply not feasible to use these cameras in the same way that a person might use their eyes. Intelligent systems have, therefore, relied on less information-rich means of understanding their context and providing useful forms of information, and people have continued to use their cameras to manually document their lives.

With the introduction of novel wearables such as the Google Glass, which feature front-mounted, hands-free cameras capable of streaming continuous visual data, there is incredible potential to lessen this disconnect between an intelligent system and its user. Along with advances in scene recognition capabilities, this gives us the opportunity to allow intelligent systems to understand physical contexts in entirely new ways. In this paper, we propose an infrastructure that will allow for real-time scene recognition and provide an effective means of browsing massive amounts of collected data: an infrastructure intended to support the development of autonomous scene-triggered actions and effective summarization and documentation of a user's day-to-day activities. This is a two-part process. One part, scene recognition, has some degree of immediacy to it. The second part is more user-oriented: users should be able to effectively make sense of and interact with vast amounts of collected visual data. As a proof of concept, we have designed and constructed a Google Glass application and a website, which work together to achieve these two goals.

PO-8588 (Track: Communication and Connectivity)

Experimental Evaluation of Co-existent LTE-U and Wi-Fi on ORBIT

Samuel Baysting (Rutgers University)

LTE and Wi-Fi are the two prominent wireless technologies in the market today, each with its own advantages. Wi-Fi resides in the unlicensed 2.4 GHz and 5 GHz spectra, making it readily available for consumers while LTE requires a licensed spectrum to operate, usually under the supervision of cellular service providers, but provides data connectivity for mobile devices and ensures the quality of service. To satisfy the increasing mobile data demand, unlicensed operation of LTE services is emerging as a solution which conflicts with the Wi-Fi operation in these spectrum bands. This research project aims for experimental evaluation of the performance of Wi-Fi in the presence of co-channel LTE-U. In our previous work, an analytical model is constructed based on the protocols of LTE and Wi-Fi and used as a baseline in this current work. I have conducted experiments on the ORBIT testbed at WINLAB using USRP SDR technology as well as the open-source OpenAirInterface (OAI) which is the software implementation of LTE. Also, I have used off-the-shelf available Wi-Fi 802.11n nodes in single-input-single-output (SISO) mode. For evaluation purposes, we have tested the Wi-Fi throughput under different LTE bandwidths- 5, 10 and 20 MHz. Our results show that, in the co-channel operation with LTE, Wi-Fi throughput gets degraded by 20 to 60% for the scenario under consideration. We also show that our analytical model matches with these experimental results. We note that no such experimental evaluation is available in the literature. Thus, this experimental evaluation provides the validation of the analytical model using real systems. This evaluation further helps to support inter-network coordination between Wi-Fi and LTE to mitigate interference and improve overall data rate of the network.

PO-2922 (Track: Information Processing Technologies)

Interactions Between Gliding Dislocations in 3C-SiC(001)

Steven Ceron (University of Florida); Hiroyuki Nagasawa, Maki Suemitsu (Tohoku University)

3C-SiC has been identified as a leading semiconducting material for use in high voltage, high temperature, and high frequency devices. In contrast to the other SiC polytypes, 3C-SiC has shown great potential through its high saturated electron drift velocity and its exceptionally low density of states at the 3C-SiC/Si interface, making it an attractive option for use in power-switching metal oxide semiconductor field-effect transistors (MOSFETs) with a blocking voltage of 600 – 1200V. However, stacking faults form as a result of the 19.7% lattice mismatch at the 3C-SiC/Si interface, and then propagate during epitaxial growth along four equivalent planes. The counter pair of carbon-terminated stacking faults will propagate along the (-111) and (1-11) planes, and the counter pair of silicon-terminated stacking faults along the (111) and (-1-11) planes. During epitaxial growth, there is no possibility for opposing stacking faults to intersect; as a result, one stacking fault simply terminates the other and thus an electrically active defect is formed.

After epitaxial growth has concluded, the presence of the stacking faults cause an intrinsic stress to play a role on the system. The stress causes the carbon-core partial dislocations at the edges of the stacking faults on the four respective planes to deviate in specific directions from their current plane, resulting in the expansion of the stacking faults along those directions. As a result of the deviation of the stacking faults from the four equivalent planes, they are now able to perpendicularly intersect, thus producing crowd lines of point defects called forest dislocations. The forest dislocations are made up of a line of frank type dislocations and are believed to be the main cause of high leakage current density in the semiconducting material.

Monte Carlo simulations are employed to model the formation, propagation, and expansion of stacking faults, as well as the generation of the forest dislocations. The numerical analysis allows for a clear picture of the density of the forest dislocations throughout the system as a function of the stacking fault density, shear stress, and material thickness. In addition, the study predicts the orientations along which the forest dislocations will most likely form. It is expected that the highest leakage current will occur when the electricity is transmitted through the material in these orientations. Further analysis of the mechanisms by which forest dislocations form and the leakage current occurs will lead to more sophisticated fabrication processes of 3C-SiC.

The results of these simulations are not only applicable to 3C-SiC but could also lead to greater insight into the mechanisms by which electrical degradation occurs in different semiconducting materials that are used for a variety of transistors. The application of these numerical studies to different crystal structures could result in a major improvement in the efficiency of transistors which would lead to the processing of larger amounts of information in a shorter amount of time.

PO-2156 (Track: Humanity and Social Development)

Comparing Auction Pricing Mechanisms for Single-Minded Bidders

Tyler Wood, Rodrigo Rogel-Perez (Connecticut College)

We consider a single-round, sealed-bid combinatorial auction for allocating a set of items to a set of bidders, each of whom is interested in a single particular bundle of items, also known as the single minded bidders problem. In this model, we have a limited number of goods, and a limited number of players. Each player desires a specific bundle of goods and has a valuation for this bundle. Players are not interested in incomplete bundles. Without knowing any other player's bid, each player privately submits a bid for their bundle, the algorithm decides who gets what and charges each winner a price no larger than their bid value. Furthermore, if two players' bundles share a good, only one of these players can win, as the items are distinct and indivisible. A player's payoff if they win is the difference between their valuation and their payment amount, and 0 if they lose.

Two key constraints of auction mechanism design include maintaining truthfulness and fairness. Truthfulness is achieved when each player bids their true valuation for their bundle and receives no competitive advantage from inflating or deflating this value when bidding. The way we do this is by charging players their critical values: the value under which they would no longer win their desired bundle. The other characteristic of a truthful auction is monotonicity, which is the principle that by changing one's bid upward, they are not going to go from being a winner to being a loser; they only risk paying more than their valuation.

Using a variety of selection methods for winners - arranging players by number of desired goods in their bundle, by overall value they place on their bundle of goods, or by the value per item in their bundle - we implement three distinct greedy algorithms in this auction setting. We also look at a variety of pricing mechanisms. We elected to charge players either their simple critical value (the full value of the next highest competing player), by the critical value per item of the next highest competing bidder multiplied by the number of goods in the winner's bundle, or by adapting and using Random Sample Optimal Price (RSOP), which, informally speaking, is the strategy of dividing the players into two groups, finding the best price for each group, and charging it to the other.

The main optimization benchmark we examined was social welfare, which is the sum of the valuations of the winning bidders. We also compared the profit earned by the different auction mechanisms, which is the sum of what winners actually paid for their bundle.

We experimentally show that when using a uniform distribution of goods, higher profits are yielded on average when charging by the unit. We also find that expected profit grows the fastest when we increase the number of players in the uniform distribution. Results for social welfare will be determined with ongoing research, but we expect to see similar trends as those found with profit.

PO-8313 (Track: Humanity and Social Development)

CamelTours: Preserving Cultural Heritage through a Mobile Web-App

Virginia Gresham (Connecticut College)

CamelTours is an open-source software web application developed by an interdisciplinary research team comprising students and faculty at Connecticut College. The project addresses persistent inequities in access to the means and technologies by which local communities can author their own histories. CamelTours has two main purposes: (1) to allow anyone with access to a web browser to easily and automatically build multimedia tours by uploading images and audio files; and (2) deliver multimedia content onto the mobile devices of tourists and other end-users in the form of audio-narrated image slideshows.

One defining feature of CamelTours is that on-site access to tour content does not require an Internet connection. Tours can be downloaded and cached prior to travel or at a WiFi-enabled starting point. Users access narrated slideshows by scanning QR codes during their self-guided tour. Because ours is a web app rather than a native OS app, offline access of data posed a significant and unique technical challenge. Our solution to this problem was that we used local browser storage as a method for caching tour content.

CamelTours serves the interests of historical societies, museums, and other communities by allowing their visitors to engage in the site outside of the regularly scheduled hours, increasing the use of modern technology at their sites, introducing a new method of teaching the material, and dovetailing with the cultural movement towards mobile devices. Since it is a free and open source software application, organizations that would need to spend thousands of dollars to develop their own native applications do not need to raise funds for adding new technology to their location. In addition, since the QR code for each tour stop links directly to the web-hosted content that is controlled and managed by the tour creator, the information can be dynamically updated, preventing the need for signage to be updated when the information needs to be.

Currently, there are several CamelTours being created by communities within Connecticut College, in the surrounding area, and across the state. These communities include Connecticut College's Office of Sustainability, Connecticut College's Office for Volunteers for Community Service (OVCS) along with Southeast Area Transit (SEAT), Guilford, CT's Guilford Preservation Alliance (GPA), and the Connecticut College Arboretum. We are currently in conversation with national parks, nature reserves, and other organizations who might be interested in using CamelTours. We view CamelTours as a sustainable, convenient tool which many groups would benefit from.

Ongoing and future work on CamelTours includes the addition of a mapping feature for node and tour locations, creation of a searchable, browse-able catalog of existing tours, enhanced features for ease-of-use such as automatic re-sizing of images, auto-conversion of audio files, and making use of geo-location data from the tourist's mobile device to enhance their experience on the tour.