Online Proceedings

Poster Session 1

Commons East, Easel 64

11:00 AM to 1:00 PM

A Survey, Model Design, & Benchmark Test Implementation of Agent-Based Applications

Caleb Yang, Senior, Computer Science & Software Engineering, Mathematics (Bothell Campus)
Mentor: Munehiro Fukuda, Computing and Software Systems, University of Washington Bothell

Our research at the Distributed Systems Laboratory of the University of Washington Bothell seeks to develop and release an agent-based simulator (Multi-Agent Spatial Simulation C++) for researchers in various fields such as in biology, business/industry, and economics/social sciences. Researchers already use agent-based modeling techniques; where the chosen micro-behavior for agents produce the simulation's macro-behavior. For example, the life-cycle of a mosquito agent is a chosen micro-behavior a researcher would use to model the spread of disease in a city. Which contrasts with the assumed macro-behavior in differential equation based simulations. However, researchers do not use a universal application that is easily programmable, but instead have the overhead of learning how to use other dedicated applications. My objective is to utilize the identified core logic of new agent-based models by coding them as a benchmark test program, further improving the in-house simulator through the benchmark analysis. The benchmark analysis will compare speed, performance efficiency, and scalability with RepastHPC and FLAME. RepastHPC and FLAME will be considered the alternatives because of their known popularity and usability in the research of agent-based modeling. We expect and have already found that not all applications will be capable of being directly ported because of factors such as an agent's micro-behavior, how agents communicate, even how the topology is constructed. Where a topology is how the system arranges the environmental elements such as in slices of a 2D plane, or a network of connected nodes. This information can be used to improve the in-house simulator's library for future releases. Additionally, with the benchmark analysis we can determine empirically whether or not the in-house simulator is a better alternative for researchers.

Session 1I

McNair Session - Exploring Science from Cells to Exoplanets

Session Moderator: Janneke Hille Ris Lambers, Biology

MGH 254

12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Pollen Preference of *Osmia lignari*a (Hymenoptera: Megachilidae) in a Commercial Blueberry Field

Margaret Elizabeth (Maggie) Hartman, Senior, Fisheries and Wildlife Management, Northrn Michigan Unv
McNair Scholar
Mentor: Rufus Isaacs, Entomology, Michigan State University
Mentor: Mario Pinilla-Gallego, Entomology, Michigan State University

Alternative pollinators such as the mason bee (*Osmia spp*.) are becoming increasingly important in agriculture as European honey bees (*Apis mellifera* L.) continue to decline. *Osmia lignaria* are especially important pollinators because they make contact with the anther and stigma during nearly every flower visit and are less likely to rob the plants of nectar without pollination. Previous studies indicate *O. lignaria* preferentially visit plants in the Rosaceae family, such as apple, cherry, pear and plum. The objectives of this study were (1) to analyze pollen loads in relation to proximity of natural areas surrounding the blueberry field and (2) to determine their pollen preference in a blueberry monoculture ecosystem. This study was conducted in a commercial blueberry field in southwestern Michigan. Pollen samples from flowering plants and *O. lignaria* nests were collected. Acetolysis was performed on all pollen samples, and pollen from *O. lignaria* nests was qualitatively and quantitatively analyzed. At this study site, *O. lignaria* collected pollen from white clover (Trifolium repens) and black cherry (Prunus serotine) most often. In spite of its availability, pollen collected from blueberries (Vaccinium corymbosum) accounted for significantly less of the total pollen. These findings are useful in determining the viability of *Osmia* species as crop pollinators. Based on the results, *Osmia lignaria* would not be a good option for blueberry pollination.

POSTER SESSION 3

Commons East, Easel 70

2:30 PM to 4:00 PM

Design a Pulsed Optically Detected Magnetic Resonance Microscope

Maya Dunn, Senior, Physics: Comprehensive Physics
UW Honors Program
Mentor: Kai-Mei Fu, Physics/ECE

Diamond magnetometry enables the measurement of small-scale magnetic fields using nitrogen vacancy (NV) defect centers in diamond. Nanoscale magnetic field detection has a range of applications in biology and chemistry, such as imaging of magnetically-tagged molecules for the study of biological processes. Diamond magnetometry uses optically detected magnetic resonance (ODMR), a technique which combines radio frequency (RF) magnetic fields with optical excitation to control the defect spin. To detect DC magnetic fields, typically continuous wave RF and optical fields are used. However it is well-understood that continuous optical excitation limits the sensitivity of the technique. This project demonstrates a pulsed ODMR system executed in LabVIEW, in which optical initialization and radio-frequency spin control are staggered in time and compares the performance against the continuous wave execution. This program will enable more sensitive measurements of biological systems where orientation matters.

POSTER SESSION 3

Commons East, Easel 69

2:30 PM to 4:00 PM

The Effects of High Temperature Annealing on NV Centers in Diamond

Kelsey Bates, Senior, Physics: Comprehensive Physics, Mathematics (Comprehensive)
Mentor: Kai-Mei Fu, Physics/ECE
Mentor: Emma Schmidgall, Physics

The nitrogen-vacancy (NV) center is a defect in diamond formed by replacing two carbon atoms by a nitrogen atom and a vacant lattice site. The NV center is a promising qubit candidate for quantum information, and its sensitivity to magnetic fields allows it to measure these fields. Due to the lattice structure of diamond, the NV center can have one of four possible orientations. For quantum information and sensing applications, control over this orientation is desirable, and would enable the production of better quality devices. Ab initio models predict that the NV orientation can be controlled through annealing, however the model depends critically on the barrier heights for defect diffusion which are difficult to calculate quantitatively. Preliminary data from our group demonstrated that heating the diamond up to high temperatures ($>$ 1000 C) can sometimes cause single NV centers to appear, disappear, or change orientations. However, information on the frequency at which these changes occur, and thus information on barriers for diffusion, were unknown. Here we conduct thousands of single defect studies to determine these relevant rates as a function of the annealing temperature and time. While NV centers fluoresce under green laser light, restricting the polarization of this light only allows NV centers in that direction to fluoresce. By taking multiple confocal images at several polarizations, two families of orientations can be distinguished. These images are taken before and after the annealing process and then are compared using customized computer software to gather statistical data on the dynamics of single NV centers.

POSTER SESSION 3

Commons East, Easel 71

2:30 PM to 4:00 PM

Towards Quantum Information with NV Centers in Diamond

Ian Christen, Senior, Mathematics (Comprehensive), Physics: Comprehensive Physics
Mary Gates Scholar, NASA Space Grant Scholar, UW Honors Program, Washington Research Foundation Fellow
Mentor: Kai-Mei Fu, Physics/ECE

All physical systems are ultimately governed by the laws of quantum mechanics. Over the past decades, it has become clear that these laws enable new generations of quantum information technologies that can profoundly outperform their classical counterparts. However, this depends critically on (i) the ability to efficiently entangle quantum systems (qubits) at rates much faster than the rate of quantum decoherence and (ii) the ability to scale the system with reasonable cost per added qubit. Color centers in diamond, such as the nitrogen-vacancy (NV) center, have emerged as a promising qubit candidate. Pairs of NV centers can be entangled via the interference and detection of emitted single photons. Entanglement generation with this method was previously demonstrated in a non-scalable manner; adding additional qubits would require the costly hand-assembly of macroscopic equipment. This project aims to develop integrated circuitry for quantum information, where each macroscopic device is shrunk to an equivalent piece of photonic circuit. Such circuits are easy to devise, but are extremely difficult to realize in the non-ideal circumstances of reality. Two main effects contribute to this difficulty: (1) the optical properties of NV centers are damaged by local imperfections in the diamond environment and (2) comparatively low fabrication precision prevents ideal production of photonic circuitry. We are developing both (a) passive and (b) active methods to mitigate these errors. This includes (1a) high temperature annealing of our diamond to reduce local defect concentration, (1b) applying electric fields to dynamically stabilize the local electro-magnetic NV environment, (2a) improving etch quality by reducing sidewall roughness and slant, and (2b) developing a wet etch to deterministically correct circuit dimensions. Further progress depends on traversing large parameter spaces to determine the optimal settings for success. Thus, automated testing procedures are being developed to make this traversal possible.

POSTER SESSION 3

MGH 241, Easel 162

2:30 PM to 4:00 PM

Examining Mutations in Presenilin 2 Associated with Alzheimer's Disease

Leah Ariel Osnis, Senior, Biochemistry
UW Honors Program
Mentor: Suman Jayadev, Neurology
Mentor: Susan Fung, Neurology

Mutations in the gene Presenilin 2 (PSEN2) cause familial Alzheimer's disease (fAD). FAD shares clinical and pathological features of sporadic, late onset AD thus fAD cell models can be useful to study mechanisms relevant to all forms of AD which is critical to developing effective AD therapeutics. Presenilin 2 protein (PS2) forms the catalytic subunit of the γ-secretase complex, which cleaves amyloid precursor protein and releases Aβ1-42, considered a pathogenic contributor to Alzheimer's disease (AD). Our laboratory is interested in a fAD associated PSEN2 mutation, a frameshift two base-pair deletion (PSEN2 K115Fx) . The PSEN2 K115Fx is predicted to either lead to a truncated protein suggesting that the mutation may create a shortened peptide that interferes with normal cellular function (dominant negative or toxic gain of function) or result in degradation of the RNA transcript and subsequent loss of normal amount of PS2 protein (loss of function). To better understand how PSEN2 mutations cause disease, we have two objectives. The first aim of this project is to determine if the PSEN2 K115Fx does indeed result in a truncated protein or influence levels of wildtype PS2. I will be collecting human cultured fibroblasts isolated from AD patients with the PSEN2 mutations or controls and prepare cell lysate for analysis by Western blot. My colleague will also be analyzing mRNA levels from those same samples to determine the stability of the PSEN2 mutant and wildtype transcripts in all cases. The second aim is to determine the impact of the mutation on PS2 enzymatic activity. I will culture the cells described above, then infect with a luciferase based enzyme reporter assay to compare the impact of PSEN2 mutations on γ-secretase mediated cleavage of APP. My work will help identify the candidate mechanisms by which the PSEN2 K115Fx mutation causes AD.

POSTER SESSION 3

Commons East, Easel 68

2:30 PM to 4:00 PM

Building a Low Cost Laser Power Meter and Controller for Quantum Information Research

Jared Nakahara, Senior, Electrical Engineering
Mentor: Kai-Mei Fu, Physics/ECE
Mentor: Michael Gould, Physics

Quantum information research often require lasers to deliver energy to devices and to acquire data. The goal of this project is to create an inexpensive and easy-to-build tool to measure and control laser power to support our lab's quantum information research. The tool interfaces with our lab's existing data collection and analysis modules. A standalone module is also present for adoption outside of our lab. Some of the intended applications of this tool are the generation of saturation curves for quantum emitters, and performing photoluminescence excitation spectroscopy on samples, both of which require precise control of laser power. The system uses a National Instruments data acquisition device to record a voltage generated by a laser power sensor. The software module also interfaces with an Arduino microcontroller, which can be used to adjust the laser's power. The software module allows the user to set, monitor in real-time, and record laser power from a graphical user interface. The data taken utilizing the developed power controller will advance the development of quantum computation hardware based on single photons and quantum spins. Quantum computers are theoretically predicted to solve certain classes of problems that are currently unsolvable on today's computers, including the factoring of large numbers which is at the heart of current secure communication protocols.