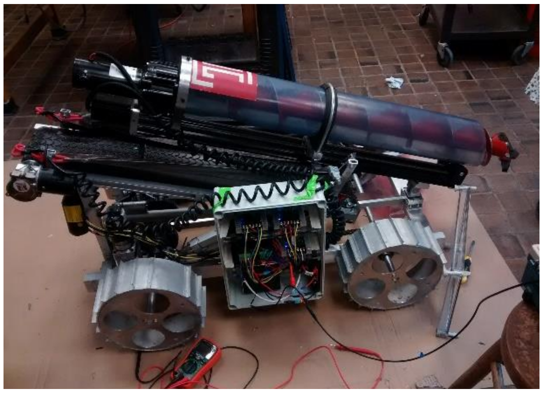
ENGINEERING PORTFOLIO

Bhautik (Brian) Amin
Temple University

B.S. Bioengineering

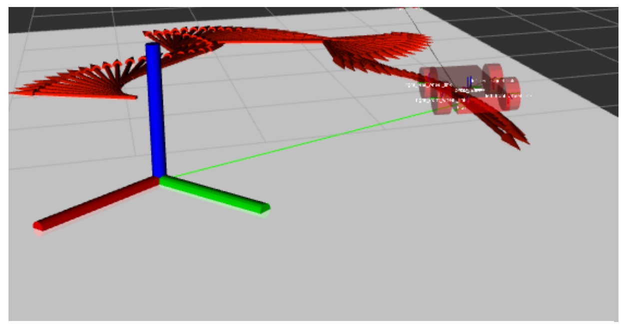
NASA Robotic Mining Competition



2017 Competition Robot

Upon joining the Temple University Space Exploration and Embedded Systems Lab, under the advisement of Dr. John Helferty – I am serving as the systems and software engineering team lead for the university's entry to the NASA Robotic Mining Competition. In this competition, my team and I are tasked to build an autonomous mining rover, capable of traversing harsh terrain to excavate simulated lunar regolith.

Most of my work with this project is to maintain all of the subteams (electrical, mechanical, software, materials, business), and carry out most of the project management and logistics (for both the engineering, and the business) in order to make this competition happen for the team. Along with this, I am also the lead engineer for the software team specifically. For the software team, I employed heavy use of project management through Gitlab, and carried out with the team much of the design work for the autonomous ROS architecture, as well as the network and manual control architecture for the robot. With the competition, there is a hard bandwidth limit (~50kb/s) which really makes optimizing the transmission of data from the robot to the user interesting and challenging. Some of the work I have done would be building a fiducial tracker based pose estimation node for global localization of the robot in the mining arena. Along with this, I wrote some hardware drivers for the motor controllers, as well as sensors such as the IMU. I also worked on the dynamic modeling of the robot, modeling the forward kinematics of the robot so when our ROS navigation stack published command velocities down to hardware level, my software to hardware handlers would easily be able to translate the data to wheel velocities that could be understood by the PID controllers in the hardware level.



Gazebo Simulation of the Robot with the navigation stack while visualizing odometry

Marker testing using small mobile platform

Autonomous Nerf Turret

Autonomous Nerf Turret

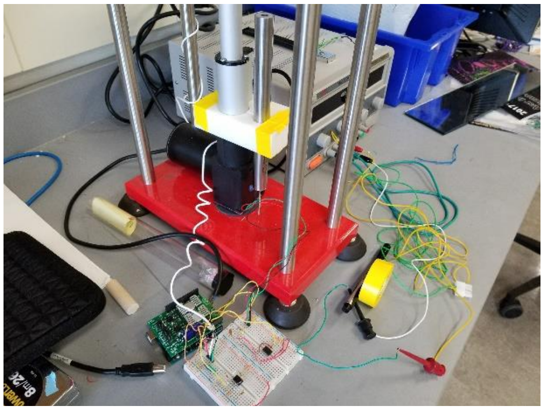
During some down time, I do like to get together with my engineering teams from the lab and work on side projects as well. One of my most notable side projects is the development of this autonomous nerf turret. Using computer vision and machine learning, the turret tracks faces and keeps them in the line of site. I finished this project last year, but in this past year (2018) I went back to improve much of the software I initially wrote for this project (OpenCV in Python). I wanted to make this turret a bit 'smarter' and redesign the control system that governs its motion. Setting up a PID Controller to move a DC motor to appropriate specified angles given by an IMU, and using the Microsoft Kinect SDK for more accurate real-time tracking and depth sensing. It's always been a fun project to work on during spare time.

A Robo-Revival

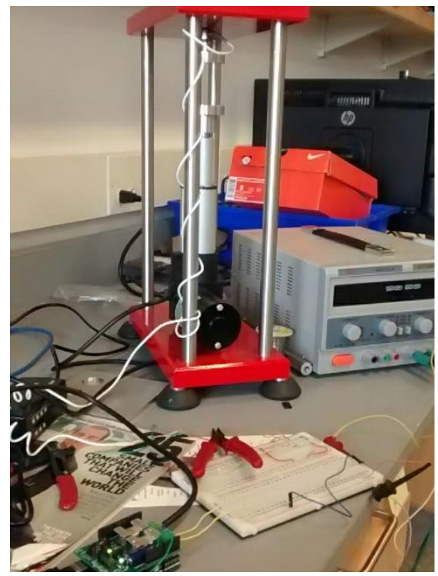
Retired competition robot

This front-loader robot competed in the NASA Robotic Mining Competition back in 2011 (Before I started competing). It was sitting in the corner of the lab collecting dust for the longest time. I decided to spend a couple weekends getting up and running, replenishing it with new tech, and writing software to be able to manipulate it. I wrote low level network socket drivers, and setup a JSON transmission line between a base station mobile app and the robot to be able to control it. The robot ran off a Raspberry Pi I configured to be its own wireless hotspot, and this robot was then used by the university for display and demonstration events. Eventually for a summer research study I chartered, I experimented with gesture based controls, using "Scoops" as a primary testing platform. The gesture based controller essentially queued commands given by the user to a camera (gesture convex tracking) and the robot would reply the given macros.

Mechania: Mechanical Tester

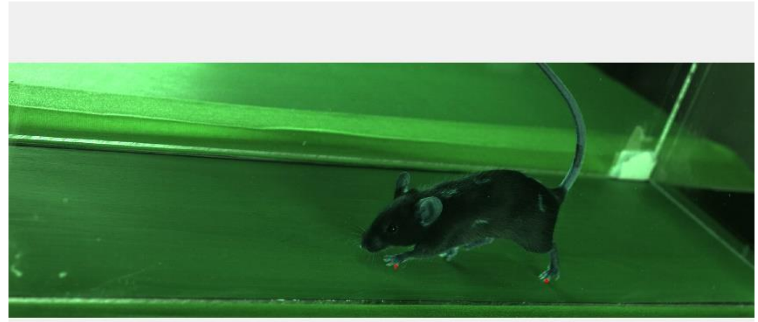

Wiring some amplifying circuits

I chartered this project under the advisement of Dr. Ruth Ochia from the Temple University Bioengineering department as an independent study. The project consists of the development of a mechanical testing machine able to gauge the mechanical properties of various bones, ligaments, and soft tissues through compression, tensile, and 3-point bending testing. My main duties with this project is to write the software the user will use to interface with the device, design and manufacture various mechanical parts for the device (such as plates, clamps, etc.), as well as design signal conditioning circuits for the sensors as well as a safe control and power systems for the device. I'm currently working on developing software for the device using C#/WPF, interfacing with an Arduino Uno connected to an array of sensors that measure displacement (magnetic encoder test strip as well as an LVDT) and force (a load cell). Along with this, I must abide to ASTM standards, and run my device through various verification and validation tests, as well as design and manufacture (through machining or 3D printing) various testing plates, brackets, and clamps.


Mechanica, mechanical tester machine

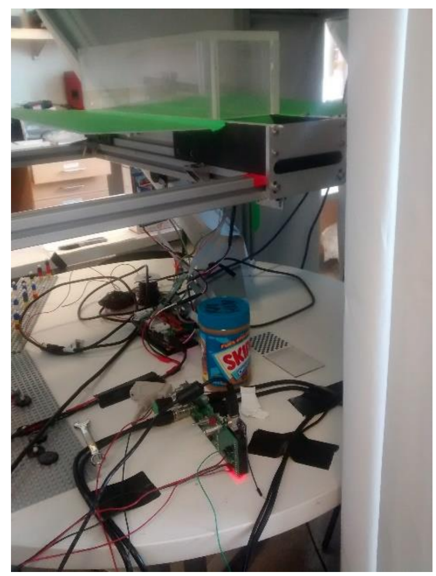
Laboratory Treadmill and Gait Analysis

Under the advisement of Dr. Andrew Spence, when I worked out of the university biomechanics engineering lab. In the lab, I built and programmed laboratory robotic treadmills that would be used for gait analysis of various rodents and cockroaches. I also explored the robust dynamics and behavioral elements that these animals portrayed during locomotion, and researched how the collected kinematics data from gait analysis could be potentially used to make robots carry out more robust adaptive gaits during locomotion. One of my first projects in this lab was the training of a graduate student's MATLAB machine learned based markerless paw tracker. From here I aided in porting this platform over to Python and OpenCV for real time tracking. From there, I started to dive more into ROS and build new features to the current gait analysis treadmill's computer vision odometry system, as well as go one to designing a new large scale treadmill. Along with this, I taken on side projects working with a biologically inspired hexapod robotic platform to investigate robustness of cockroach gait cycles.



Markerless Paw tracking

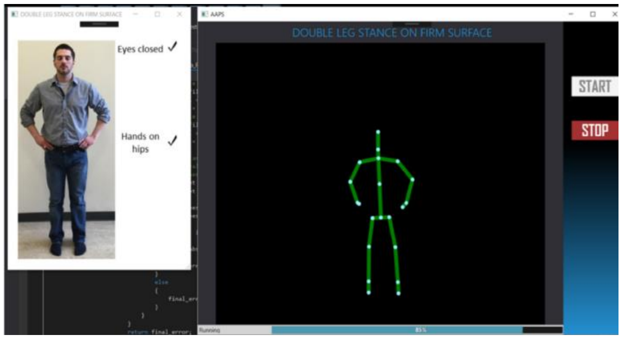
New treadmill project



Treadmill for gait analysis

Hexapod robot

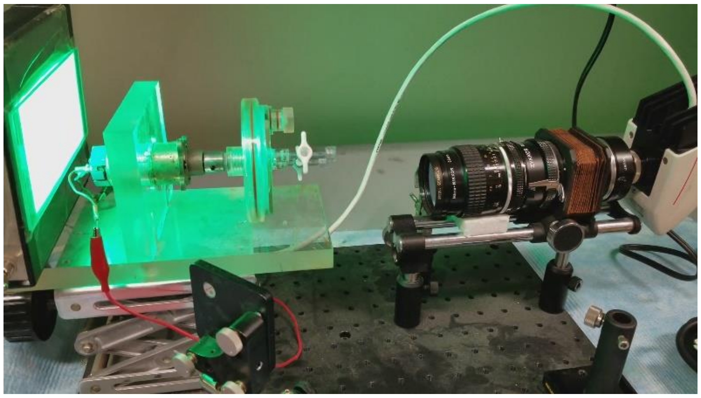
Visual Balance Testing Platform



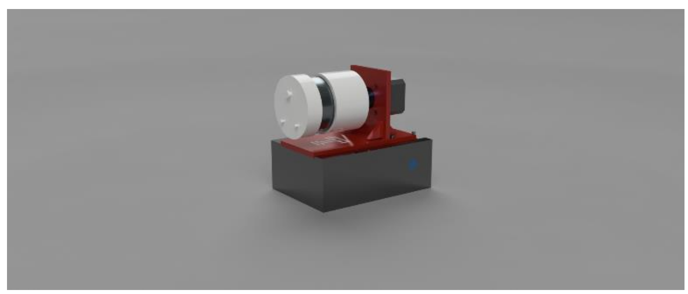
AAPS balance analysis

I worked out of the Neural Instrumentation Lab for a couple of semesters under the advisement of Dr. Iyad Obeid on AAPS. It was a suite of applications written in C#/WPF utilizing a Microsoft Kinect 2 to conduct visual balance tests to determine if the given occupant was suffering from a concussion. I wrote two pieces of software along with another developer in the lab for the suite of applications. A program a video converter program to take the multilayered. XEF files outputted by the Microsoft Kinect and export them in any user specified format. The program consisted of much multi-threading and optimization, to be able to convert many videos in a queue at the same time, without becoming memory hungry. Another program I wrote was a video annotator app that would allow clinicians to easily score research generated video segments manually, and in which the data would be sent over a socket to a machine learning platform to train upon the data received. I worked in a more software-developer like environment, employing heavy use of version control and project management (issue ticket tracking, etc.).

Exploring Partial Gravity

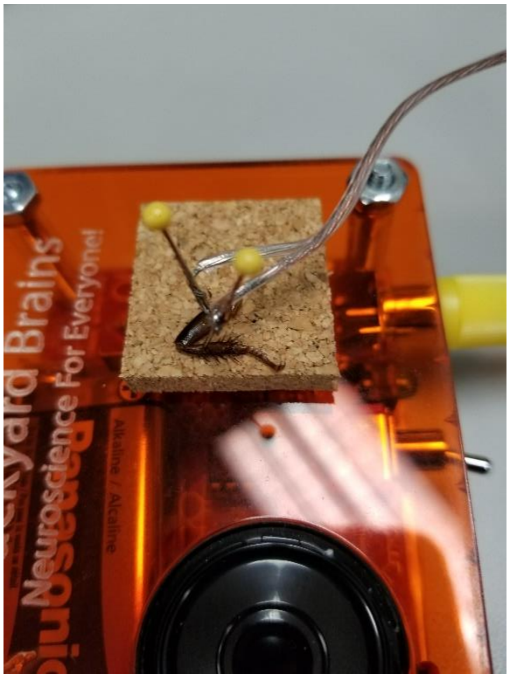


For my senior design project, I decided to take a step out of my comfort zone, and jump into looking into the relationship of gravity and biology on a cellular level. I am working with my senior design team to develop an angle-variable rotating wall vessel bioreactor kit that would essentially allow cultured cells to experience a constant state of freefall. With the varying angles, it is proposed that the effect of gravity lessens to the corresponding angle, and the cell will experience some level of simulated partial gravity (Such as on the Moon or Mars). Ironically, this project pulls more on my robotics and software knowledge more than the biology. Developing a device with a robust control system to maintain RPM and angles, as well as withstand being run for long periods of time within a high temperature high humidity incubator is the exciting and challenging component to this project. One particular task I am currently working on for this project is developing an OPM imaging rig to verify that the given shearing forces applied to the cells are within nominal predicated areas, the software that runs the camera uses computer vision to run optical flow to assess the trajectory of the cells/particles within the chamber. I also worked on developing a kinematics and computative fluid model of the device to understand the forces the cells are encountering, and what goes on as the device starts to roll up to a user specified angle/gravity state.



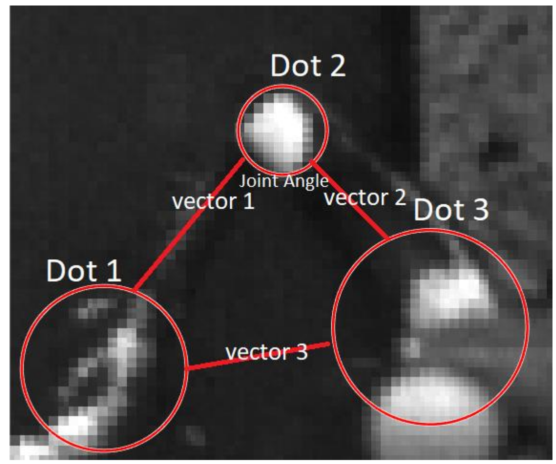
Autodesk Fusion 360 Model of final prototype

Hacking a roach

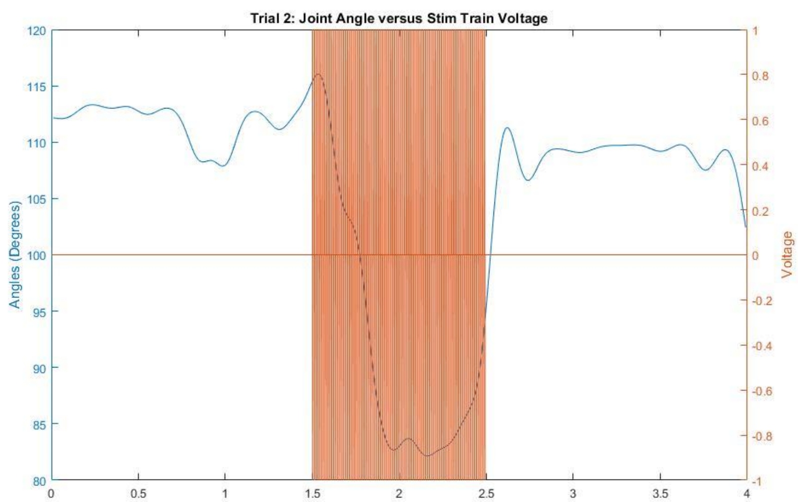


Backyard brains amplifier box

For my capstone, I built and worked with a BackyardBrains neural amplifier box to stimulate and acquire neural signals from various cockroach appendages. It was an interesting and inciteful jump into the field of neuroengineering and signal processing. I also build a roach tracker in MATLAB to see the correlation between joint angle change versus various spike train stimuli.



2D kinematic for tracking script



Sample data from angle-stimulus trials

Diving into business

From fall semester of my freshman year, to my sophomore year (surprisingly when I was still Ia Biology/Geology major); I have been competing in both Temple University's Be Your Own Boss Bowl (a business plan writing competition, spring), and the Innovative Idea Competition (endeavor proposal competition, fall). My spark into the world of entrepreneurship started freshman year when I took a general requirement class called "Creativity and Innovation: Strategic Management." The class educated me in the world of start-ups; how to brainstorm and come up with novel ideas, the importance of understanding value within an idea, how to find what is valued within a market, and much more. During the class, I was motivated by my professor to try brainstorming a couple project ideas and send them over to the idea competition. The idea I submitted was a business centered around connecting consumers (within the ag industry) to engineers/programmers to essentially design devices to help solve some environmental problem they may be facing within their agricultural industry. The company consisted on providing electronic platforms for these developers, and would intermediate the service to connect them to consumer; vice versa. Following the feedback, I received from the judges of the competition, I was motivated to participate in the business plan writing competition the following semester. In which I had to work with a mentor in writing a full business plan of my theoretical company; and participate in a "shark-tank" like live pitch of my project. The following fall of that year, I competed the same idea again in the innovative idea competition, and my entry was regarded within the 20% of projects.