Senior Design Expo

THURSDAY, MAY 8, 2014

12:00 - 3:00 PM

LERNER HALL, ROONE ARLEDGE AUDITORIUM

COLUMBIA | ENGINEERING

The Fu Foundation School of Engineering and Applied Science

Projects

Applied Physics and Applied Math Department

1. **Structural Investigation of Nanoscale Materials from X-Ray Diffraction Data through Modelling**
   Veronica Reynolds
2.

Biomedical Engineering Department

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   N.H. Diane Kim, Daniel B. Park, Sophie Wang, Timothy Weber
2. **Albatross**
   Jared Rozowsky, Peter Hosinski, Hyunho Rhee
3. **Auscultaid**
   Annabelle Anandappa, Kathryn Lau, Hari Raman, Alan Zambeli-Ljepović
4. **DownRight**
   Matthew Chang, Yuri Gloumakov, Tanya Shah, Wendy Sun
5. **High Quality Life Technology**
   Andrea Bogarin, Jessica Kleinbart, Eli Mondragon, Shannon Sullivan
6. **InVisiCath**
   Obiora Azie, Dominique Bratton-Palmer, Arnold Hwang, Natasha Marks, Amanda Tipton
7. **LiftOff**
   Yaas Bigdeli, Aditya Girish, Joshua Muñiz, Nirali Sampat
8. **lifeART**
   Sarah Kim, Yoojin Lee, Nicole C. Moskowitz, Alex Song, Jaemin Yu
9. **myRun**
   Sonia Bansal, LeTicia Brown, Mary Quien, Diana Umana
10. **PreVCon**
    Min Hyuk Seo, Spencer Omuemu, Shin Young Lee, Stanley Tiu
11. **TKA*one***
    Emily Cen, Forrest Miller, Elsa Swanson, David Xing

Civil Engineering Department

1. **Steel Frame Office Building**
   Group 1: Mira Armstrong, Erin Bessette-Kirton, Kelvin Liu, Greg Noll, Robbie Queen
2. **Steel Frame Office Building**
   Group 2: Tamar Caplan, Edgar Espinoza, Sofia Flores, Jordan Pardo, Xiong Wang
3. **Steel Frame Office Building**
   Group 3:
4. **Steel Frame Office Building**
   Group 4: Tianyang Cai, Margaret Cowie, Michael Chavez, Chris Stilwill, Dagmawi Yntiso
5. **Steel Frame Office Building**
   Group 5: Wade Burelbach, Hillel Gontownik, Claire Kao, Hussayn Meghji, Ryan Morgan
6. **Steel Frame Office Building**
   Group 6:

Chemical Engineering Department

Computer Engineering Department

Computer Science Department

Earth and Environmental Engineering Department

1. **Sustainable Building Upgrades: An Energy Analysis of a Harley-Davidson Dealership in Woodstock, IL**
   The Green Bikers: Tyler Lancaster, Mikayla Hoskins, Yoachim Haynes, Sydney Forrester
2. **Sustainable Energy Solutions in a New England Oyster Hatchery**
   John Clapp, Antonio Cuesta, Anna Gunther
3. **Water Portfolio Diversification Plan for a Municipal Water District in Southern California**
   Michael Escobar, Christina Hernandez, and Shambavi Sadayappan

Electrical Engineering Department

1. **Class D Subwoofer**
   Woof Woof: Efthymios Philip Papageorgiou
2. **Neural Engineering with EEG**
   iThink: Arnold Hwang, Conrad Richardson, Ignas Kazilas, James Olsen
3. **Beacon: GPS Triangulation Unit**
   The Finders: Timmy Li, Linda Sun, Michael Yan, Zuokun Yu
4. **Weight Training Using Magnetics (MagLift)**
   Gym Rats: Allison Duh, Olarn Pornpitaksuk, Rushal Rege, Akshay Shah, David Zhang
5. **Snow Density Indicator**
   Nathan Casey Abrams
6. **Heliostat**
   Scotty, Beam Me Up: Marquis McGregor, Nabil Merchant, Jasmine Roberts
7. **Amimin – a 3-D Input Instrument**
   Ahmet Ali Arslan
8. **Wireless EKG**
   The Pulse: Drew Limm, Branden Lowe
9. **Gaming Enhancement Glasses**
   GlassPi: Jake Kazimir, Patrick Taylor
10. **MedMinder**
    Zaid Syed

Industrial Engineering and Operations Research Department

Mechanical Engineering Department

1. **Pedal Powered Strandbeast**
   The Beasts: Benjamin Aguilar, Halvard Lange, Eric Laukkanen, Charles MacKenzie-Smith, Regina Zmuidzinas
2. **Solar Array Tracker**
   The Internationals: Karthik Ayyagari, Felipe Becerra, Prashant Dhanraj, Philipp Stoelting
3. **Hand/Forearm Exoskeleton**
   In Lumine Tuo (ILT): YooChan Chang, Zaoyuan Ge, Samuel Guo, Kyle Hom, Nathan Rodriguez
4. **Braille Teaching Machine (B-Reader)**
   Team M & M: Sok Kim Eng Chham, Kyle Fleming, Nikita Gupta, Carolina Trigueros Torres
5. **Person Tracking Basketball Passing Machine**
   The Imagineers: Rahul Bhagavan, Seaun Eddy, Shalni Pawa, Daniel Seagren, Carter Williams
6. **Autonomous Herb Garden with Multiple Sensors**

Hydropotomous: Jessica Cohen, Jamie Collier, Bikesh Dahal, Benjamin LeBlanc

7. **Upper Body Exercise Machine with Feedback**
   Fitness Phenoms: Staci Celiberti, Dylan Leonard, Taylor Robinson, Victoria Velez
8. **Weight Training Using Magnetics (MagLift)**
   Gym Rats: Olarn Pornpitaksuk, Rushal Rege, David Zhang, Allison Duh, Akshay Shah
9. **Automatic Rooftop Farming System**
   Asunción Consulting Group: Jack Bott, Tizian Bucher, Marcelo Cordova, Ricky Coria
10. **Haptic Feedback Drawing Pad**
    Virtual Handlers: Kyle Doyle, Chi Yung Fung, Daniel Sims, Phil Smith
11. **Tactile Vortex Generator**
    Team VorTAC: John Echeverri, Dylan Smith, Harrison Stokols, Silas Wilkinson
12. **Delta Robot**
    Shadow Fax Machine: Aldo Avanzini, Alexander Isinhue, Bennett Welker
13. **Laparoscopic Snake Robot**
    The Docs: Timothy Cousins, Christopher Miller, Ismail Mustafa, Emily Nathan
14. **Automatic Toilet Seat (EZ Lift)**
    Sanitary Kings: Brittany Lashley, Sheila Misheni, Anthony Padovano, Richard Parraga

Applied Physics and Applied Math

Structural Investigation of Nanoscale Materials from X-Ray Diffraction Data through Modelling

Veronica Reynolds

Abstract

The primary question of this project is: given x-ray diffraction data of an unknown sample, what can we learn about its corresponding structure? For materials with long-range order this question is solved by crystallography. At the nanoscale, however, our traditional structural analysis methods break down. My investigation involves a series of attempts to obtain structural information such as interatomic distance distribution, coordination number, and particle size from theoretically-calculated powder diffraction data of unknown samples using the pair distribution function (PDF).

Biomedical Engineering

Acunex

N.H. Diane Kim, Daniel B. Park, Sophie Wang, Timothy Weber | Advisor: Prof. Lance Kam

Abstract

More than 385,000 gastrointestinal (GI) anastomosis procedures are performed annually. These procedures join two segments of intestinal tissue and are typically performed in coordination with GI bypass and resection surgeries. Anastomotic methods subject the sensitive healing site to prolonged over-compression that can lead to an inflammatory response and stricture formation, causing a weakened, leak-prone connection. Additionally, strictures may create a high-pressure zone upstream from the anastomosis site, which may also contribute to leaks. Leaks are a dangerous postoperative complication occurring in up to 26% of surgeries. The morbidity rate of patients with leaks is 45% and the mortality rate is triple those with intact anastomoses. The Acunex solution harnesses innovative microneedle technology into a compliant stent to maintain lumen patency and strengthen the seal, while mitigating the high stress regions that can induce ischemia. Initial testing demonstrates that the Acunex device can be successfully incorporated into current methods to prevent the complications associated with GI anastomosis.

Albatross

Jared Rozowsky, Peter Hosinski, Hyunho Rhee | Advisor: Dr. Kevin Wong & Prof. Gerard Ateshian

Abstract

There are nearly 2 million people living with limb loss in the United States; approximately 18.5% are trans-femoral amputees. Volume fluctuations in the residual limb, which can cause residual limb volume to change by as much as 10%, are an acute and chronic problem for amputees. Current prosthetic sockets, which act as the interface between the residual and prosthetic limb, cannot sufficiently accommodate for variations in limb morphology or volume. An ill-fitting socket can lead to ongoing discomfort, compromised mobility, pressure injuries, or even the need for a new socket. Team Albatross proposes an adaptive socket that provides a comfortable fit between the prosthetic and residual limb that can accommodate for these limb volume fluctuations. The new socket will maintain the structural support of current sockets, but will employ jam-phase transition material to create an adaptable solid surface.

Auscultaid

Annabelle Anandappa, Kathryn Lau, Hari Raman, Alan Zambeli-Ljepović | Advisor: Prof. Henry Hess

Abstract

Physical examination of the lungs is universally used as the first step in detecting signs of lung pathologies. However, the false positive rate of 18% suggests that this largely qualitative process can be highly inaccurate. The exam is compromised by inter-user variability and lack of standardization. This encourages reliance on secondary screening techniques, such as chest x-rays, and prophylactic prescription of antibiotics in cases of suspected infection. For community-acquired pneumonia in the U.S., $830 million is spent on unnecessary chest x-rays. These expenses could be mitigated by improving examination accuracy. Auscultaid provides a platform that simultaneously acquires lung sounds from all lobes, facilitating improved detection of adventitious sounds and increasing the specificity of the lung examination. Objective lung examination using the Auscultaid system will reduce the costs of unnecessary testing and treatment and provide a more accurate method of diagnosing and monitoring lung disease.

DownRight

Matthew Chang, Yuri Gloumakov, Tanya Shah, Wendy Sun | Advisor: Prof. Elisa Konofagou

Abstract

Hip fractures are serious fall injuries that often result in long-term functional impairment and potential loss of independence and mobility in elderly populations. Over 258,000 elderly Americans are admitted annually for fall-related hip fractures with an associated total medical care cost of $15.6 billion. Though there are several padded hip protectors, they are largely ineffectual. To address the ongoing issue of hip fractures due to falls, DownRight has designed a responsive system to protect the hip during a fall. DownRight uses a sensor system to detect when the wearer is falling. A detected fall triggers a pocket of air to inflate; this provides a cushion for the hip and protects it from fracture. Initial prototypes have accurately detected falls and signaled the pocket to inflate. This responsive design will provide discreet fall protection for elderly persons.

High Quality Life Technology

Andrea Bogarin, Jessica Kleinbart, Eli Mondragon, Shannon Sullivan | Advisor: Prof. X. Edward Guo

Abstract

Birth asphyxia, the interruption of oxygen to the fetus during labor, accounts for 23% of neonatal deaths worldwide. For example, at Mulago Hospital in Uganda, we found that asphyxia was an exacerbating factor in 46% of neonatal mortalities. Birth asphyxia is quite rare in developed nations, due in large part to the ready availability of monitoring technologies that can alert physicians that intervention is necessary. At Mulago and other hospitals in low-resource settings, there is a severe dearth of functional screening technologies that would enable fetal monitoring, thus the initial signs of fetal distress may go undetected. High Quality Life Technology has developed a device that continuously monitors fetal heart rate and uterine contractions using phonocardiography and electromyography, respectively. The combination of sensors provides an accurate, low cost method for alerting medical staff when a fetus is in distress.

InVisiCath

Obiora Azie, Dominique Bratton-Palmer, Arnold Hwang, Natasha Marks, Amanda Tipton
Advisor: Prof. Elizabeth Hillman

Abstract
Peripheral intravenous catheters (PVC) are one of the most common vectors of medical treatment in the United States, reaching over 151 million patients per year. Infiltrations, in which the catheter breaches the venous wall into the surrounding tissue, are the cause of over 25% of all PVC failures and cost hospitals $3-5 billion annually. Infiltrations occur when micro- and macro-movements of the catheter within the vein create damage on the wall, eventually leading to a vascular rupture. Consequences of infiltration include swelling, tissue necrosis, and compartment syndrome, which, in severe cases, can require amputation. Current market products focus on stabilizing the catheter externally to reduce different complications; however, these methods have had mixed results on infiltration rates. To address this issue, InVisiCath has designed a novel PVC that utilizes an elastic joint and a shaped tip to prevent infiltrations by reducing the frequency and intensity of catheter-venous interactions.

L!ftOff

Yaas Bigdeli, Aditya Girish, Joshua Muñiz, Nirali Sampat | Advisor: Prof. Barclay Morrison III

Abstract
According to the US Department of Health and Human Services, 20 million elderly Americans have trouble independently transitioning from a seated to a standing position. Difficulties in standing are often caused by chronic conditions, such as osteoarthritis, or post-surgical complications. There are few existing sit-to-stand solutions, but the devices that are available are cumbersome and unsuitable for use by a single person. To address this need, L!ftOff has designed a user-controlled, portable, and lightweight device to assist with transitional mobility. The device utilizes an inflatable cushion that has been ergonomically designed to assist a person as they rise from a seated position. By substantially reducing the torque around the knee joint and reducing the amount of energy required to stand up, L!ftoff's device could improve the standard of living for the elderly population.

lifeART

Sarah Kim, Yoojin Lee, Nicole C. Moskowitz, Alex Song, Jaemin Yu | Advisor: Prof. Elizabeth Olson

Abstract
One in eight couples are affected by infertility, and, of those who seek assisted reproductive technologies, 99% turn to *in vitro* fertilization (IVF). However, the average success rate of live births with IVF is only 22% due largely to the suboptimal exposures of the embryo during culture. Current

IVF protocol induces sudden changes in the culture environment and places stress on the embryos, accounting for a 25% decrease in embryo viability. Furthermore, as media is not replenished frequently, toxins can easily build up in the media, leading to cell death. Our device, emBrace, offers a closed, microfluidic platform, which maintains an optimal culture environment, minimizes stress on the embryos, and continuously replenishes media. Moreover, emBrace allows for monitoring of the embryos without the need for culture removal from the incubator. Initial prototypes have demonstrated that our device effectively reduces shear stress, provides continual media replenishment, and maintains cost efficiency.

myRun

Sonia Bansal, LeTicia Brown, Mary Quien, Diana Umana | Advisor: Prof. Andrew Laine

Abstract

Up to 40 million Americans run regularly. Annually, up to half of runners report a lower limb injury. Chronic injury can often be attributed to improper running form. When evaluating running form, footstrike and knee movement are important parameters that are indicative of the stresses on the legs. Proper running form varies between people, thus programs to monitor running technique require personalization. To address this need, we have designed myRun, a system aimed at monitoring running to promote user-specific proper form. The device measures a runner's footstrike, knee flexion, and knee valgus, and provides feedback based on a regimen devised by a physical therapist or trainer. Initial prototypes are able to determine footstrike sequence and detect knee flexion angle and knee valgus. These measurements will be used in coordination with a mobile app to monitor form and provide feedback to the user.

PreVCon

Min Hyuk Seo, Spencer Omuemu, Shin Young Lee, Stanley Tiu | Advisor: Prof. Clark Hung

Abstract

Among major sports played by young people ages 5-19, American style football has the highest rate of concussions at 3.66 reported concussion cases per 100 players. This amounts to 146,000 youths per year who experience concussions due to football. Despite increasing focus on concussion detection and prevention at all levels of football, current solutions fail to effectively reduce the incidence among young players. Failure to reduce concussion rates is largely attributable to the fact that the majority of helmets are not designed to reduce a major cause of concussions: high angular acceleration on the brain that occurs during impact. PreVCon strives to reduce concussion cases by integrating crumple zones into helmets. Our design consists of replaceable helmet inserts that are engineered to directionally deform or crumple, decreasing angular acceleration and reducing harmful forces on the head and neck. PreVCon's solution will provide concussion protection that can be easily used with existing helmet technology.

TKAone

Abstract

Total knee arthroplasty (TKA) is one of the most common surgical procedures in the United States, with over 600,000 primary surgeries and 60,000 revisions performed each year. The leading cause of revision is periprosthetic bacterial infection (PPI), which occurs in up to 3% of all TKAs. At a cost of over $50,000 per revision, the total annual cost of PPI is nearly $400 million. Current methods of diagnosing infection rely on blood tests, cultures, assays and radiography. These tests are invasive, unreliable, and can only detect later stages of infection, by which time revision is inevitable. We have designed a novel solution that detects infection *in vivo* and alerts the patient in real time. Our device measures changes in the optical properties of synovial fluid caused by the immune response to infection, and wirelessly reports this data. This innovative approach will allow for implant salvage without painful and expensive revision surgery.

Civil Engineering

Steel Frame Office Building

Group 1: Mira Armstrong, Erin Bessette-Kirton, Kelvin Liu, Greg Noll, Robbie Queen

Abstract
The expansion of Dunder Mifflin Paper Company, Inc., requires the construction of a new corporate headquarters in Asylum Township, Pennsylvania. The three-story office building measuring 60' x 90' was designed using a steel moment frame and individual column spread footings. The building also consists of reinforced concrete floor and roof slabs. All design aspects were determined by the engineers in accordance with ASCE 7-10, AISC, and ACI 318-11 design requirements. The design of this building includes seismic analysis, calculation of the soil modulus of subgrade reaction, and evaluation of live, snow, and wind loads. The structural sections were designed based on structural analysis performed in SAP 2000. The office building has been designed to obtain a LEED certification at the gold level. The design report also includes a work breakdown schedule, CPM schedule, and the engineers' cost estimate.

Steel Frame Office Building

Group 2: Tamar Caplan, Edgar Espinoza, Sofia Flores, Jordan Pardo, Xiong Wang

Abstract
The objective of this project is to design an office building that will be constructed in a flat, suburban location in Asylum Township, Pennsylvania. The general design requirements state that the office building consists of a total of three stories: two above ground, plus a basement. The proposed office building's dimensions are 60' x 90' from center to center. The story height is not less than 12' with the first floor top of slab elevation not exceeding 18" above finished grade. Lastly, the height of the building above grade should not exceed 30'. As for our specific office building, we have constructed a three-story building with a total height of 42'. The office building is composed of structural steel with a steel braced frame. The concrete floor and roof slabs are designed to act compositely with the beams. As for our foundation, we have decided to utilize strip/spread footing. The office building was fully modeled and analyzed in SAP 2000, and designed in SAP and by hand, after which it was rendered in Revit and AutoCAD. The building must meet various design requirements. The building has been designed to withstand the wind loads, seismic load, live loads, dead loads, as well as any other loadings that may be specific to Asylum, Pennsylvania. Furthermore, we have analyzed and determined the full construction process for the office building, including concerns from scheduling and quantity take-off to environmental and LEED concerns.

Steel Frame Office Building

Group 4: Tianyang Cai, Margaret Cowie, Michael Chavez, Chris Stilwill, Dagmawi Yntiso

Abstract
This report outlines the structural design, construction management, and sustainable design of a three-story (basement plus two stories above ground) office building with an atrium on the first floor in a flat, suburban location in Asylum Township, Pennsylvania. The plan dimensions are 60 feet by 90 feet center to center of exterior corner columns. The structural height of the building is 36 feet. Each story height is 12 feet. The first floor top of slab elevation is 8 feet above the finished grade. Exterior stairs are designed outside of the entrance. The structure system of the office building is a steel moment frame with a one-way slab and beam floor system supported by individual column spread footings. The basic design of the office building includes 7.5-inch slabs, W14*30 beams, and W12*50 columns throughout. For exterior beams, 30 feet spans are chosen and spaced 30 feet on center. For interior beams, both 30 feet and 15 feet spans are used. The one-way slab spans 15 feet between beams. The details of the design can be found in the main body of the report. This report covers the following aspects: soil calculation, expected loads on the structure (dead, live, snow, wind and seismic loads), the design of interior composite beams and exterior non-composite beams, the estimation of the column sizes, the slab design, project planning, delivery method, CPM schedule, cost estimates, and LEED Gold Certification (60+ points) design.

Steel Frame Office Building

Group 5: Wade Burelbach, Hillel Gontownik, Claire Kao, Hussayn Meghji, Ryan Morgan

Abstract
In accordance with ABET requirements for “depth and breadth”, our senior design project group designed a three-story office building. This capstone design was an exercise in demonstrating four aspects of what we have learned as graduating Civil Engineers: Structural, Geotechnical, Environmental, and Construction Management. The three-story office building will be constructed in a flat, suburban location in Asylum Township, Pennsylvania. This abstract is NOT COMPLETE.

Earth and Environmental Engineering

Sustainable Building Upgrades: An Energy Analysis of a Harley-Davidson Dealership in Woodstock, IL

The Green Bikers: Tyler Lancaster, Mikayla Hoskins, Yoachim Haynes, Sydney Forrester

Abstract
The project involves performing an energy analysis and design of a Harley-Davidson dealership undergoing a retrofit in the city of Woodstock, IL in order to reduce the energy consumption, greenhouse gas emissions and operating costs of the building. Improvements to the existing thermal envelope (potentially by introducing a green roof) and HVAC system are under investigation. Passive solar, rooftop solar photovoltaics (PV), geothermal, and lighting designs for the building specifications provide the building owners with several sustainable building options to achieve their goals. While reducing environmental impact is important to the client, financial considerations are the driving force for adoption; therefore each sustainable upgrade is undergoing a rigorous financial analysis as well.

Sustainable Energy Solutions in a New England Oyster Hatchery

John Clapp, Antonio Cuesta, Anna Gunther

Abstract
The project will assesses a variety of alternative energy solutions as a means of reducing the electricity demand and carbon footprint of a New England oyster hatchery. During wintertime operation, cold ocean water is pumped into the hatchery where it is heated by an immersed electrical heating element. The project analyzes the potential energy and monetary savings if the hatchery were to use geothermal energy, fuel cell energy, or propane with emission control to heat the incoming water. A design solution is provided for each of the three recommended technologies.

Water Portfolio Diversification Plan for a Municipal Water District in Southern California

Michael Escobar, Christina Hernandez, and Shambavi Sadayappan

Abstract
The Las Virgenes Municipal Water District in Southern California is facing a crisis of water. All of their water is imported from hundreds of miles away to the foothills of the Santa Monica Mountains, where it sustains a suburban population of about 75,000 people. Our team is tasked with diversifying their water portfolio by investigating underutilized resources, and emerging technologies to address concerns of water security and sustainability. Particular focus will be placed on direct potable reuse, iron and manganese treatment of groundwater, and conservation practices.

Electrical Engineering

Class D Subwoofer

Woof Woof: Efthymios Philip Papageorgiou

Abstract
This project consists of a high power subwoofer complete with amplifier and power supply. A subwoofer is a loudspeaker dedicated to low-pitch audio frequencies (bass). Subwoofers are used to augment the low-frequency response of loudspeaker systems. The amplifier circuitry, power supply, and subwoofer enclosure are all custom designs. The amplifier supplies a peak of 300 watts of power to the speaker and uses a very efficient class-D amplifier. That's loud!

Neural Engineering with EEG

iThink: Arnold Hwang, Conrad Richardson, Ignas Kazilas, James Olsen

Abstract
This research project involves measurement and analysis of electrical activity in the brain, with the goal of creating a controller for a Brain Computer Interface (BCI). We have collected EEG data related to specific motor tasks and analyzed them using signal processing techniques. We hope that our research can lead to a better understanding of neural correlates in these tasks.

Beacon: GPS Triangulation Unit

The Finders: Timmy Li, Linda Sun, Michael Yan, Zuokun Yu

Abstract
The Beacon is a small, easily portable device that allows users to track an object or person with an intuitive smartphone application. The tracking hardware consists of a GPS receiver that relays its data wirelessly via the Family Radio Services band to a receiver connected to a smartphone. Our smartphone app decodes the data and displays location, trajectory and other statistics in part by using Google Maps. This device is low-cost and versatile, and can be used for anything from tracking model rockets for hobbyists to keeping tabs on an Alzheimer's patient.

Weight Training Using Magnetics (MagLift)

Gym Rats: Allison Duh, Olarn Pornpitaksuk, Rushal Rege, Akshay Shah, David Zhang

Abstract
Designed specifically with manned low-earth orbit spacecraft in mind, the MagLift uses a magnetic particle brake to provide resistive force for weight training purposes, exploring how exercise equipment can be redesigned to be both lighter and more compact. Featuring an Arduino-powered

user interface with external data export abilities, the MagLift has been tested at up to 60 lbs equivalent weight, and results show that greater resistance is within reach.

Snow Density Indicator

Nathan Casey Abrams

Abstract
Backcountry skiing is an activity that involves hiking to and skiing in areas not patrolled by ski patrol. For that reason, avalanches pose a major threat to backcountry skiers. The standard method for predicting avalanche danger involves digging a snow pit and performing a number of qualitative tests, which is both a lengthy process and susceptible to human error. While snow density profiles are not a determining factor in avalanche prediction, they are a major factor and would provide a quick comparison between snowpacks. This project allows a skier to quickly and quantitatively measure the snow density and corresponding depth, and recall those measurements later.

Heliostat

Scotty, Beam Me Up: Marquis McGregor, Nabil Merchant, Jasmine Roberts

Abstract
The goal of this project is to design a device that can reflect light from a moving source onto a fixed target. This dual-axis reflector features photo sensors, a 3-D printed shell, and arduino-controlled motors. Applications include solar thermal power generation, image stabilization, and space communications.

Amimin – a 3-D Input Instrument

Ahmet Ali Arslan

Abstract
This control device takes the Theremin, an early electrical musical instrument, to a whole new level. Three antennas arranged orthogonally sense position of a performer's hand, which is converted to three control signals by an Arduino. These signals can control pitch and volume of an electronic instrument (as in a Theremin), but also a third parameter such as a filter critical frequency (for effects such as produced by a wah-wah pedal). The system output is very easy to program and integrate with the user's software of choice. Although it is created for artistic expression, the Amimin can be used in any application that uses a continuous, real-time data input through a hand's motion in 3-D space.

Wireless EKG

The Pulse: Drew Limm, Branden Lowe

Abstract

This device replaces the mass of wires normally required to couple a suite of EKG sensors to a storage or processing device. Signals from several EKG sensors are conditioned, then amplitude modulated, each to its own audio frequency carrier. The composite signal is transmitted wirelessly via Bluetooth to a receiver for demodulation and further processing.

Gaming Enhancement Glasses

GlassPi: Jake Kazimir, Patrick Taylor

Abstract
The goal of the project is to design a fully functional, wireless video headset running from a standard composite video signal. Using an Xbox 360 as our basis for video, we perform high-frequency analog-to-digital (ADC) conversion, as well as wireless transmission between a series of Raspberry Pis, responsible for data transmission and manipulation. With Wi-Fi communication serving as a wireless backbone, we aim to achieve a low latency, high speed transmission system with a reasonably high frame rate.

MedMinder

Zaid Syed

Abstract
Lack of adherence to the prescribed medication regimen is a widespread, significant problem. Missing doses can lead to dramatic decrease in quality of life and may even reduce life expectancy. MedMinder provides a practical and comprehensive way to manage one's medication. The physical interface of MedMinder consists of several pill bins, a touchscreen, and a camera. Medication information can be entered simply by scanning a QR code. The screen indicates which bin the pills should be poured into. When it is time to take a dose, an alarm sounds, a message is displayed on the screen, and a light indicates which bin to take the dose from. The screen can display other important information, for example, whether to take the medication on an empty stomach. The system senses when the lid is opened, and records the time the medication was taken. It also warns the user if they open the wrong bin or if the medicine is running low or has expired.

Mechanical Engineering

Pedal Powered Strandbeast

The Beasts: Benjamin Aguilar, Halvard Lange, Eric Laukkanen, Charles MacKenzie-Smith, Regina Zmuidzinas

Abstract
This project is to design and build a pedal-powered walking vehicle inspired by Dutch kinetic sculptor Theo Jansen's Strandbeast moving mechanisms. One of the unique characteristics of Jansen's closed-chain mechanism is the smoothness of the walking motion. The design aims to support a rider seated atop a custom frame, attached to a set of two Strandbeast legs on either side. The rider will move forward by pedaling the vehicle and will be able to turn the vehicle by shifting either set of the legs into reverse.

Solar Array Tracker

The Internationals: Karthik Ayyagari, Felipe Becerra, Prashant Dhanraj, Philipp Stoelting

Abstract
This project is a dual-axis active solar tracker which will manipulate a solar panel to track the sun's progress throughout the course of the day. The sun's path across the sky varies in an azimuthal manner from sunrise to sunset and an altitudinal manner from summer to winter. Creating a mechanism that actively tracks the sun optimizes the energy generated. The goal is to design, build, and optimize such a tracker, so that the boost in energy generation outweighs the energy expenditure of the tracking itself.

Hand/Forearm Exoskeleton

In Lumine Tuo (ILT): YooChan Chang, Zaoyuan Ge, Samuel Guo, Kyle Hom, Nathan Rodriguez

Abstract
This project will develop a functioning Stewart Platform exoskeleton for providing the wrist's ball-and-socket motion. The parallel plane mechanism provides six degrees of freedom. The wrist motion requires only two degrees of freedom: pitch and yaw. The application is rehabilitation for muscle degenerative diseases and stroke-related impairments. Studies have shown that limb stimulation can lead to synaptogenesis and the reestablishment of the neural pathways that control volitional movement, potentially leading to impairment reduction, added functional capabilities, and reduced disabilities.

Braille Teaching Machine (B-Reader)

Team M & M: Sok Kim Eng Chham, Kyle Fleming, Nikita Gupta, Carolina Trigueros Torres

Abstract
The project aims to assist the blind and their families learn how to read and write in braille. Instead of controlling individual pins, it will use racks with braille dots printed on them. The racks will move to display the correct configuration of braille. The refreshable tactile display will show five characters, enough to form small words. Audio feedback will allow a visually impaired user to learn the character. Visual feedback will also be provided for users who are visually abled. The system is battery powered.

Person Tracking Basketball Passing Machine

The Imagineers: Rahul Bhagavan, Seaun Eddy, Shalni Pawa, Daniel Seagren, Carter Williams

Abstract
The Shot Doctor is a motion-controlled basketball launching machine which will allow users to improve their shooting skills without the assistance of a trainer. The machine sits under the hoop and uses the Xbox Kinect 3D stereo-vision system to sense the current location of the user. It will control the velocity of the ball released thereby providing a consistent chest pass. While the frame remains stationary, the ball delivery system will rotate so that it follows the user's movement around the court. The system can include data collection and analysis of user statistics.

Autonomous Herb Garden with Multiple Sensors

Hydropotomous: Jessica Cohen, Jamie Collier, Bikesh Dahal, Benjamin LeBlanc

Abstract
Hydroponic systems provide an alternative agricultural method to soil-based growing for large crop yields. Recently, hydroponic systems have attracted increased attention from the home grower market, as they provide a way to grow plants such as fresh produce easily indoors. This system is fully automated, inexpensive, and compact. Using simple construction methods, it is a streamlined system that removes the hassle of manual hydroponic systems that require frequent adjustments.

Upper Body Exercise Machine with Feedback

Fitness Phenoms: Staci Celiberti, Dylan Leonard, Taylor Robinson, Victoria Velez

Abstract
In the fields relating to physical therapy and exercise science, there has been a great focus on developing means to measure force generated by a specific muscle group in the human body. However, there has been little attention paid to determine if there exists a balance of strength between both sides of the body. Muscular symmetry is nature’s intended state, and this ideal state of balance can be disrupted by cases such as injury to a muscle, training muscle groups on one side of the body more than the other, or even an event as tragic as a stroke. Producing the maximum force for a muscle can lead to overexertion and injury. Instead, the amount of power a muscle can produce in a period of time will be measured and compared to the same muscle on the opposite side of the body.

Weight Training Using Magnetics (MagLift)

Gym Rats: Olarn Pornpitaksuk, Rushal Rege, David Zhang, Allison Duh, Akshay Shah

Abstract
Modern day weight training machines use stacks of massive plates and the pull of gravity to provide resistance for user exercise. The Magnetic Resistance Exercise Machine (MREM), also referred to as the MagLift, ultimately provides this resistance through a magnetic particle brake. Instead of changing the weight of a moving stack, a user will select a desired "weight" that will be translated into a certain amperage, which is then sent into the electromagnetic system to create the proportional resistance.

Automatic Rooftop Farming System

Asunción Consulting Group: Jack Bott, Tizian Bucher, Marcelo Cordova, Ricky Coria

Abstract
The project is a self-controlled watering system consisting of a control unit and supplementary units. The control unit has two planters, a microcomputer, battery, and a solar panel. Rainwater is stored in a tank. The system measures ambient temperature, system temperature, relative humidity, barometric pressure, rainfall, tank water level, daylight hours, and battery charge. From the measured data an evapotranspiration estimate is calculated and a pump is powered based on plant need.

Haptic Feedback Drawing Pad

Virtual Handlers: Kyle Doyle, Chi Yung Fung, Daniel Sims, Phil Smith

Abstract
This is a haptic feedback device for rehabilitation of fine motor skills. A pen is attached to three cables, each pulled by a motor around the edge of a screen that will display patterns to draw. Three motors provide a force in any direction on the plane, to guide the user through the appropriate drawing motions. The assistance provided can be lowered over time as nerves or muscles regenerate. This system has the benefit of freeing the user's hand from bulky and heavy glove-type haptic feedback devices.

Tactile Vortex Generator

Team VorTAC: John Echeverri, Dylan Smith, Harrison Stokols, Silas Wilkinson

Abstract
The goal of our project is to design and fabricate a vortex air ring shooter that delivers tactile feedback for a variety of applications. This device will be able to aim and shoot vortices of air at specified targets. These vortices will be formed by pulsing high displacement speakers and forcing air out of a nozzle at high speeds. The device will be paired with existing screen applications to enhance the user’s experience and give tactile feedback. The target application for this device is interactive gaming.

Delta Robot.

Shadow Fax Machine: Aldo Avanzini, Alexander Isinhue, Bennett Welker

Abstract
The goal is to design and fabricate a delta robot: a parallel robot with multiple inputs acting on a single end effector simultaneously. Commercially, delta robots are often used for pick-and-place operations where objects are in mechanically imperfect locations and must be manipulated quickly. We want to the delta robot is to have it 3D print with comparable positioning accuracy to a commercial robot.

Laparoscopic Snake Robot

The Docs: Timothy Cousins, Christopher Miller, Ismail Mustafa, Emily Nathan

Abstract
The goal is to create a 15 mm diameter laparoscopic snake robot with micro stepper motors and worm gears. The laparoscopic snake robot is being prototyped with surgical applications in mind. The typical laparoscope is a long, stiff tool that is inserted into the abdominal cavity for minimally invasive surgeries. This robot has four joints which allows movement in many different directions and creates a flexible, surgeon-controlled laparoscope.

Automatic Toilet Seat (EZ Lift)

Sanitary Kings: Brittany Lashley, Sheila Misheni, Anthony Padovano, Richard Parraga

Abstract
The ezLift, an automatic toilet seat apparatus, enables a person to use the restroom in a more convenient, sanitary manner without touching the toilet seat. The most important factor in the design is the independent control of the top and bottom toilet lids as well as the back drivability. The device must open the top and bottom seats independently for different users. The design consists of a DC Motor, followed by a gear train that controls the top cover and bottom seat.

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