INTRODUCTION

Driver assistance systems (DAS) are systems developed to automate/adapt/enhance vehicle systems for safety and better driving. Safety features are designed to avoid collisions and accidents by offering technologies that alert the driver to potential problems, or to avoid collisions by implementing safeguards and taking over control of the vehicle.

A collision avoidance system is an automobile safety system designed to reduce the severity of a collision or prevent the collision. The system using Sensors such as LIDAR, Cameras, Radars to measure the Position, Distance, Speed, & Velocity. It determines the probability of impact and Based on probability thresholds system takes required action by Warning, Pre charging Brakes and Applying Brakes.

A study on several FPGA techniques are done, amongst which Scheinman method of simplification is implemented along with the Fuzzy logic representation.

SYSTEM DESIGN

- The inputs to the camera systems determines the speed and direction of objects in the front and behind the vehicle.
- The probability of impact for each zone is calculated and if a particular probability threshold is met and the current gear position matches the direction of impact the system will take the appropriate response.
- Response include indicating a warning, pre charging the brakes or employing emergency braking.

VERILOG

```verilog
module collisionAvoidanceSystem(
    input [1:0] RearStatus,
    input [1:0] FrontStatus,
    input [1:0] GearPostion,
    output reg [1:0] CollisionWarning );

localparam GP_Park  = 2’d0,
GP_Reverse = 2’d1,
GP_Neutral = 2’d2,
GP_DriveLow = 2’d3;

always @(
    RearStatus, FrontStatus, GearPostion)
begin
    CollisionWarning[0] = ( GearPostion[0] & ~GearPostion[1] & RearStatus[0] ) | ( GearPostion[0] & GearPostion[1] & FrontStatus [0] );
end
endmodule
```

Fuzzy Logic Representation

Mamdani Type Fuzzy Inference System

ANFIS Fuzzy Inference System

RESULTS

CONCLUSION & FURTHER STUDY

Developed a support system that is capable of alerting the vehicle operator and reducing the impact of collision using collision avoidance system. We successfully tested and simulated a Driver Assist system using Verilog coding and FPGA. Further, a few more techniques of FPGA such as Threshold gates, Boolean Neural networks by F & M Method and Liu’s Method, State space machine to develop state table will be implemented.
Opportunity and Significance
The ACE Therapy WebApp addresses the issues of a web application that’s directed towards geriatric physically impaired patients. This web app implements a dynamic user interface that allows users to remain on one page whilst staying connected with their primary therapist.

Define the specific technical problem or opportunity addressed and its importance.

Technical Approach, Accomplishments and Results
We were able to achieve all of our functional and non functional goals and we were able to do a complete UI overhaul to match the needs of our client (ACE Therapy)

Next Steps for Development and Test
ACE Therapy was able to create testing scripts through an automated method called Selenium. We have been able to create over 100 test scripts that allows us to keep a bug free program. We also were able to implement automated deployment through Kudo. This will allow for a more seamless delivery approach for future designers.

Technical Objectives
What we needed to do was implement functions that made the web app easier to use for the older patients. They needed usernames implemented rather than user ids. There needed to be better security for our all users of the ACE Therapy Web App. We needed to define accurate levels of security to prevent different users from viewing pages they shouldn’t be able to. We need to create analytical graphs and charts that display user input in an organized matter.

Related Work and State of Practice
(needs work)
The project builds on code from a previous semester of Senior Project that needs to be changed based on the UI changes.

Commercialization Plan & Partners
We would like to thank Tom Linebaugh for allowing us to work on a great application.

We would also would like to thank Kevin Hayes, Dir of IT Security for assisting us with our security functionality for our user login.

We would also like to thank Nasim Hamidian, Dr. Khayyam Hashmi, Dr. Sam Bryfyncsck for giving us great feedback and keeping our project going in the proper direction.

In order to commercialize the product, we have to create a bug free system that appeals to other clinics. Hopefully, the users of our program speak highly of our product and our marketing can be carried out by a user to user method.

References
Bradley Boortz, Zachary Kinning, Rumman Sagoto, Yosef Siddiqui
Advanced Note Taking on Geneset Analysis

Dr. Khayyam Hashmi, Dr. Sam Bryfczynski, Dr. Radu Vanciu, Dr. Mohammad Ebrahim Khalaj

Computer Science

Blake Levine, Jon Kloss, Mustafa Siyaj, Brannan Castor, Mohamad Mandouh

College of Engineering

Opportunity and Significance

Genetics Research happens across the globe by researchers who may be working on similar projects, but cannot work together. This application is designed to enable genetic researcher to write and share research in a collaborative manner.

Technical Approach, Accomplishments and Results

The User Note microservice by created using Spring as our backend and an AngularJS Web application as our front end. The Spring backend communicates with a PostgreSQL database. We also built the User Notes microservice to be compatible with Docker so it could be deployed to an AWS web-server.

Technical Objectives

This project was created using a series of Java microservices which work independently of each other. One of these microservices handles all functionality related to Notes.

One of our objectives was to make the application as portable as possible. We built the front end module and the notes microservice so they can be reused in other Advaita applications.

Related Work and State of Practice

This application was initially built by students at Wayne State University over two semesters. The previous teams designed the Genes of Interest application that we integrated with the Notes Module

Next Steps for Development and Test

There still features that remain to be implemented that will allow researchers to share and access each other's notes, as well as some general user experience features also remain.

These Features are planned to be implemented by the next team working on this project

Commercialization Plan & Partners

This application was built for the Advaita Corporation, a bioinformatics company based in Plymouth Michigan.

Advaita will be hosting this application as another product in their suite of gene research products. There are plans to use the note module built in this project into Advaita’s other systems.

Thank You
A microfluidic chip for encapsulating liver cells

Opportunity and Significance
Liver is one of the vital and complex organs in the body. Yet, the most widely used treatment for curing patients with acute liver failure is liver transplantation, while around 1500 patients die each year in U.S on the waiting list due to severe donor shortage[1]. Of the most recent alternatives is to implant encapsulated healthy liver cells inside patients body without the need for the whole liver transplantation.

Technical Objectives
In this research, we have used a novel technique and materials for the efficient encapsulation of liver cells inside the extracellular matrix. We have employed 3D printing techniques combined with the PDMS fabrication to make smooth microfluidic channels for encapsulation of liver cells. Liver cells are encapsulated in a biocompatible, biodegradable natural polymer enhancing cell viability and activity.

Related Work and State of Practice
Current studies are focusing on designing the new microfluidics in order to increase the uniformity of the capsules. Viability and capsule efficiency are the two important parameters to be investigated.

Next Steps for Development and Test
Future work will be focused on increasing the uniformity of the capsules and also increasing the number of encapsulated cells in each experimental run. After reaching this step, the encapsulated cells will be implanted in vivo in order to investigate their efficiency and viability in vivo.

Commercialization Plan & Partners
Employing microfluidic techniques in biomedical engineering and pharmaceutical industry is getting popular everyday. Commercialization of microfluidics can be done to make efficient and economical high throughput screening systems instead of the current drug discovery techniques that are being used in pharmaceutical industry. Moreover, using dozens of microfluidic systems working together, we can save time and cost dramatically since it is vital to transplant the cells inside the patient's body.

References
A real-time EMG based controlling system for Upper Limb Prostheses

INTRODUCTION

An upper limb prostheses is an external mechanical structure which has joints that correspond to the patient arm [1]. Allowing patient to intuitively control robotic prostheses can improve the performance of prostheses as well as the user experience of patient. For this purpose, we developed an electromyogram (EMG) signal based upper limb prostheses system, which can allow users control the robotic joints movements by EMG signal from their muscles.

METHODS

In this study, we proposed an embedded controlling system for upper limb prostheses which was illustrated in Fig.1. Two channels filtered and integrated EMG signals were collected by EMG sensors, and then sent to the Microcontroller Unit (MCU). The MCU used Direct Memory Access(DMA) and Analog-to-Digital Converter (ADC) to transform analog input signal to digital signal, and then used Fast Fourier Transform(FFT) method to decide the control signal for stepper motor. Stepper motor directly drives the prostheses to make the movement.

![Figure 1 System Block Diagram for EMG based prostheses](Image 180x549 to 662x645)

For the hardware part of this system, two MyoWare™ Muscle Sensors (SparkFun Electronics, AT-04-001) board measure the rectified and integrated EMG signal of muscles, showed in Fig.2. The Microcontroller Unit (MCU) of this system is STM32 (STMicroelectronics, STM32F103RBT6), which uses ARM 32-bit Cortex™-M3 CPU with 128KB flash memory, and the maximum frequency is 72MHz. The stepper motor is driven by microstep drivers (MB450A) using 24V 7Ah batteries.

For the software part of this system, the MKD-Keil uVision4 is used to write the controlling algorithms using C++ language. The effective frequency of EMG signal range from 0~500Hz, according to Nyquist–Shannon sampling theorem the sampling rate must faster than 1000Hz. Based on the system clock of MCU, we choose the sampling rate at 1100Hz. After acquiring two channels EMG signals, we use Fast Fourier Transform (FFT) method to analyze the frequency spectrum of two muscle’s EMG signals, and send the control signal to driver stepper motor moving.

![Figure 2 EMG signals acquiring from MyoWare™ Muscle Sensor](Image 180x549 to 662x645)

RESULTS

We invited 5 volunteers to do experiment. Two electrodes were placed on flexor or carpi radialis muscle and flexor carpi ulnaris muscle. Each volunteer was asked to do the flexion for 10 times and extension for 10 times. When volunteer flex the palm the stepper motor should run positively, and when volunteer extend the palm the stepper motor should run reversely. Table 1 showed the accuracy of motor motion for each volunteer when doing the experiment.

<table>
<thead>
<tr>
<th>Volunteer</th>
<th>Flexion</th>
<th>Extension</th>
<th>No movement</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8/10</td>
<td>7/10</td>
<td>18/20</td>
<td>82.5%</td>
</tr>
<tr>
<td>2</td>
<td>10/10</td>
<td>10/10</td>
<td>20/20</td>
<td>100%</td>
</tr>
<tr>
<td>3</td>
<td>9/10</td>
<td>8/10</td>
<td>19/20</td>
<td>90%</td>
</tr>
<tr>
<td>4</td>
<td>9/10</td>
<td>8/10</td>
<td>20/20</td>
<td>92.5%</td>
</tr>
<tr>
<td>5</td>
<td>9/10</td>
<td>9/10</td>
<td>19/20</td>
<td>92.5%</td>
</tr>
</tbody>
</table>

![Table 1 Accuracy of motor motion for 5 volunteers](Image 180x549 to 662x645)

DISCUSSION

The real-time EMG based controlling system shows good sensitivity and stability in experiment. However, there are still some unsolved problems. For example, the experiments were conducted in healthy volunteers, and we haven’t tried the system for disabled patients, so the adaptation of this system for patients should be further tested. Different volunteers’ EMG signals show big difference, so before a volunteer testing the system, we should calibration the threshold for different person. For better user experience, an online calibration algorithm should be proposed.

Further study can also consider proportional control based on the amplitude of EMG signal, for example, if a user contract his muscle with more force, the stepper motor can run faster. This controlling system can also be considered applied in other area such as lower extremity exoskeleton or wheelchairs.

CONCLUSIONS

In this study, we developed a real-time EMG based controlling system for upper limb prostheses. The system shows good sensitivity and stability in recognizing muscles’ different status.

REFERENCES

Assessing Detroit Regional Traffic Conditions Using Intelligent Transportation System Data

**OPPORTUNITY AND SIGNIFICANCE**

- Intelligent Transportation System (ITS) data can measure and monitor the operational performance of the Detroit road network as conditions change, including new public transportation, construction zones, and winter operations.
- ITS data can provide speed mobility graphs which can be used as a method for analyzing cost-benefit calculations.
- The speed mobility graphs quantify travel time delays along I-75 by analyzing 566 traffic message channels (TMC) that produced 983,778,775 travel time data points over a 5 year period.

**METHODOLOGY**

- Example of high congestion (65+ MPH)
- Example of low congestion (<35 MPH)
- Consistent traffic designation near interchange in Canada

**NORTHBOUND 75**

- Zilwaukee Exit: 117
- Mackinac Bridge Exit: 249

**SOUTHBOUND 75**

- Zilwaukee Exit: 61
- Mackinac Bridge Exit: 20
Background

ATCO focuses on quality inspection for automotive suppliers. ATCOQRS was designed to ease the communication barrier between Quality Engineers and Production Line Workers. The mobile application alerts Quality Managers about new tickets created while the web application allows for notification customization and data analysis.

Technical Approach and Results

ATCOQRS is going to be implemented into the Atco headquarters and also be proposed to other quality inspection companies.

Integration will require reworking the mobile and web application to interact with the Atco systems.

Commercialization Plan & Partners

The product was developed for Atco Industries to use and distribute to other quality inspection companies.

If Atco Industries determines that the application meets all requirements and standards, they will continue to implement the software as an enterprise grade software solution.

Objectives

• The application must react in real-time
• Mobile app alerts users about newly created tickets
• The web app allows for the ability to group users for mobile and email notifications
• Quality Managers can view and change information about all tickets in the form of charts and tables

Technology

• Xamarin Android / C#
• Microsoft Azure
• ASP.NET
• MySQL
• Google Play Location Services

Next Steps for Development and Test

ATCOQRS is going to be implemented into the Atco headquarters and also be proposed to other quality inspection companies.

Integration will require reworking the mobile and web application to interact with the Atco systems.

References

Thank you Dr. Sam Bryfczynski and Dr.Khayyam Hasmi for all of the guidance throughout the project. Another special thank you to our clients, who were very helpful throughout the planning of the project!
Automated UAV Food Delivery System

Opportunity and Significance

As unmanned aerial vehicles (UAV) become more affordable and commonplace, companies are beginning to look at how this new technology can be implemented in delivery systems. This automated UAV food delivery system is on the forefront of this field, offering a way for pizza companies in particular to utilize drones to provide fast delivery service.

Technical Objectives

The goal of this project is to provide pizza companies with a reduced cost alternative to automobile delivery. Utilizing UAV technology, companies will be able to eliminate the labor cost involved with pizza delivery. This project aims to provide a safe alternative to current delivery methods which will maintain the same standard of quality and keep food warm and secure during transit.

Related Work and State of Practice

Companies, namely Amazon [1], have begun to patent very early stage ideas for UAV delivery system processes. These patents simply define systems, but have yet to patent technology. Additionally, some companies have begun to make prototypes for testing [3] [4], but have yet to implement them in the field or patent the new technology.

CFD Modeling

Figure 1: CAD modeling of prototype. Left side image shows carrier with door closed. During fabrication, actuator cut out along top of carrier was removed and actuator placed inside. Right side image shows carrier attached to UAV model courtesy of Charles Doppia via GRABCAD [2].

Figure 2: CFD simulation of drone-carrier assembly during flight at a surrounding temperature of 25°C and linear velocity of 30 mph. The top image displays the static temperature and the bottom shows the velocity magnitude both over a period of 60 sec.

Figure 3: CFD simulation of drone-carrier assembly during flight at a surrounding temperature of 12°C and linear velocity of 30 mph. The top image displays the static temperature and the bottom shows the velocity magnitude both over a period of 60 sec.

Figure 4: Contour plot of displacement incurred due to load stress. Loads applied in model are greater than actual loads experienced.

Figure 5: Contour plot of displacement incurred due to Von Misses stress. Loads applied in model are greater than actual loads experienced.

Figure 6: Contour plot of displacement incurred due to shear stress. Loads applied in model are greater than actual loads experienced.

Looking to the future

Further Research:
In terms of the carrier prototype, it is preferred that the material be changed to a much lighter option. A feasibility study would need to be conducted to better understand what materials could research would need to be conducted into autonomous drone technologies, as well as how to appropriately apply them.

CFD Modeling

Future Development:
Our team believes the success of this product in a real market setting is very dependent on developing the full drone and mechanism. Further development would include investigating the feasibility of drone technologies, and how to appropriately apply them.

Upcoming Testing:
The most significant area of testing in system performance is environmental testing. The design team plans to identify and develop testing needs, with a heavy consideration to the impending material change.

Approach:
The initial focus moving forward would be on developing a more robust carrier mechanism. After the completion of the box, the drone applications would be examined, followed by complete series of full system testing.

Commercialization Plan

In order to commercialize this product, we would first need an investor, or a collection thereof, to provide the necessary capital to create a robust and each of their respective and consistent production solution.

Financial:

Corporate:
Our design team would need to work very closely along side pizza corporations to better refine the delivery system to their specific needs.

Regulatory Hurdles:

Governmental regulations regarding the safe operation of unmanned drones will most certainly prove to be the biggest hurdle in the commercialization plan. Perhaps a legal expert would need to be consulted to properly handle the alignment of the product within the law.

References

User Needs
When approached by our client, the main problem was falling and not being able to get back up or call for help. Based on research and the interview this was a fear among many elderly patients. This issue will be solved first by gathering information about the average senior citizen as well as statistics about how many people fall.

Needs Served:
- Alerts emergency services or contacts automatically when client falls
- Option to cancel alert in case of false alarm
- Comfortable enough to wear on a daily basis
- Weight
- Ability to use in shower
- Long lasting power source
- Affordable
- Device should last 2 years
- Easy to use
- Detects fall

Goals and Constraints
- Rechargeable Weekly for 4-6 hours
- Easy to use
- User interface with the device
- Attaching the device to the patient
- Canceling false alarm
- Easily wearable
- Affordable <$100
- Lightweight <100g
- Water resistant to at least 5 feet for 1 hr
- Uses a system fail safe
- Radius of radio signal - 600 ft to the landline
- A component that can detect instantaneous changes in movement

Design Development

Design Output

Design Verification

<table>
<thead>
<tr>
<th>Component</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arduino Uno [1]</td>
<td>$24.95</td>
</tr>
<tr>
<td>Breadboard[2]</td>
<td>$4.97</td>
</tr>
<tr>
<td>Pulse Sensor[3]</td>
<td>$3.97</td>
</tr>
<tr>
<td>Berry IMU Accelerometer/Gyroscope/Altimeter * [4]</td>
<td>$25</td>
</tr>
<tr>
<td>IO pins [5]</td>
<td>$4</td>
</tr>
<tr>
<td>IO pin header [6]</td>
<td>$5</td>
</tr>
<tr>
<td>Solder [6]</td>
<td>$15</td>
</tr>
<tr>
<td>4.7 kΩ Resistors [8]</td>
<td>$5.77</td>
</tr>
<tr>
<td>Total</td>
<td>$96.65</td>
</tr>
</tbody>
</table>

*Since custom-boarding after creating the prototype will be pricey due to the size, it is estimated that the total price when creating the actual device will be 2 to 3 times this price.

Design Review
A list of specific changes or additions to the device were put together based on all of the feedback given. The list is as follows:

- Specification of how we will construct the ABS Plastic Housing Unit
- A lot of issues brought up can be addressed within the programming of the device. These will be done when we are able to program the device.
  - Heartbeat Sensor
    - Specifically, when the device doesn't detect a heartbeat, whether it is due to the device being dropped or the user not having a heartbeat
  - Accelerometer
    - Specifically, what will constitute as a "fall" and what doesn't constitute as a "fall"
  - Raspberry Pi Chip
    - Integration of all the systems to work together with the operating system

References

**Opportunity and Significance**

Design of aerial drone is one of the most interesting design projects which needs understanding of basics of flight, electronic components and laws of motion. BE 1200 class has opportunity to design and manufacture drone using 3D printing technology. NX 10 CAD Software, and CURA 3D printing software are used to create virtual prototypes.

### Aerodynamic Duct Design Objective

1. Increase air flow rate in axial direction
2. Protect high speed propellers in the event of crash

### Electronic Components

- **Microprocessor**: is programmed using libre-pilot open-source software
- **Motor 3 phase**
- **Battery 1000mAh**
- **Receiver Range 1km**
- **Battery Connector**
- **Speed Controller 10A max**

**Propeller Parametric Design**

**Final Prototype Design**

Assembly/3D Printing

Final Assembly is done using fine tuning of electronic parts and 3D printed parts for equal weight distribution. Any misalignment is compensated by changing speed profile of motors.
Benchmarking of a Personal Air-Sampling Device

Russell Charles

Dr. Chin-An Tan and Dr. Joseph Caruso

Opportunity and Significance
Long term exposure to low concentrations of environmental pollutants can lead to a negative impact on our health. Accurate and precise measurements of these pollutants is needed to quantify and better understand their effects. The goal of this project is to analyze and benchmark custom-built personal air monitoring devices.

Technical Objectives
Analysis of a custom-built personal air sampling devices investigated the following:
- Airflow readings
- Consistency of air flow as obstructions accumulate.
- Battery performance

Primary questions of investigation included:
- Did the device maintain a 1LPM flow rate throughout the study?
- How did voltage supplied to the pump scale if the intake valve becomes occluded?
- Did battery capacity fade over course of the study?

Related Work and State of Practice
Many air-pollutant studies use static air monitoring stations to determine pollutant concentration in an area. Various models are then applied to estimate the human exposure. Dr. Caruso seeks to improve current methodologies for measurement to account for individual differences in daily travel and life styles, with a focus on Detroit teens with asthma.

Analysis of Airflow
- Data analyzed from 13 devices, containing 1112 files (N = 35,375 voltage measurements).
- A supplied voltage of 3.1V @ 400 mA is required for an air flow rate of 1 LPM.
- Analysis of device data shows near constant flow rate is maintained approximately 76% during operation.

Analysis of Battery Performance
- Battery performance was validated by comparing experimental runtime to the theoretical runtime of 19 hours.
- A webcam was used to record continuous device operation for 27 days. At each night, after the battery energy was depleted, the device was allowed to recharge until at 100% SOC.
- Neither device was able to run for 19 hours, however no remarkable capacity loss of the battery was observed.

Next Steps for Development and Test
Further Testing
- Vibration testing for effect on air flow consistency, battery voltage, and mechanical endurance.
- Thermal testing of battery and pump for a range of ambient temperatures.
- Cycle life of device battery cells.

Future Developments:
- Reduction in device size and sound generation.
- Improved ergonomic case design.
- Transition to dual-layer PCB for wire free design.
- Improved battery chemistry to ensure sufficient runtime, while not increasing size.

Commercialization Plan & Partners
Partners:
- Prisma Dynamics LLC designed and assembled the original custom device.

Plan:
- Market with the strategy of custom technology solutions.
- Critical components will be ordered from online suppliers, such as the PCB.
- Final assembly will be continue to be completed by Prisma Dynamics LLC.

Challenges:
- Implementation of future development decisions.
- Obtaining patent for technology.
- Determine correct production volume.

References
Bicycle Crash Data Analysis - Detroit

Saki Rezwana, PhD Student
Steve Remias, Assistant Professor
Department of Civil and Environmental Engineering

SCOPE OF THE STUDY AND OBJECTIVES
To reduce the number and severity of bike crashes in Detroit, Michigan, a comprehensive study is needed to identify causes, contributing factors, and potential countermeasures. The objectives of this research are to determine specific causes and risk behaviors for bike crashes in Detroit, Michigan; examine best practices and successful countermeasures; and provide recommendations on how to reduce bicycle crashes.

STUDY AREA

SIGNIFICANCE

TECHNICAL APPROACH

NUMBER OF BICYCLE CRASHES IN DETROIT (2010-2015) 809

BIKE CRASH STATISTICS - DETROIT TEMPORAL

SPATIAL

ROAD AND RIDER’S STATISTICS

COUNTERMEASURES

The two major risk behaviors associated with bicycle crashes in Detroit are failing to yield and overtaking (both by bicyclists and motorists). NHTSA identifies driver training and “Share the Road” awareness programs as countermeasures that work for drivers and bicyclists.

BICYCLE SAFETY RECOMMENDATION

- Always ride WITH traffic
- Wear bicycle helmets and reflective clothing
- Obey the rules of the road as other vehicle operator, such as all traffic signs, lane markings and signals, and use hand signals to indicate turns, slowing or stopping
- Stay as far to the right when riding in traffic lanes
- Avoid entering the roadway without first stopping to look for vehicles
- Have a white front headlight and a red rear reflector if riding after dark or in low light conditions.

Source: Secretary of State, MI

FUTURE RESEARCH

This observational study of Detroit bicycle crashes summarises the characteristics of bike crashes in the city. This approach should be scaled to investigate bicycle crash characteristics for the entire state of Michigan. A statewide study would help identify critical features or countermeasures that could reduce bike crashes and promote biking as a safe mode of transportation.

REFERENCES
1. Pedestrian and Bicycle Crashes and Causes in Michigan; TY Lin (2012)
3. Michigan Traffic Crash Facts (MTCF)
Combined Photoacoustic and Fluorescence Imaging as a Dual-Modality

Opportunity and Significance

- The overwhelming need for, and clinical interest in, noninvasive diagnostic procedures
- Single modalities alone can only provide a limited amount of information
- A dual-modality system would allow for enhancements in noninvasive diagnostic procedures for tumor detection\(^1,\(^2,\(^3\)

Technical Objectives

- The development of a dual-modality imaging system that combines photoacoustic (PA) microscopy and fluorescence imaging (FI)
- To outline the enhancements to the both qualitative and diagnostic information available in the combined images from this system

Related Work and State of Practice

- The development of a unique laboratory setup for the project was designed and implemented
- Validation of the system, including image acquisition and data acquisition, in progress

Technical Approach, Accomplishments, and Results

- The combined system has been designed and is being optimized for dual image acquisition
- System is designed with external triggering to coordinate acquisition between PA and FI
- Validation of system requires FI image acquisition and PA image reconstruction

Next Steps for Development and Test

- Final validation and optimization of system function to enhance imaging capabilities
- Acquisition of biological samples or specimens to test diagnostic capabilities
- Enhance design for imaging biological systems

Commercialization Plan & Partners

- The research effort were done entirely at Wayne State’s Optical & Photoacoustic Imaging Research and Analysis Laboratory (OPIRA)
- We have connect with a physician from the Henry Ford Health System to develop a project for imaging nanoparticles in glioblastoma
- Limitations to research efforts are related to resources available for the laboratory

References


This project thanks the College of Engineering UROP for their award and support.
Opportunity and Significance

Ultrasound Shear Wave Elastography uses an implemented force to cause a change in mechanical property of soft tissue. Due to malignant cells being made up of multinucleated cells, they hold differing mechanical properties than healthy tissue, leading to the ability to detect different tumors like melanomas. The force induced is one of the variables of a programmable ultrasound as well as the transducer elemental arrangement, as being explored in this study. In this research, a programmable Verasonic Vantage 128 ultrasound Machine with a L7-4 linear array transducer was used.

Technical Objectives

In this study, a mechanical source for the “push beam” was implemented using an oscillation probe technique. This will bypass the need for expensive external equipment usually paired with the programmable ultrasound. Further, the elements of the transducer were arranged into 5 subgroups of 12 elements with 17 elements in between them. The subgroups simultaneously transmit an unfocused beam while the rest of the elements are off. All elements are on for the echo detection.

Related Work and State of Practice

Various techniques are being studied in real time ultrasound Elastography in tumor detection, however, practiced methods require expensive equipment with high frequency machines.

Technical Approach, Accomplishments and Results

Mechanic Oscillation setup is depicted below in Figure 1:

Elemental arrangement of the transducer are depicted below in Figure 2:

A full single Field-of-View Two-Dimensional Shear Wave Speed Map from a Local-Frequency-Estimation is depicted below in Figure 3:

Next Steps for Development and Test

Once method is confirmed using inclusion phantoms, a series of clinical trials will be conducted. Dr. Daveluy runs histology clinics twice a week and stated they see roughly one melanoma case a clinical day. This leaves room for method verification leading to a noninvasive practice in early melanoma detection.

Commercialization Plan & Partners

Dr. Nasiriavanaki lead a group of research students in a series of research projects dealing with an optical coherence tomography and a programmable verasonic vantage 128 ultrasound machine in reference to dermatology.

Dr. Daveluy will give us the opportunity to validate this method within clinical settings. Dr. Nasiriavanaki will further the commercialization of the method.

An IRB approval is needed to conduct clinical trials, however this should be attainable as the ultrasound machine is already FDA approved. Further commercialization requirements available upon request.

References


Wayne State DOSO Research Grant
Condition Assessment of End-of-Use Products for Remanufacturing

Jovan Morgan | Advisor: Jeremy L. Rickli | Dept. Industrial & Systems Engineering

Opportunity and Significance
As a result of remanufacturers encountering high uncertainties in component quality, advanced technology such as 3D scanning serves as a vital component used to reduce inspection and assessment to eliminate error and make remanufacturing and reprocessing more efficient. Often manufacturers spend more money, energy, and time fixing human error as it relates to quality checks and schematic calculation errors that cannot be detected by the human eye. Therefore, the goal of my project is to use an automated 3D laser scanner (Capnaut) as a test object to detect surface defects, corrosion, and calculation error through offline quality inspection. Potentially reducing labor time and cost for both consumers and manufacturers.

Technical Objectives
• Use schematic design and calculation to create 3D model – By using schematic design I was able to use its calculations to draw the (Capnaut) using AutoCAD software. Having the (Capnaut) drawn as a 3D model is critically important for data acquisition and analysis.
• Create a fixture to secure the 3D model – A fixture is vital for securing a zero position to ensure consistent scans.
• Design a trajectory path for automated scanning – Use compatible 3D software for the purposes of converting programming data over to (TP) Teach Pendent controller which operates the Fanuc robot and the automated laser scanner.

Related Work and State of Practice
The below diagram displays the various processes of sustainable remanufacturing. Sustainable remanufacturing is a global concern which addresses ecological, economical and socio-political needs of the human race as well as considering the availability of natural resources and the ecosystems for future generations. As a participant of the (REU) Sustainable Remanufacturing program, I was afforded the opportunity to ascertain knowledge and skills that propel sustainability efforts. Initially the goal of my project as a (REU) participant was to gather point clouds of the (Capnaut) and compare it with the 3D model. However, I have now extended that study into figuring out the kinematics of the robot to create a better trajectory for the (Capnaut), which will aid in further research efforts to have consistent data that allows a better comparison between a 3D model and an actual object in this case the (Capnaut).

Technical Approach, Accomplishments and Results
Figure 1
This figure represents the setup design for scanning. Table is plotted in a specific location known to Roboguide software to create the trajectory.

Figure 2
This figure represents the simulation robot created to program automated scan paths and using the dimension of the part from the blueprint and the physical location seen in figure 3.

Figure 3
This figure represents the computed point clouds in MATLAB, it is the dimensional information of the scanned part which shows all the data points for clearer analysis and modification purposes.

Figure 4
This figure represents the schematic design and dimension used to draw a 3D model that will is used to program the trajectory and automate the scanning process.

Next Steps for Development and Test
In the future by standardizing the scanning procedures and controlling the variations in the scans this technology can be widely used in the industry. For example, industry currently uses this form of technology; however, it is not consistent or reliable due to obstruction and inconsistency as it relates to scan paths and parameters. Controlling these factors and knowing its causes by conducting research can help both academics and industry. This extended research will provide causes and effects of the change in parameters and controlling the noise variations. In conclusion, it is most essential that academia in the near future focus on ways to study different parameters and the affect on scan quality.

COE Undergraduate Research Experience
Working as an undergraduate researcher in alongside Ph.D. student Mojahed, under the leadership of Dr. Jeremy Rickli gave me a wealth of knowledge and experience that I could not possibly gain inside a classroom. Dr. Rickli’s research consisted of a three part framework for condition assessment, material deposition, and reprocessing. As a result of his cutting edge research Ph.D. student Mojahed and I were able to use previous methodologies and concepts to study and find solutions to remanufacturing processes and quality checks. My research will be able to help Dr. Rickli and Ph.D. student Mojahed have consistent data to improve condition assessment processes and collect feasible scans for accurate analysis.

References

Acknowledgements
I would like to thank the College of Engineering and the Industrial and Systems Engineering department for awarding me this opportunity. Ahmed Al-Mirza contributed hugely to the creation of the simulation program used for testing. Mojahed M. Alkahteeb contributed previous knowledge and sustainable experience.
CONTROL OF LASER TIMING IN LASIK EYE SURGERY
PADMASHREE,HARSHITHA,PRATEEK AND CHANDAN

ABSTRACT
• Over the past 25 years, surgical techniques, tools, and procedures for vision correction have evolved rapidly.
• Radial Keratotomy (RK), used in the United States primarily during the 1980s.
• This involves cutting spoke-like incisions.
• This flattens the eye’s surface mainly to correct nearsightedness.
• But results, especially long-term, created problems for some individuals.

INTRODUCTION
• LASIK laser eye surgery has many benefits.
• It works and is proven to correct vision in most cases.
• Vision is corrected almost immediately or by the day after LASIK laser eye surgery.
• Recovery is quick and usually no bandages or stitches are required after LASIK laser eye surgery.
• After having LASIK laser eye surgery, most patients no longer need corrective eyewear.
• Other side effects, although rare, may include: Glare, Seeing halos around images, Difficulty driving.
• Fluctuating vision

ALGORITHM
Step 1: When the state of B is 1 i.e (B=1), Laser is turned ON.
Step 2: The value is stored in the first flip flop
Step 3: This value is stored to next flip flop after every completion of one cycle.
Step 4: Laser is turned off after three clock cycles.

STATE FLOW DIAGRAM

CONCEPT

CODE

IMPLEMENTATION

*Market is seeking new and more accessible therapies, including earlier detection and non-invasive surgical treatments, to treat the most common diseases. Advances in the fusion of diagnostic imaging modalities and their associated algorithm developments are the primary drivers in developing equipment to meet these patient needs. Advanced algorithms require scalable system platforms with significant increases in image processing performance, yet in smaller, more accessible, portable equipment. Integrated into multicore CPU platforms, help accelerate the implementation of sophisticated imaging algorithms onto these platforms, high-level development tools and IP implementation libraries are required.
Opportunity and Significance

• To allow the Denso International America (D IAM) Telematics Team to simulate vehicle scenarios on a mobile-friendly web application
• Its importance is to provide testing engineers a platform to run tests on a vehicle telematics system and conveniently display the results.

Technical Objectives

• Integrate mobile-friendly web application with DIAM interface server
• Create a platform for administrators and testing engineers to start scenarios or commands
• Store and display information from the vehicle server

Technical Approach, Accomplishments and Results

• Created a mobile-friendly web application using the .NET framework to simulate scenarios and commands
• Scenarios and commands are initiated by testing engineers, then run through DENSO’s interface server
• Successful in testing the connection between the web application and DENSO’s interface server
• Provided the ability to review log history from previous scenarios and commands
• During a live scenario, a map with latitude and longitude markers was displayed for the user
• Ran a live scenario using the application with DIAM partners

Next Steps for Development and Test

• Geofencing to create the geographic boundary of a vehicle’s location and alert testing engineers

Related Work and State of Practice

• Vehicle Telematics
• DENSO Interface Server
• ASP .NET
• C#

Commercialization Plan & Partners

• Our DIAM partners were:
  • Jonathan Swierczynski
  • Marie Cooper
  • Tsunehiro Katou.

• This product will not be commercialized by DIAM, and will be used internally by the Telematics Team.

Sponsored by Denso International America (DIAM)
Abstract

Nano digital circuits have been the topic of interest in molecular medicine for the last three decades. Some researchers have analyzed some human body operations as equivalent to simple nano gates and their connections. In this poster, an overall quantum-dot cellular automata (QCA) design for a generalized pipeline cellular array, which can perform all the basic arithmetic operations such as squaring, square rooting, multiplication, and division is presented. The array is design with the minimum number of cells and clock zones which gives an excellent implementation of various molecular applications using majority-based nanotechnologies.

Quantum-dot cellular automata (QCA)

QCA is one of the promising emerging nanotechnologies that are being considered as possible alternatives to complementary metal-oxide semiconductor technology due to the physical limitations of CMOS [1-3].

generalized pipeline cellular array

A generalized pipeline cellular array is an arithmetic processor that can perform all the basic arithmetic operations such as multiplication, division, squaring, and square rooting [4]. In this array, controlled adder-subtractor arithmetic cell and control logic cell are used as the basic cells.

Conclusion

In this poster, a generalized pipeline cellular array that can perform all the basic operations such as squaring, square rooting, multiplication, and division has been implemented in QCA. The equivalent majority-based networks of the basic cells have been realized with minimum numbers of gates, levels, and inverters. This results in an excellent QCA design for a generalized pipeline array in terms of cell amount, area, and clock frequency.

References

ABSTRACT

Blood Doping is the practice of boosting the no. of Red Blood Cells in the bloodstream in order to enhance athletic performance. Because such blood cells carry oxygen from the lungs to the muscles, a higher concentration in the blood can improve an athlete’s aerobic capacity (VO2 max) and endurance. The project detects the misuse of certain techniques and/or substances to increase one’s red blood cell mass, which allows the body to transport more oxygen to muscles and therefore increase stamina using Field-Programmable gate Array.

INTRODUCTION

Blood doping is defined as the use of illicit products i.e. erythropoietin (EPO), darbepoietin-alfa, hypoxia-inducible factor (HIF) stabilizers and methods in order to enhance the O2 transport of the body to the muscles. The body undergoes aerobic respiration in order to provide sufficient delivery of O2 to the exercising skeletal muscles. The maximum O2 uptake depends on cardiac output, O2 extraction and hemoglobin mass.

The cardiac output of an athlete is difficult to manipulate as the distribution of cardiac rate (80%) is at the maximum during competitions. In addition, O2 (90%) extraction is at maximum when exercising. Therefore, only way to enhance once physical performance is to increase the 12 content in the artery by enhancing the hemoglobin mass.

METHODS OF BLOOD DOPING

The three widely used types of blood doping are:

- Blood transfusions
- Injections of erythropoietin (EPO)
- Injections of synthetic oxygen carriers.

CONCLUSION

We can conclude that logic can be designed for any real life problem and implemented using the FPGA board. As per our prototype design, using the expression, we could design four Outputs for detecting the doped cells from blood.
Opportunity and Significance

Diabetes mellitus is a metabolic condition, which affected 25.8 million people in the U.S in 2010 and has thus increased to 29.1 million people in 2012.

Develop a system based on heart rate, for diabetic individuals regardless of age, to have an alert system and notify of low heart rate.

The estimated total economic cost of diagnosed diabetes in 2012 is $245 billion, a 41% increase from our previous estimate of $174 billion in 2007.

Technical Objectives

Create an add-on device for patients with diabetes that will utilize an application that runs on iOS systems.

Have an alarm go off to alert the users of a low heart rate and use of Kardia Mobile to send EKG to physician.

Compatible with multiple heart rate monitors such as Apple Watch and Fitbit.

Technical Approach, Accomplishments and Results

• Each user saves their information within the application in order to tailor the application thresholds for heart rate to themselves.

• If the patient's readings fall outside or go above the target range, the patient is alerted and instructed to take their EKG.

• EKG and heart rate are sent to a physician through the application.

Technologies

• The mobile app was built using XCode with the SWIFT programming language.

• The Charts API will be used to graph the heart rate data.

• We are planning to use a parse server through AWS for our product

Next Steps for Development and Test

The Heart Rate Application will be available to users through the Apple App Store. Our application will then be partnered with Cardiology practices to be as a recommendation to diabetic patients as an add-on device to their normal sleeping habits.

Commercialization Plan & Partners

This product was built as a project for the Biomedical Engineering Program. It was given to us by our client as a possible solution to the Dead in Bed syndrome facing diabetic individuals.

If there is a great reception to the application on the App Store development will continue to improve on the telehealth ability and vital measurement.

Special Thanks

Thank you to Professor Brian Mundo and Dr. Andrei Borisov for your advice, guidance and recommendations throughout the development and preliminary design of

Thank you to the Biomedical engineering department for providing us with this incredible experience and funding the product.
ABSTRACT

The design of efficient and low-emissions diesel engines is increasingly dependent upon the fidelity of numerical simulation models, including those describing the fuel spray process. Following the injection event, the subsequent mixing of the fuel jet with air plays a deterministic role in the subsequent combustion and emissions formation. Accurate spray modeling requires precise knowledge of the characteristics of the injection process, and the metrics used to characterize the injection event are the area and velocity coefficients [1]. Through application of first principles (conservation of momentum), this project will result in an experimental setup to empirically determine these critical injection constants that will increase the accuracy of engine combustion simulation models. A piezo-electric pressure transducer will be used to measure the resulting force produced by an injector fuel jet, from which the above constants will be determined.

OBJECTIVES

- Design a fixture to secure a diesel fuel injector and pressure transducer in an orientation such that the fuel jet impinges on the transducer, with the axis of the jet normal to the sensor.
- Conduct experiments using a piezo injector over a range of injection pressures, measuring the forces produced by the jets of this injector.
- Perform data analysis to determine injection coefficients.

INJECTION COEFFICIENTS

\[ C_v = \frac{u_{eff}}{A \cdot \rho} \]
\[ C_a = \frac{A \cdot \rho \cdot \Delta P}{A_{geo} \cdot \rho_{fuel}} \]
\[ C_d = C_v C_a \]

NEXT STEPS

- Perform a calibration procedure on the pressure transducer.
- Set up a data acquisition system or oscilloscope to record pressure transducer output.
- Analyze data obtained from pressure transducer to determine injection coefficients.

REFERENCES


Opportunity and Significance

Developing an easier method of removing compacted snow and ice.

Provide a more comfortable experience for the user through the use of heated hand grips.

Overall an electrically heated shovel will make the shoveling experience less stressful.

Technical Objectives

1) Heat the edge of the shovel head to a temperature that “slices” through compact snow and ice.
   - How hot does the blade need to be?
2) Developing an adjustable grip that promotes user comfort for all over the duration of shoveling.
   - What type of handle/grip would best reduce user fatigue?
3) Provide warmth to the user’s hand, via heated grips, to better combat harsh winter conditions.
   - What method of heating would be most appropriate to promote a safe working condition?

Technical Approach, Accomplishments and Results

We performed a patent search:
- Heated Snow Shovel w/ Ice Chopper Attach.
- Heated Ice Scraper
- Heated Handle Construction
- Long Handle Striking Tool and Sliding Handle

From the patent search the project was split into two key components: the blade and the grip.

Blade
1) What material should the blade be?
   - General Purpose Low-Carbon Steel – Provided the strength and thermodynamic properties required.
2) How will the blade be heated?
   - Nichrome Wire was chosen to heat the blade due to its high temperature range and its packability.
3) How will the blade be attached to the shovel without disturbing the functionality of the shovel?
   - 4 flush screw end pins will hold the blade on the top side of the shovel head.

Grip
1) How will the grip be heated?
   - An electric heater wire pad, designed to fit around a motorcycle handlebar, was used to provide heat to the user’s hand while simultaneously ensuring safety.
2) How will the grip be able to lock/adjust?
   - The grip is designed to fit flush to the shaft to allow enough clearance to slide freely. Pipe clamps are then tightened at both ends to prevent slippage.
3) What method provides the most comfort for the user?
   - A grip that slides up and down the shaft to provide comfortable handling for users of all sizes

Next Steps for Development and Test

Testing
- Further testing in winter conditions are required to show proof of functionality.
- Prototype needs to be refined according to the test results.
- Aesthetics of the shovel can be improved to hide loose wires.
- Pipe clamps could be replaced with modernized locking mechanisms.

Commercialization Plan & Partners

Partners
- Professor Mohammad Ali Ozbeki
- Bob Kas-Mikha (Machinist)
- Wayne State University

- The first main step to commercialization is to acquire a backer via a kickstarter program.
- We would also need a supplier to support us to reduce the cost of the product.
- Some of the main hurdles of commercializing is reducing the cost of our product. Currently our project is expensive for what it is.
- Another hurdle of commercialization is mass production would be difficult without a supplier.

Project funded by Wayne State University
Encouraging Entrepreneurship Among Engineering Students

Opportunity and Significance
The Innovation and Entrepreneurship program is facing low student enrollment. The entrepreneurial organizations at Wayne are disconnected and many of the events each organization holds overlap with one another. We recommend that WSU redesigns the entrepreneurial ecosystem on campus using a student-centered approach in a way that will condense these organizations & make it easier to get involved in entrepreneurship.

Technical Approach, Accomplishments and Results
Data was collected by conducting interviews with entrepreneurship faculty here at WSU & other schools, distributing surveys to students and researching successful entrepreneurial practices.

Step 1: Identify the misgivings students have with current offerings here at Wayne State:
● Commuter college; large amount of transfer students leads to low awareness
● Once enrolled in a curricular offering, little is done to encourage teamwork across disciplinary lines
● Curricular programs often compete with the offerings of extra curricular programs

Step 2: Identify successful programs at other colleges & universities:
● Our research shows the most successful colleges and universities consolidated their entrepreneurial offerings into one center
● Centers were typically student-led with faculty support
● Centers often also used their schools website & academic portals such as Handshake to reach students, as opposed to sending out emails

Next Steps for Development and Test
Based on our research we recommend that Wayne State University does the following:
● Consolidate all entrepreneurial related offerings into one student-led center which places emphasis on collaboration & creativity
● Utilize Handshake & Blackboard to post about offerings & act as a resource to get students in touch with other students across disciplinary lines
● Conduct a “customer discovery” survey to find out which offerings, curricular or otherwise, are most sought after by employers

Technical Objectives
1. Increase student awareness of entrepreneurial resources at WSU
2. Increase student enrollment in entrepreneurship courses
3. Create a student-lead organization to promote entrepreneurship

Related Work and State of Practice
Existing Entrepreneurial Programs
● Anderson Institute
● Innovation Warriors
● OptimizeWayne

Commercialization Plan & Partners
We will be willing to work with entrepreneurship and engineering faculty to help redesign the entrepreneurial ecosystem.

The biggest challenge facing implementing our recommendations entails collaboration amongst currently competing department heads.

References
Aubrey Agee, Personal Communication
Elizabeth Kondrat, Personal Communication
Erin Rook, Personal Communication
Jeff Stoltman, Personal Communication
Gary Witus, Personal Communication
Opportunity and Significance

- Michigan’s great Lakes contain 21% of earth’s fresh water.¹
- The Great lakes Restoration Initiative identified cleaning up area of concern as a priority.²
- A low cost wireless sensor capable of monitoring water quality with geo-tagging via internet of things (IoT) is required.

Technical Approach

- Prototyping platform: Arduino Uno
- GPS Chip: the Arduino GPS Shield
- Wireless Communication: Through The Arduino GSM Shield
- Water Quality matrix: pH ∈ [6.5,8.5], electrical conductivity (eC) ∈ [5,50] mS/m, turbidity <5 NTU.³

Next Steps for Development and Test

1. Deployment outside of Laboratory
2. Moving out of Arduino prototyping to microcontroller based design for compactness.
3. Integrating all sensors on a single circuit.

Commercialization Plan & Partners

- As it is, the prototype costs less than $100.
- With further work, the cost can be reduced drastically.
- Can significantly reduce the cost of water quality monitoring and add value to great lakes restoration efforts.
- Currently looking for commercial partners.

Related Work and State of Practice

- Arduino based GPS tracker was designed previously.⁴
- IoT based sensor arrays for air quality monitoring was developed.⁵

References

2. https://www.gtri.gatech.edu/priorities.html
## Opportunity and Significance

- Engineering change is used by engineers to solve problems and then optimize the solutions within certain constraints set by materials, technology, environment, economy and other human-related factors.
- Voice of the customer (VOC) analytics is used to measure the combined effect of textual, subjective and quantitative feedback received from customers and transform it to output design change requirements.
- Thus, the integrated customer satisfaction index (ICSI) which measures customer’s overall satisfaction on a particular product/service supplied by a company is created and warranty cost is included.
- Then, using the ICSI values as inputs to create a modified fuzzy-QFD template to enable engineering design change.

### Technical Objectives

- To develop a framework to translate customer’s information which has been captured and modeled to ICSI into engineering change requirements that will meet customers’ needs and satisfaction.

### Related Work and State of Practice

- This work is an extension of the prior research done in the modelling of customers satisfaction index that incorporates financial implication.
- The earlier work is proposed to address the customers problems in areas of product recall and facility allocation configuration.
- The current work involves the use of integrated customer satisfaction index which has been calculated from earlier research as input in the quality function deployment to enable engineering change.
- In this research, a modified fuzzy-QFD was used in the analysis and engineering design changes were proposed based on the result of the QFD analysis.

## Technical Approach, Accomplishments and Results

The proposed methodology for fuzzy based ICSI to enable engineering change is shown in figure 1. In this section, we present the conceptual architecture for this research project. This novel research consists of three main approaches:

### I. Interpret customer data through data mining and dynamic CTQ library.

### II. Use of Fuzzy logic in creation of ICSI Model and Mapping ICSI values back to CTQs

### III. Using CTQs and ICSI values as inputs to a modified fuzzy-QFD to make engineering change proposal

![Figure 1: Architecture of engineering design change driven by VOC analysis](image1.png)

![Figure 2: CTQs with mapped ICSI value](image2.png)

![Figure 3: A modified fuzzy-QFD (Built with CTQs and ICSI Values) for Engineering Design Change](image3.png)

## Next Steps for Development and Test

- The next phase of this research will involve the development of the model into a software tool that will aid in making engineering change suggestions.
- And the major challenge is programming the model using a programming language.

## Commercialization Plan & Partners

This is currently under-development with our respective partners.

## References

Opportunity and Significance
There are many charities available in the world that people are unaware about. Additionally, people can become overwhelmed by the amount of charities that exist when deciding to donate to one. Giv matches charities to users and presents them charities they would be most interested in donating to.

Technical Objectives
- Build Giv mobile application on Android
- Build server to send receive information about users and charities
- Match users to charities based on their Tweets and questionnaire results
- Allow users to search for and submit charities
- Send user notifications about charities
- Share charities via social media, sms, and email

Related Work and State of Practice
As of now, people are able to find charities to donate to from searching websites, but usually the smaller charities are overshadowed by the larger ones and do not appear on the search. Another method is through word of mouth, but this still does not give the smaller charities a chance to grow into a larger charity.

Next Steps for Development and Test
The next steps for this application is to implement donations within the app. The money donated will go straight to the charity to ensure that they receive the necessary funds in order to continue their operations and make a positive impact on society. Furthermore, we will require user participation in order to evolve our database to include countless other charities.

Learning Experiences
- Ionic Framework
- Apache Cordova
- Angular JS 2
- PHP
- Python
- Twitter API
- Automated Testing (Jasmine,Karma,Appium)

Special Thanks
Special thanks to Dr. Sam Bryfczynski, Dr. Khayyam Hashmi, and Saeid Balaneshinkordan for their help and guidance throughout the semester.

Also, a thanks to Lester Mitchell for contributing his time and effort in guiding us throughout this project and providing us with constructive criticism in order to ensure the success of Giv.
Opportunity and Significance

This software will enable General Motors to accurately predict commodity trends. Commodity futures are a large part of the global economy and accurate prediction software would be a massively useful tool.

Technical Objectives

We attempted to use machine learning technologies in order to predict seasonal and nonseasonal time series. These time series are inherently difficult to predict due to their pseudo-random nature. Signal processing techniques and multiple neural networks were employed to improve the overall accuracy of the predictions. The classic ARIMA algorithm was used as a baseline metric for the machine learning approach.

In addition, these predictions were used to estimate future financial indicators in order to find buy and sell signals for the specified commodities.

Related Work and State of Practice

Other approaches utilize different levels of sentiment analysis to make predictions as well as many different neural network configurations to make the financial prediction. The previous semesters team utilized a single neural network combined with sentiment analysis to make their predictions.

Technical Approach, Accomplishments and Results

Signal processing algorithms were employed to preprocess the data used as input into our array of neural networks. By employing this preprocessing technique and using multiple neural networks, we were able to increase the prediction accuracy by over 20% for all metrics. Additionally, all metrics and trend lines were added to a simple dashboard style interface to allow for visualization of the data.

Next Steps for Development and Test

The current product is a proof of concept of merging machine learning concepts with a typical backtesting suite. Further development is required to open up the application to new data sources, adding more complete data visualization tools, and improved machine learning techniques. In particular, neural networks could be used to find trading signals within a commodity time series instead of the more classic financial indicators. The weight vectors of this neural network could help shed light on which variables are most important.

Commercialization Plan & Partners

This project was a collaboration between General Motors and Wayne State University.

This project is intended for academic research purposes and will not be commercialized at this time.

References

Opportunity and Significance

• Currently, graphene is too expensive to be cost effectively implemented in many commercial applications
• Applications include display screens, circuits, conductive inks, super capacitors and more.
• Reducing this cost of production would allow for widespread use of graphene in various fields.

Technical Objectives

Our objective is to use supercritical CO\textsubscript{2} drying supplemented by shear mixing and ultrasonic frequencies to create graphene.

Questions sought to answer:

• Is it possible to create high quality graphene (1-3 layers) using sCO\textsubscript{2} dryers
• Can this technology be scaled?
• What price can graphene production be minimalized to?

Related Work and State of Practice

• A couple studies have created graphene using shear mixing at a small scale
• One study conducted in China used an ultrasonic probe to create graphene at a small scale

Technical Approach, Accomplishments and Results

Technical Approach:
Separating layers of graphite using sCO\textsubscript{2} in combination with ultrasonic frequencies and shear mixing.

Next Steps

Optimization and Characterization- Optimizing pressure, ultrasonic frequency, solvents, and dispersion techniques to acquire highest quality.
Scaling- Full scale system must be demonstrated before this technology can be implemented into current graphene manufacturing facilities.

Commercialization Plan & Partners

Partners: Michael Golfetto, CTO
Grant Lorimer, CEO

Board of Advisors: Gary Witus
John Panorgias
Dan Lorimer
Ren Carlton
Jay Hansen

Commercialization Plan:

• Partner with XG sciences, one of the largest current Graphene manufacturers, located in Michigan.
• Sell samples to 3D printing companies until a deal is created with XG sciences

References

### BUSINESS MODEL

#### Key Partnerships
- McMaster-Car
- OAC
- Mercotac
- Applied Magnets
- Epec
- Amazon
- Prospective wholesaler

#### Key Activities
- Production is our key activity
- Create a cost effective and viable turbine
- Continued improvements on the turbine

#### Customer Relationship
- Niche market
- Utility Provider that needs to meet RPS Quota
- Green Activist

#### Value Proposition
- Clean Energy and Less Emissions
- More efficient than solar energy
- Reduces electrical bill
- Space saving compared to other turbines

#### Channels
- Customer will be reached by wholesalers
- Partner indirect Channel

#### Customer Segment
- Create trust and integrity with customers
- Long term relations with wholesaler and customers

#### Key Resources
- Wind Turbine Patent
- Financing: Interest from the Army Tardec.
- Tax Credit

#### Customer Relationship
- Niche market
- Utility Provider that needs to meet RPS Quota

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#### Key Resources
- Wind Turbine Patent
- Financing: Interest from the Army Tardec.
- Tax Credit

#### Revenue Stream
- One-time transaction
- Sales would contribute all of the revenue

#### Cost Structure
- Total cost of finished materials is $1500.
- Most expensive parts: magnet,
- Billet Plate, and slip ring connector and boot

#### RESULTS OF WIND SURVEY

![Anemometer](image)

Wind Speed Measurement - Mean with Std Deviation

- Mean wind speed across different locations and times.
- Standard deviation indicates variability in wind speeds.

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**Harnessing Wind Energy in Urban Canyon**

**Industrial & Systems Engineering**

**Joseph Romano, Charlie King, Ayush Singh & Rushabh Vasani : Advisor – Prof. Gary Witus**
Histological Analysis of Nerve Regeneration in Nerve Conduits Enhanced with Growth Factors and Aligned Fibers

Opportunity and Significance
Peripheral nerve injury can cause a complete loss of functionality in the respective limb if the injured nerve improperly regenerates. The current ‘gold standard’ is an autograft but nerve growth conduits (NGC) have been developed to direct regeneration. In this study, we fabricate a NGC with aligned fibers and growth-factor releasing microspheres. Histology is used to evaluate the extent of regeneration by measuring nerve fiber density and the myelination of axons in both exercise and without exercise groups.

Technical Objectives
Determine if there is a synergistic effect on nerve growth when physical therapy and extended growth factor release NGC are combined through histological analysis.

Related Work [1]

Figure 1: Aligned scaffolds fabricated w/ (right image) & w/out microspheres (left image) incorporated and cultured with DRGs

In Vitro
• Cell culture studies about dorsal root ganglion (DRG) with microspheres showed unidirectional neurite growth in aligned fibers (Figure 1)
• Growth is both directed and more robust with the GF microspheres & aligned fibers

Figure 2: NGC + GF

Figure 3: NGC + GF + PT

Figure 4: NGC + PT Group, with H&E

Figure 5: NGC without PT, Neurofilament stained with DAB

Next Steps for Development and Test
• We expect to see increased regeneration histologically. Future steps consist of more staining and analysis of longitudinally-cut nerves.
• Cross-sectioned paraformaldehyde-fixed nerves have to be sliced and stained with toluidine blue solution which dyes nucleic acids blue & polysaccharides purple.
• The gastrocnemius muscles will also be histologically analyzed for muscle fiber regeneration.

Technical Approach, Accomplishments, and Results

In Vivo (3 month longevity)
Five Surgical Treatments:
• Group 1: Autograft
• Group 2: NGC with growth factors and physical therapy
• Group 3: NGC with growth factors but NO physical therapy (PT)
• Group 4: NGC without growth factors but WITH physical therapy
• Group 5: NGC without growth factors and without physical therapy

Post-Harvest
• Paraformaldehyde-fixed nerves were paraffin embedded, longitudinally sectioned, and stained w/ rabbit anti-neurofilament 200 antibody and hematoxylin-eosin (H&E)
• H&E stains nuclei and protein
• Coloration with 3,3-diaminobenzidine (DAB) stains neurofilament [2]

References

Thank you to the College of Engineering for the Undergraduate Research Opportunity (UROP) Grant.
Opportunity and Significance

This application was developed to assist users with managing a large network of contacts and to provide information on contacts on an on-demand basis.

Technical Objectives

- Provide an all-inclusive database to manage contacts and locations with industry-specific details
- Geo cached contacts and location data to enhance UI and filtering mechanics
- Add custom fields as necessary to adapt the software to the desired user’s industry
- Generate reports of contacts and addresses based on any datapoint saved for any contact
- iCanvass allows the user to visualize a network of contacts according to user-defined filters to enhance the value of the contact management system, and provide for a deeper level of functionality and performance compared to currently available options in the market place

Related Work and State of Practice

Applications that allow you to manage contacts and inventory do not include mapping functionality. iCanvass allows the user to visualize their network of contacts and inventory on a map for an overall easier and more efficient way to manage them.

Next Steps for Development and Test

Advance the map functionality to enable a more efficient and productive canvassing experience.

Technical Approach, Accomplishments and Results

- Maps out locations on map from users contacts and locations
- Tracks tasks and individual contact record ‘health’ to preserve strong relationships and enhance the sales pipeline by providing customizable strategic reminders as necessary
- Allows for project management, where each project can have a list of associated contacts and inventory
- Group and filter contacts and locations
- Can create custom fields to input new types of data for a contact or location

Learning Experience

Full stack web development using the following tools:

- Javascript
- Node
- ES6
- React Js
- Redux
- Express Js
- PostgreSQL
Opportunity and Significance

In the United States, there are currently 250,000 patients living with paralysis due to spinal cord injuries, with another 12,000 new cases appearing annually [1]. Neural stem cells (NSCs) can be injected into a patient at the site of injury to help restore function by replacing damaged neurons and/or producing cells that protect and promote the growth of existing neurons [2]. Previous trials of NSC therapies required 20 million cells per patient, delivered in a single injection [3,4]. There is currently a shortage of NSCs on the market, with the high demand going unmet due to the complex and costly steps required to produce large numbers of NSCs of adequate quality for injection. Because the central nervous system has immune privilege, patients can safely receive NSCs from a generic cell line [5]. The hypothetical process described here can take in a frozen vial of 100,000 induced pluripotent stem cells (iPSCs) and produce a large batch of NSCs.

Process Economics

- $134,220 fixed investment cost (excluding building)
- $1,784,262 cost per batch
- 8.17x10^10 NSCs produced per batch
- 10 batches produced per year
- 40,850 patients supplied per year
- $655 price per patient to make 1.5 times expenditure

Quality Control Measures

- Remove spontaneously differentiated colonies in dishes
- Test differentiation potential of cells throughout process by culturing embryoid bodies and neurospheres
- Karyotype assessment of final cell batch

References

3. “Culturing Pluripotent Stem Cells (PSCs) in Essential 8™ Medium.” Culturing Pluripotent Stem Cells (PSCs) in Essential 8™ Medium. N.p., n.d. Web. 09 June 2016
Intraoral Tongue Drive System (iTDS) For Physically Challenged People

Himika Sagwal, Sowmya Narayanasamy, Deepa Neelakantan, Ceren Terci

Dr. Harpreet Singh
Electrical Engineering

ABSTRACT
The Tongue Drive System (TDS) is a new unobtrusive, wireless, and wearable assistive device that allows for real-time tracking of the voluntary tongue motion in the oral space for communication, control, and navigation applications. In real life the external TDS (eTDS) does not meet safety regulations because of the limited mechanical stability of the headset. The intraoral TDS (iTDS), which is in the shape of a dental retainer, firmly clasps to the upper teeth and resists sensor misplacement. So, an ultralow-power local processor for the TDS that performs all signal processing on the transmitter side, following the sensors is proposed.

INTRODUCTION
The TDS architecture and performance by able bodied subjects and those with severe physical disabilities (tetraplegia) have prior versions of TDS that are categorized into two main groups, iTDS and eTDS. The iTDS is in the shape of a dental retainer and is placed inside the mouth while the eTDS is in shape of a headset.

Improvement with FPGA
• In previous versions of TDS, the raw sensed data was transmitted to a PC/smartphone to perform all signal processing and command classification resulting in high power consumption but with FPGA all signal processing occur at the sensors resulting in lower power consumption.
• Augmented operation time and decreased in battery size.
• Reduction of data transmission from 24 to 1 byte per command.

WHY TONGUE?
The tongue is connected to the brain over a shorter distance via the hypoglossal nerve than hands and fingers providing fast and accurate movement with many degrees of freedom.

APPLICATIONS
• Navigation
• Communication
• Control

DESIGN IMPLEMENTATION
In this study, an intraoral TDS (iTDS) which consists of four 3-D magnetic sensors, a processing FPGA, and a wireless control unit is proposed.

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</table>

• Output 1 is ‘1’ when sensor 1 and 3 are active
• Output 2 is ‘1’ when sensor 2 and 4 are active

CONCLUSION
The limited mechanical stability of the eTDS makes iTDS an attractive option for daily life use. However, the impractical battery lifetime of iTDS leads us into designing a local processor that performs all signal processing and command detection locally before wireless transmission. The original TDS transmits all the raw data to an external computer to detect a command, while a TDS with a local processor only transmits the detected command, thus scaling down the data transmission.
Regained Mobility: A Low-Cost 3D Printed Myoelectric Prosthetic Hand

**Developed by** IronHand: Ashley Apil, Austin Cook, Justin McChristion, Raghav Talreja

**Biomedical Engineering**

**Professor Brian Mundo**

---

### Background

- 10,500 people in the US are registered as having a wrist/hand amputation¹
- Target user has inability to perform daily tasks independently²
- Insufficient funds for myoelectric solution

**Technical Objectives**

Our design goal is to develop a method to assist hand amputees in performing simple tasks independently with natural muscle control.

**Target Values:**

- Weight: 0.65lbs - 1.35lbs³
- Price: Less than $500

**Functionality Goals:**

- Grab and hold objects without slip
- Operation between -20 °C and 40 °C
- Functions under 10 lbs. of force
- No slip within 20 lbs. of force
- Water resistance of +5 ingress

**Related Work and State of Practice**

- Current market devices and technologies are unaffordable
- Can be upwards of $10,000⁴
- Prosthetic hands are not currently being developed at Wayne State University

---

### Design Output Overview

**Shoulder Cuff**
- Lithium ion battery with USB power output
- Arduino Uno Microcontroller
- Variable Grip Strength Dial

**Sleeve**
- Gel liner and adjustable buckle strap
- EMG pads

**Hand**
- Three finger with thumb design
- Cable system for movement
- Finger Grips
- Analog Feedback Micro Servo Metal Gear Motors

**Miscellaneous**
- 3D manufactural materials: Ninjaflex Plastic
- Training manual and initial training for patient

---

### Future Development and Testing

**Immediate:**
- Design and development of EMG processing software
- Testing accuracy of myoelectric motor movement
- Verification of design input checkpoints

**Long Term:**
- Developing methods for mass manufacturing:
  - Stereo Lithography Apparatus (SLA)
  - Laminated Object Manufacturing (LOM)
- Patient functionality validation
- Higher degrees of movement in programming

---

### Commercialization Plan

- Currently only at prototype stage
- Need to validate functionality of timing belt
- Need to develop EMG signal processing aspect of device
- Need to streamline assembly

---

### References


Acknowledgements to the Biomedical Engineering Department, Yang Zhou with Dr. Chaoyang Chen’s Robotic Rehabilitation Lab, and Professor Brian Mundo.
Opportunity and Significance

Mothers specifically have demonstrated medical conditions caused by increased musculoskeletal force and fatigue.¹ The current car seat carrier is one of the main contributing factors to this problem. A lightweight infant carrier as a lightweight solution is necessary to address this problem.

Technical Objectives

The user, also referred as the caregiver of the infant, needs an independent, safe, lightweight, portable infant carrier compatible with strollers and shopping carts in order to alleviate the fatigue experienced due to carrying infants up to the 95th percentile.

Functional Requirements:
- Cannot contribute to muscle fatigue in the person handling the carrier
- Hold a 95 percentile infant up to one year of age
- Does not impede current function of the car seat
- Convenient to place in infant and remove from the car seat
- Minimize the physical manipulation of an infant
- Cannot cause discomfort, pain or injure the infant

Performance Requirements:
- Priced at approximately $100
- Lightweight at 5.5 lbs
- Use of a sturdy and durable material that withstands 178 N²
- Can withstand temperatures of up to 172 degrees Fahrenheit¹
- Optimal infant body posture for maximum oxygenation²

Interface Requirements:
- Compatible with top three carrier brands: Graco, Chicco, and Britax³
- Compatible with standard shopping cart
- Compatible with standard stroller
- Compatibility of insert material, car seat, and carrier to avoid degradation of any material
- Easy to install within current infant carrier/car seat devices
- Cannot cause dermatitis of any kind
- Washable/completely removable

Next Steps for Development and Test

- Hard shell material- lighter/sturdier option
- Varying sizes to account for > 1 year olds
- Car seat capabilities
- Crash testing
- Customer feedback: survey
- Next stage prototype development with final material selection

Commercialization Plan & Partners

The team is currently working with Dr. Shamaya Crehag who first introduced the problem of extraneous stress on caregivers while transporting infants during the Winter 2016 semester.

Challenges

- Building a brand to sell this product would require identifying a manufacturer
- Competitive marketplace
- Extensive regulations and approvals necessary

To commercialize the product we plan to pursue a licensing deal with the top three carrier brands: Graco, Chicco, and Britax. This approach would produce profit without taking on the risk that producing our device ourselves would have, and the license can be shared with many different brands.

References


Low-Cost and Scalable IoT Sensor Packages for Environmental Sampling

Dr. Yongli Zhang
Civil and Environmental Engineering

This project has been supported by SWEET Lab In Department of Civil and Environmental Engineering

Opportunity and Significance
- Low-Cost and Ubiquitous Sensors
- Connection to Internet
- Data Mining Techniques
- Data Visualization

Technical Objectives
The objective of the project is to present a low-cost scalable IoT sensor package to allow users to test environmental criteria (such as temperature, turbidity, etc.).
- Low-cost in comparison with other packages in market
- Easy to setup on drone (for testing over lakes)
- Capable to transmit data through internet and store data on the GE Predix cloud to predict future behavior of the model that we created based on the data
- User-friendly interface and low-weight

Technical Approach, Accomplishments and Results
- Water, Soil, Air Sampling
- Community Engagement
- Data Visualization

Next Steps for Development and Test
- Lab Work and Website Development
- Field Work
- Community Engagement
- Commercialization

Commercialization Plan & Partners
- SWEET Lab Wayne State University
- Detroit TechTown
- Our firm – Under registration

Related Work and State of Practice
- Data with more resolution
- Drive the Creation of Meaningful Data
- Community Engagement

Data Mining Platforms

Packages Preparation: $200
Data Server Storage: $15
Operational Cost: $0 - Varied

2 Yrs Plan
- 1/2 Yr: More Modules of Sensor Packages
- 3/4 Yr: Website Development and Cloud Data
- 1 Yr: Marketing and Commercialization
- 1.5 Yr: Mass Production of Sensors

Selling the Sensor Packages
- Data Mining and Visualization

Revenue

Dr. Yongli Zhang
Assistant Professor
Team Advisor

Javad Roostaei
PhD Candidate
Environmental Eng. IoT & Environmental Specialist

Hamid Sadeghi
M.S. Electrical Eng. Website and Sensor Specialist

James V. Wagnen
BS. Student Mechanical Eng. Data Specialist GE, IBM

Zohreh Doosti
MBA Student Finance and Marketing Specialist

Dr. Yongli Zhang
Assistant Professor
Team Advisor
ABSTRACT

Approximately 2.2 million Americans rely on wheelchairs for assisted mobility. These wheelchairs allow users with weak leg muscles, poor balance, paralysis, or other issues to retain some mobility. Standard wheelchairs do not account for users who still retain control of their legs, thus patients are unable to develop strength in their legs, or retain independence in mobility. In order to help improve manual wheelchairs to assist patients with limited leg use, but still supply them with a sense of independence and rehabilitation, a group of biomedical engineering students of Wayne State University has taken on the task to design and prototype an add-on device to a manual wheelchair to meet the needs of these limited leg use patients. Through the design and development process, a general solution to use the patients’ weakened leg muscles to drive the manual wheelchair movement rather than the arms was developed. This solution will satisfy the user needs and the goal of the project to drive a manual wheelchair forward with the legs rather than the arms. The design solution for the add-on device for manual wheelchairs is to use a gear, chain and lever system to translate the motion of the legs in and upward and downward (kicking up) motion to driving the wheelchair forward.

PROBLEM DESCRIPTION

Lack of Independence
• Some users are unable to move without assistance
  • Arm strength is not adequate, electric methods are expensive

Strength Loss
• Some patients still possess control of their legs, but lack the strength or balance for walking
  • Geriatric patients, rehabilitation patients
  • Wheelchairs today do not allow them to use their legs for movement
  • Leads to disuse of muscles, which then leads to strength loss

Leg Use
• Patients cannot use their legs to move the wheelchair properly
  • Can only push backwards
  • Pulling forwards is very fatiguing, and bad for posture

USER NEEDS STATEMENT

An add-on device for existing wheelchairs that will allow patients to use their weakened leg muscles to drive movement.

DESIGN SPECIFICATIONS

1. Extended width must be less than 32 inches (standard width for wheelchair accessible doors)
2. Folded width must be between 9 and 12 inches as per other wheelchair designs
3. Allow user to go at least 2.4 mph, the average speed of a manually operated wheelchair.
4. Allow user to exert less effort than a conventional wheelchair
5. Allows for user to propel themselves forward using a “pumping” action.
6. Easily attachable by a physical therapist
7. Able to exert up to 90 N of force (possibly more depending on weight of device) on the wheelchair for movement, with a typical output of 50-60 N
8. Must not change structure of the existing manual wheelchair
9. Must not interfere with the arm propulsion & turning system of the manual wheelchair
10. Able to be used for at least 16 hours
11. Must not exceed 130 N force on user legs for safety

PROTOTYPE

• Gear, chain and lever system: translates the motion of moving the legs in and upward and downward (kicking up) motion to drive the wheelchair forward
• Additional fifth wheel is attached to the manual wheelchair between the two rear wheels
• Additional fifth wheel will have sprocket attached to it to drive wheelchair
• Chain attached to additional fifth wheel gear and connects to front sprocket
• Leg pulls the aforementioned bar, rotates the primary sprocket, rotating secondary sprocket, and thus, the driving wheel and the wheelchair forward.
• Modified footrests with straps to make kicking motion comfortable and easy for user

VALIDATION TESTING

• Maximum force input
• Maximum device rods strength
• Comfort of footrest harness
• General comfort
• Stability of device (no tipping of wheelchair)
• Safety tests: prevention of over speeding, overexertion, and user harm (pinching)
• Device functionality tests: no additional wheel drag, overexertion
• Multiple terrains: tests if device works on most terrains

FUTURE PLANS

• Finish physical prototype by adding lever system
• Finish CAD model and FMEA analysis
• Complete validation testing
• Add multiple speeds & damping system

REFERENCES

*“Wheelchair Online” 2016 Wheelchair Online. 2016.
About

PMEAS (Portable Multi-Effect Audio Software) is a modulation application for musicians. Its purpose is to be loaded on a tiny and affordable computer, such as a Raspberry Pi, and replace an expensive collection of hardware modulation effects pedals.

Benefits

- Easy to use and set up
- More precise functionality
- Open source
- Inexpensive
- Hardware independent

Portability

The PMEAS modulation application is separated from the user interface application. The purpose for this is so the user can control multiple Raspberry Pis from one user interface.

Why?

Music can be expensive. A quintessential tool for musicians, an average effects pedal can go for upwards of $90 and only offer 2 or 3 effects. The goal of PMEAS is to make musicianship more accessible by providing a low-cost, easy-to-use, easy-to-improve platform for music performance. Instead of buying several pedals at $100 each, you can buy one $35 raspberry pi, install PMEAS, and use the same audio equipment you're used to.

Technologies

The technology stack of the system includes the following:

- Python
- C++
- PYO
- QT5/QML

Thanks To

- Dr. Khayyim Hashmi - Professor
- Dr. Sam Bryfczynski - Professor
- Younes Nehaji - Team Manager
- Ben Ciaglo - Client
1. **Design Statement**

   Our team is designing a mini elliptical machine which helps people do exercise. The main goal of our team's design is to let people enjoy an unique exercise mode and to make the machine smaller and lighter.

2. **Technical Approach**

   **Inspiration**

   Our design is an elliptical machine. The idea comes from the piston. One point of the pedal has a round movement, and another point has a front and back movement. The total movement is an elliptical movement.

   **CAD Model**

   This is the final CAD model. The front part is an active wheel, and the back part is roller bearing slides. The top part of the machine is pedal. They are connected with ball bearing and rod.

3. **Component Designs**

   ![Component Designs](image)

4. **Function, Features & Innovation**

   The main function of our product is helping the elders and officers to do some simple exercise. The sizes of our product is probably 5in. x 8in. x 19in. Portability and convenience are the features of the product. We also add some extra parts for innovation such as friction device that can regulate the resistance. We also use special components like lazy susan.

5. **Conclusion & Next Steps**

   The components of our product are producing. The next step is assembly and test. When we finish the stress, friction, and noise test, we will consider the material we should change or add. We will improve our product.

**Team Members**

- Zhaotun Gong
- Pengjie Jiang
- Zhuojun Wang
- Yihong Zheng
Opportunity and Significance

Laminar burning velocity is a topic which has long been studied, but the accuracy and effectiveness of measuring techniques is still a widely debated topic. A strong understanding of the laminar burning velocity is important, because every flame begins as laminar and the initial laminar burning velocity characteristics determine properties of the final turbulent flame.

Technical Objectives

The objective of this research is to create a model which can properly simulate the reaction of ethanol in a constant volume chamber and accurately calculate laminar burning velocity. Additionally, two new ethanol mechanisms are tested using the newly developed model against experimental data to validate both the model and mechanisms.

Related Work and State of Practice

This work builds on the experimental work of multiple researchers as well as minimal simulation work. Experimental work in this area has proved the rigid constant volume combustion chamber to produce the most accurate results [4]. Additionally, Gulder has derived an equation which can calculate laminar burning velocity mathematically [2]. Finally, some modeling work has been done by Samimi et. al. previously [5].

Technical Approach, Accomplishments and Results

Figure 1: Constant volume combustion chamber set up used for modelling

Figure 2: Experimental data at 298K and 1 atm vs simulation data modeled using a mechanism by Marinov [3]

Figure 3: Experimental data at 298K and 1 atm vs simulation data modeled using a mechanism by Burke et. al. [1]

Figure 4: Experimental data at 298K and 1 atm vs simulation data modeled using a mechanism by Samimi et. al.

Next Steps for Development and Test

Next steps for this simulation include comparison against experimental data created by Samimi et. al. to further validate the mechanism. Additionally, this model will be used to validate laminar burning velocity calculations derived from experimental data.

Future Applications

This research, if further developed through experimental lab work, can be used for application in the automotive industry in order to better understand internal combustion characteristics. A more accurate measurement of laminar burning velocity can improve understanding of combustion dynamics and produce more data regarding laminar flame thickness, overall activation energy, and reaction order; all derived from this parameter.

References


Opportunity and Significance

Innovative and environmentally friendly, our design will provide exercise to the operator while offering a quick and economical method to landscaping. In addition, our design will require less maintenance when compared to a gas powered mower.

Objectives

- Avoid high costs of gasoline
- Environmentally friendly
- Aid in physical health
- Provide a fun method to what essentially is a boring task
- User friendly “Hands-Free” position adjustment of mower

Technical Approach, Accomplishments and Results

We approached this task with simplicity in mind. Too often, systems are over engineered to the point where failure is inevitable. We revolutionized the task of lawn maintenance by using fewer moving parts when compared to that of a gasoline lawn mower. Our team was able to design a simple, environmentally friendly, and fun way of completing an otherwise laborious task.

Capabilities

- Safe handling
- Can cut grass within half inch
- Multiple positions in order to reach difficult areas
- Reduce time needed to cut grass
- Cardio exercise

Development and Testing

Numerous tests will be required in order to manufacture and produce such a design. Development and experience will constantly produce a more efficient and robust design. The idea is to always innovate and continue progress!

Pugh Matrix

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Image: Mower Bike prototype with the Pugh Matrix chart and a technical analysis chart.
Effects of UV-Long Wave Exposure on Mechanical Properties of GAG Hollow Fibers
Greta Mulbauer, Adviser Dr. Howard Matthew
Department of Chemical Engineering

OPPORTUNITY AND SIGNIFICANCE
Volumetric Muscle Loss (VML) occurs in patients who have undergone tumor extirpations or chronic denervation by way of blunt or sharp trauma. The basal membrane of their skeletal muscle is damaged, removing chemical and mechanical cues which muscle fibers use for regeneration.

TECHNICAL OBJECTIVES AND RELATED WORK
The Howard Matthew Tissue Engineering Lab proposes the 3D printing of glycosaminoglycan (GAG)-based hollow fibers developed by a previous undergraduate student (Mr. Alex Gagliardi), culturing muscle stem cells and chemically binding the GAG fibers, mimicking the myofibers of the skeletal muscle. This can be developed by starting with:

1. Modification of chitosan (CTS) polymer.
2. Evaluation of GMA-CTS photocrosslinking effects on mechanical strength of microcapsules and hollow fibers.
3. Analysis on growth rate and differentiation of muscle stem cell cultures in GAG-CTS hollow fibers.

TECHNICAL APPROACH
Batches of microcapsules with varied levels of GMA substitution were made. The effects of GMA level and UV photocrosslinking on the strength of GAG-CTS microcapsules was tested by 1) manually crushing the microcapsules while in saline bath, and 2) rapidly crushing the microcapsules using a low force mechanical testing system.

1 mL of GAG mixture (1.0% CMC/4.0% CSA) was injected into rapidly spinning modified GMA:CTS baths.

Microcapsules were also studied using a load cell.

ACKNOWLEDGEMENTS
- Dr. Howard Matthew, Wayne State University, Department of Chemical Engineering
- This project has been generously funded by the Department of Chemical Engineering, as well as Wayne State University Undergraduate Research Opportunities Program.

REFERENCES

NEXT STEPS FOR DEVELOPMENT
1. Establish permanent design for load cell device
2. Continue exploring various GMA degrees of substitution in GMA:CTS
3. Rat muscle stem cells (Lonza) will be expanded in culture; encapsulate in GAG-CTS
4. Cell-containing microcapsules will be photocrosslinked with different durations of UV exposure, and growth of stem cells will be evaluated over several days using AlamarBlue assay
5. GMA-CTS and UV duration with best performance will be used to encapsulate stem cells in GAG-CTS hollow fibers using Gagliardi protocol; stem cell differentiation will be evaluated in long-term cultures
Optical Coherence Tomography as Applied to Skin Care in Humans

Sarosh Irani

Opportunity and Significance
When determining the success of various skin creams and lotions, qualitative methods such as macroscopic analysis and photographic evidence are currently used. OCT can provide high resolution images of human skin in a non-invasive way, indicating its potential for quantitative assessment of the affects of skin care products on human skin. In this project, I intend to report the use of OCT for quantitative assessment of skin topography.

Technical Objectives
The goal of this experiment was to ascertain whether OCT can be used as a viable method to detect the efficacy of skin care products. Over the course of this project, I will use the OCT device with precision and control, develop tools which can be used to analyze OCT images, and integrate my findings into a well written research paper.

If successful in imaging human skin with accuracy and detail, OCT can become a common tool in the development of wrinkle reducing products. It can also be used to analyze human skin before and after treatment.

Related Work and State of Practice
OCT has long been used in the field of ophthalmology. Its ease of use and high resolution images have proven invaluable in obtain cross sectional images of the retina.¹ More recently, it has been applied to dermatology and has been used to image various regions of human skin. At Wayne State, Dr. Avanaki’s work on the OCT machine has yielded improvement on the OCT resolution,³ designed virtual tissues (phantoms) for use,⁴ and investigated the use of OCT in the diagnosis of basal cell carcinoma.²

Next Steps for Development and Test
- Currently developing a code for average skin roughness; can be applied to all OCT images
- Once developed, I will conduct a full, 28 day trial with various subjects and two different skin care products.
- The images taken throughout the trial will be analyzed with the various codes
- This analysis will provide proof of the effectiveness of the various products, and comparison to qualitative methods will ascertain the possibilities of OCT in clinical dermatology

Commercialization Plan & Partners
Our project was conducted in partnership with the Wayne State Department of Biomedical Engineering and the Integrative Biosciences Team.

I would work with local dermatologists to commercialize this system. These medical professionals would have a need for verification of the success of various products in improving skin condition. OCT can provide accurate in vivo imaging of human skin, and analysis of these images can point to an improvement or decline in skin condition after treatment.

Gaining acceptance of OCT as a dermatological tool remains a hurdle to overcome. OCT originally was a solely optometric system, used to provide images of the human retina.

References
1. Three Dimensional OCT images from retina and skin
2. “Investigation of Basal Cell Carcinoma using dynamic OCT”
3. “An Intelligent Speckle Reduction Algorithm for OCT images”

I would like to acknowledge and thank WSU UROP for their financial support of this project and Dr. Avanaki for his expertise and support on this topic.
Opportunity and Significance

- Students in the OPT Training Program are required to submit regular reports and evaluations.
- Staff members part of the OISS office have to review the reports and convert the approved reports to into a XML file to be submitted into the proper government facility.
- In order to help orchestrate this process the OPT Reporting website allows students to submit their information. The website processes the information and displays it in a comprehensible grid in the staff portal.

Related Work and State of Practice

- Wayne State currently uses a very outdated website for their OPT students. The current forms are not aesthetically up-to-date and have alignment issues. The current colors and buttons are out of place.

Technical Approach

- When a student enrolls in the OPT program they are given a EAD Start Date and an EAD End Date that determines how long he/she would be in the program. Using these dates our application would track the student’s employment status, when to send out automatic email reminders, and create XML files that will be sent to government officials for evaluation.
- If students fail to report any changes to their personal or employment information at given deadlines, they will be notified daily via automatic emails.
- Administrators can view statistics that reflect the current status of all enrolled students.

Technical Objectives

- Automated Email System
- XML Generator
- Staff Portal to View Students in System
- Student Portal for student to submit and update information
- Using the following technologies
  ○ HTML5/CSS3/JavaScript/ JQuery/ JQWidgets/ Bootstrap/ PHP/ MySQL/ Google API

Next Steps for Development and Test

- We have deployed with the client and they will use our reference material to continue to improve and maintain the website.

Commercialization Plan & Partners

- Our group worked with the following people
  ○ Jonathan Hicks (Client)
  ○ Rakesh Porob (Client)
- In order to deploy the website our group worked with Hussein Mehdi (Client’s Assistant).
- The main hurdles for our group were connecting to the FSA Server for login process and the deployment of the website on Wayne State’s Server.
Opportunity and Significance

The development of this portable can crusher is going to help the environment great. This product will increase recycling and the best part about this, is it doesn't have a motor completely mechanical.

Technical Objectives

This project is to design, develop, and test a portable can crusher of aluminum cans. The objective is to make it efficient, compact, and environmentally friendly to use with low maintenance.

Related Work and State of Practice

Kadhim: Fabrication  
Jaffer: Reports and Testing  
Ben: Modeling and Fabrication

Technical Approach, Accomplishments and Results

- We have looked at many different patents to get a better clearer understanding of how to go about this project.  
- Came up with 3 different concept designs  
- Did a Pugh analysis to find the best design that fits are criteria.  
- Made some calculations  
- CAD modeling  
- Bill of Material  
- Built prototype of can crusher from both wood and metal.  
- Design Validation

Next Steps for Development and Test

- Testing of Steel/Aluminum prototype is in progress  
- Any reworking from now will be complete by the end of this week  
- A special and cheaper prototype is currently in the making  
- This special prototype satisfies a environmentally friendly criteria and also makes the overoall prototpye cheaper  
- The special prototpe will be revealed during our presentations

References

There were Several similar ideas we used from other portable can crushers on the market. We’ve integrated those into our design. These patents are as follows
- US Patent #8448570  
- US Patent #3,062,130  
- US Patent #4345520  
- US Patent #4,570,536

-Funding from WSU Engineering for first prototype
Opportunity and Significance
This device was designed with the intent to assist in breathing for patients suffering from emphysema. Although, it is made applicable to other conditions in which an individual is having difficulty obtaining the proper amount of oxygen per breath. Our device functions as a portable oxygen concentrator, which converts atmospheric air to a highly oxygen concentrated air output. Emphysema and Chronic Obstructive Pulmonary Disease (COPD) affect a reported 11 million people, providing a large population which could benefit from the medical assistance provided by this device.¹

Technical Objectives
• Lightweight, 800 grams at most
• Provide up to 94% concentrated oxygen
• Portable and easy to carry: 6.4” H x 4.8” W x 2.5” D
• Battery life of 3 hours
• Operates in varying conditions: 42-95°F, 10,000 ft. altitude, 85% humidity.

Technical Approach, Accomplishments and Results

Main Components/Material List
• Polyethylene body
• Polystyrene screen
• Polyurethane buttons
• Compressor
• Pressure regulator/switch valve
• Circuit board components
• Zeolite sieve

Arrows denote flow of Oxygen

Functional Prototype of Oxygen Concentrator

Compactness Testing
• Device maintains 94% Oxygen output for 1200 battery cycles
• Powering device on/off, allowing battery to discharge completely. Recharge device and repeat process 1200 times

Environment Extremes Testing
• Device retains optimal function from 42-95°F
• Device maintains 94% Oxygen at 85% humidity
• Device maintains 94% Oxygen at 10,000 ft.

Efficiency of Rescaled Components
Contact Bauer Compressor Manufacturer

Commercialization Plan & Partners
• Potential Partners: WSU TCO, Airsep, Inogen, Medtronic
• 510(k) Submission
  - Electromagnetic Compatibility Testing
  - Electrical & Mechanical Safety Testing
  - VOC & Particulate Testing
  - Performance Testing
  - Predicate Device Comparison/Equivalence
• Develop Quality Assurance Program that Meets GMP Requirements
• Establish Proper Labels

References

Ergonomic Survey Results
Scored from 1-10
• Comfortability: 6.70
• Easy to learn: 9.17
• Handheld: 6.40
• Convenience: 7.35
**Abstract**

Fluorinated surfactants, chemicals found in a myriad of industrial products, have been shown to bioaccumulate in the environment. Understanding the physical properties of these molecules will promote the development of alternative surfactants that could, potentially, serve the same industrial applications with substantially lower potential for bioaccumulation. Molecular dynamics simulations are used in order to identify an accurate method to predict surface tension. Implementation and discovery of the virial method of determining surface tension is confirmed through successful reproducibility of the results reported by Vega et al[1].

**What is Surface Tension?**

Cohesion describes the attractive force between liquid molecules. Molecules on the interior of a liquid experience zero net force. Surface Tension explains the phenomenon of imbalance of attractive forces at the surface of a liquid.

**Simulation Details and Methodology**

NVT simulations were performed for water molecules at six different temperatures in order to calculate surface tension. A 40 Å slab of water molecules was placed in the center of a 30x30x100 Å³ box, surrounded by a vacuum. Simulations were performed in NAMD, version 2.9[2], using SPCE water model. The system was, first, equilibrated for 1.5 ns and, then, additional 1.5 ns was run for production.

**Results**

Surface tension was calculated according to:

\[
y = \int_{-\infty}^{\infty} [P_N(z) - P_T(z)] dz = \frac{1}{2} [P_N - P_T]
\]

\[
y = \frac{L_z}{2} [\bar{P}_N - \bar{P}_T]
\]

where, \( \bar{P}_N \) and \( \bar{P}_T \) are the normal and tangential pressure tensors, respectively.

**Future Work**

This work will include comparisons between the properties of carboxylic acids and octanol to their fluorinated counterparts. The absolute hydration free energies will be calculated for the equilibrated systems using free energy perturbation (FEP). In addition to interfacial tension, octanol-water partition coefficients and Henry’s Law constants will be calculated in order to predict the biological and environmental effects of these molecules. Accurate and conventional methods of calculating such physical properties already exist. Henry’s law constant,

\[
log H = \frac{\Delta G_{hyd}}{2.303RT},
\]

can be related to the free energy of hydration, where \( R = 1.986 \times 10^{-3} \text{ kcal mol}^{-1} \text{ K}^{-1} \) and \( T \) is in Kelvin. The partitioning coefficient for the octanol (oil)-water interface is modeled by the following equation:

\[
log K_{ow} = \frac{\Delta G}{2.303RT}.
\]

**References**


**Acknowledgment**

- Wayne State University and College of Engineering UROP
- Wayne State grid system
Opportunity and Significance

The purpose of this version of Gekko is to implement a sentiment analysis module capable of determining the market sentiment for a user-defined company.

Technical Objectives

- Create a dictionary of keywords exclusively used in advertising
- Create regular expressions to recognize grammatical patterns used in ads
- Implement a neural network classifier to recognize subjective/objective statements
- Collect training data in order to train bayesian classifier to score tweets as positive or negative sentiment.
- Fine tune classifier through natural language processing for improved results

Related Work and State of Practice

Currently, the calculation of sentiment analysis through natural language processing is a popular technique for financial analysts. Machine learning techniques are often applied to pick up on patterns that may be imperceptible to humans. With this in mind, Gekko utilizes several neural networks for the purposes of filtration of irrelevant data and the calculation of sentiment scores. One unique approach is Gekko’s use of keywords and regular expressions to detect sentence structures most commonly found in ads or objective statements.

Technical Approach, Accomplishments and Results

Gekko utilizes the Twitter Streaming API to extract Twitter data to a MongoDB database on a remote server. Tweets consisting of advertisements or objective statements are filtered out using a dictionary approach, common grammatical patterns, and a Multinomial Naïve-Bayes classifier. Sentiment analysis is performed on the remaining tweets and the associated sentiment scores are stored in the database for analysis.

Achieved Sentiment Accuracy: 73% (with slight variation)
Achieved Filtration Accuracy: 86% (with slight variation)

Next Steps for Development and Test

The module is currently deployable in its present state. It was determined that a Multilayer Perceptron yields higher accuracy than Naive-Bayes, but at a severe cost to performance. It may be worth it to examine this route further in the future.

Commercialization Plan & Partners

Team members worked in collaboration with Jameson Ruble of WSU’s Department of Linguistics. General requirements were determined by the client company, Locksley Technologies.

Regarding potential commercialization, Gekko’s sentiment analysis process was designed in a modular fashion, to best allow it to be incorporated into future projects.

The main requirement for commercialization would consist of implementing a unique strategy for stock prediction, based on Gekko’s determined market sentiment. The main hurdle would be in finding a truly unique strategy, as similar tools for financial analysts are already popular in the industry.

References

http://www.nltk.org/
https://api.mongodb.com/python/current/
http://docs.tweepy.org/en/v3.5.0/
Opportunity and Significance
- During typical natural conditions, a standard camera lens can become dirty thus obscuring the picture.
- Constant cleaning required
- Autonomous vehicles cannot pass Level 3 anonymity without cleaning devices
- Current cleaning devices are composed of compressed air and water "blades" that are only used as an emergency device while stopping the vehicle

Technical Objectives
- To create a scalable housing for camera modules with minimum package spacing so that the module can be integrated into various applications.
- Design using Unigraphics NX using CAE/Motion Study
- Create working prototype to demonstrate effective cleaning of camera housing
- Demonstrate universal application and scalability
- Outline cost to manufacture and economics
- Outline process to manufacture and real life design principles

Current State of Practice
- Obstructed field of view
- Periodic cleaning cycle
- Large amount of washing fluid lost

Results
- Complete and fully detailed CAD Model in Unigraphics NX
- CAE Analysis completed
- Mark I prototype 3D printed in SLA plastic and fully assembled
- Working prototype demonstrated

Next Steps
- Refine design into smaller package roughly size of golf-ball
- Patent Under Review
- Drive efficiencies and remove complexity in the design

Commercialization Plan & Partners
- Currently working with General Motors autonomous to implement self-cleaning camera housings on electric Chevy Bolts.
- Partnering with US Farathane for preliminary tooling and piece cost strategy for various production order volumes.
  - Testing of prototype modules planned

References
Tom Van Slembrouck – Sr. Manager, GM
Andy Seavoy – Hard Trim Supervisor, GM
Ken West – Supervisor & Prototype Support, GM
Dan Flemming – Part Cost & Tooling, USF
Jimmy Chen – Eng. Tech, Wayne State

Images cannot be disclosed at this time because a patent application, in partnership with GM, is under review.
Rehabilitative Boxing Device

Ashura Molla, Dana Nachawati, Nathan Reddmann

Cooperative Engineering

ABSTRACT
Wheelchair bound paraplegic patients require a rehabilitative therapy device that will help increase their upper body strength over time. An interactive boxing-type device would be able to keep the user engaged and motivated to continue their physical therapy regime. The device should be able to be programmable to present different patterns of stimulus to keep the user interested.

The boxing-type device must be able to obtain and output certain quantitative measurements, such as force, reaction time, return time, and accuracy to demonstrate patient improvements over time.

Benefits of physical rehabilitation:
- Strength training exercises increase upper body strength of wheelchair bound patients
- Lowers the loss of bone density and muscle mass after injury
- Decreases the risk of bone fracture
- Beneficial to a patient’s emotional health by decreasing negative thoughts from injury
- Pain reducing exercises can reduce the need for prescription drugs

BACKGROUND

USER NEEDS STATEMENT
Design a device that will measure the upper body rehabilitative progress of a paraplegic patient

DESIGN INPUT
- Must record quantitative data for the punching force with 95% consistency.
- Must convey 95% accuracy for timing
- Information produced should be transferred to a computer for analysis
- Device must be large enough for the 95th percentile male
- Device must not cost more than $1,500
- Device structure should have a minimum of 5 year lifespan
- The punching pads must be easily replaceable
- Must not compromise patient safety
- Must be compatible with a wheelchair

PROTOTYPE

Structural Components:
- 8020 extruded aluminum base wide enough to accommodate for a wheelchair
- Array of 3x3 boxing pads attached to aluminum arms
- LED light strips located on the top of each pad

Functional Components:
- Self-manufactured force sensors that output force of punch connected to Arduino
- LED light strips as a punching stimulus
- Reaction time measurements between light stimulus and force detected
- Wireless data transfer via Bluetooth
- GUI for user interface
- Rechargeable batteries as power supply

TESTING

Accuracy Testing of Sensors
- Employ impact testing and drop testing with predetermined amounts of weights on the force sensors

Software Testing of Data Transfer
- Apply repetitive punches to the device while another team member analyzes the processing speed of the data transfer through the optimum serial output and drive size calculator codes

Hardware Testing of Circuitry
- Conduct a continuity test using a digital multimeter to determine proper flow of current

Engineering Analysis of the Structure
- Simulate the device through a modeling software like NX to obtain information on the longevity of the device

Survey for users
- Provide a survey to mock patients and mock physical therapists to assess their feedback on the device

FUTURE PLANS

Conduct clinical testing to determine improvements in patients’ upper body strength over time

REFERENCES

Thank you to the Wayne State Biomedical Engineering Department for prototype funding!
Opportunity and Significance

Existing learning methods for computer vision tasks, such as image classification, object recognition, relies mostly on correctly labelled gigantic training datasets. But in practical datasets, labels are not always reliable. “Crowdsourced” labels obtained from social media or other non-expert sources are subject to error, and in subjective tasks even humans or experts may disagree on the correct label. This work allows the learning network to predict the true labels provided the training labels are unreliable.

Technical Objectives

1) To develop a framework for correctly classify images in the presence of label noise.
2) A highly robust algorithm to perform well at different scales of noise (0-70%).
3) Similarly, the algorithm should perform equally well on small datasets as well.

Related Work and State of Practice

Performance of Deep learning architecture is exponentially better but it is not very robust to label noise.

Technical Approach, Accomplishments and Results

Empirical performance is evaluated on two datasets CIFAR-10 and MNIST datasets

CIFAR-10: 10 class classification, a subset of 80 million Tiny Image Dataset.

Applications

1) Training data (Images + Corrupted labels)
   Parking Ticket
   Our Algorithm Not Parking Avoided

2) Training data Smooth Road Car Damage
   Our Algorithm Pothole Avoided

3) Behavioral modeling

References

Opportunity and Significance

• Streamline Urban Science’s current information retrieval method on OEM (Original Equipment Manufacturer i.e. Ford, Nissan) clients

• Build an application that provides interactive audio/visual explanation of automobile dealership performance analysis

• Extension of current S4 Navigate solution performed currently manually by employees

Technical Objectives

• Create a Natural Language Recognition system for both desktop and mobile platforms

• Interface with Microsoft Cognitive Services for:
  - Usage of Speech Recognition/Text-to-Speech for voice input/output
  - Usage of Artificial Intelligence to parse query

• Create database to store OEM information

Technologies

• ASP.NET framework
  - Built on the C# 7.0 programming language

• SQL Server
  - Database used to store the OEM information

• HTML5/CSS
  - Used to build the front-end UI
  - Bootstrap/Bootstrap Material Design used for CSS formatting

• LUIS.AI API
  - Used for Natural Language parsing to return intents/entities

• Bing Speech API
  - Used to transcribe voice query into a text string
  - Used to results back to the user

Technical Approach

• An Urban Science consultant or OEM Dealership Manager will enter a query (Voice or Text). The query will be parsed, the parsed information will be to generate a database call and the requested results will be displayed for the user

• If the user enters a voice query, the results will be dictated as well

Next Steps for Development and Test

• The S4 Navigator solution will be productionized from our Proof-of-Concept
  - User Authorization/Authentication will need to be implemented to limit access to information depending on the user
  - Table/Database maintenance tools will need to be implemented to adapt the database to any necessary changes

Commercialization Plan & Partners

• This project was a Proof-of-Concept for the Urban Science team for their OEM clients

• If Urban Science determines in the future that this project is adaptable to fit their needs, they will continue to expand upon our initial solution

Special Thanks

• Thank you to Dr. Sam Bryfczynski, Dr. Khayyam Hashmi and Saeid Balaneshin Kordan for all the guidance, assistance and constructive feedback steadily throughout the semester to improve our solution for Urban Science

• Thank you to our clients at Urban Science for providing us with this immense learning experience

Students:
Vandit Patel, Nathan Shea, Anish Patel, Gregory Parent

Advisors:
Khayyam Hashmi
Sam Bryfczynski
Saeid Balaneshin Kordan
Opportunity and Significance

Current imaging technologies lack the capability of early diagnosis of diseases such as Alzheimer's etc. In addition to this, they are invasive, ionizing, label dependent with limited resolution and penetration depth. PA has the potential to provide solutions to problems such as imaging of action potentials in the brain, early indication of metastasis, detection of the hematologic spread of cancerous cells etc.

Technical Objectives

Build a wearable cap with embedded sensors that can monitor the hemodynamic changes and send it wireless to mobile/PC. Functional brain imaging is performed by real-time monitoring of blood oxygenation and oxygen metabolism in resting and simulated states. We intend to make the system handy, portable and low cost by eliminating cables and going wireless.

Related Work and State of Practice

GE is currently working on building a high-resolution imaging helmet based on PET (Positron Emission Tomography) by injecting radioactive biomarkers. To the best of our knowledge, our project is the first wireless, wearable PA technology.

Technical Approach, Accomplishments and Results

Next Steps for Development and Test

We have so far determined the feasibility of employing wireless acquisition of PA signal from a single point. We will have to work on integration and multiplexing aspect of this design. We have to look into the cyber security issues as the data is sent wireless.

Commercialization Plan & Partners

We are looking forward to collaboration and intend to commercialize this device. But for now, we are doing some initial feasibility tests after which we will partner with other organizations in developing it.

References

SMART SECURITY LOCK SYSTEM FOR A SMART CITY

Akarshan, Rajeev Bhupathiraju, Mithilesh, Jahnavi
Department of Electrical & Computer Engineering, Wayne State University
Advisor: Harpreet Singh

ABSTRACT

- Security is the degree of resistance to or protection from harm.
- It is an essential aspect especially in case of home security.
- An electronic lock is a device which has an electronic control assembly attached to it.
- They are provided with an access control system.
- This system allows the user to unlock the device with a password.
- The password is entered by making use of a keypad.
- The user can also set a password to ensure better protection.
- This project is developed using FPGA.

CONCEPT

- Initially the system will be in an unarmed state.
- The password has to set and pound symbol is to be pressed to lock the system.
- Now the system is in locked state.
- Once the correct code or password is entered, the door goes to open state and the concerned person is allowed to access the secured area.
- If the password entered is wrong, the fail count increases and the door remains in closed state.
- The alarm buzzes when the fail count reaches the maximum.
- If the password has to be changed, enter the master key when the door is in open state and then enter the new password to change.
- In alarm state give the password and the master key to unarm.

PROCEDURE

- LEDs 7 to 2 are used to represent the output states alarm, locked, armed, fail and open.
- The toggle switch SW7 is used as door signal.
- Since row and column signals are to be given simultaneously we short the row and column to work on the FPGA board without any extra equipment.
- LED7 is turned on when the alarm buzzes.
- LED6 is turned on when the door is in locked state.
- LED5 is turned on when armed.
- LED4 is turned on when the password entered is incorrect i.e. fail state.
- LED3 is turned on when the door is opened.

RESULTS

- This password based smart security lock system is used in places where more security is needed.
- This system can be used to secure lockers and doors.
- As future scope, we can add fire and LPG sensors so that in case of emergency the door opens automatically.
Stair Climbing Hand Truck

Andrew AbdulNour, Charlie Wilson, Fawaz Yono, Ghadi Kanso, Omar Al Zuhd

Mechanical Engineering Dept.
Prof. Golam Newaz

Technology and Innovation
A 3 wheeled hand truck design allows smooth transition up the stairs. The lever arm allows for easier cranking of the mechanical system. The system stores energy and releases it through reinforced axle rotation. Auto rotation will be inhibited by a one way sprocket.

Technical Objectives
This hand truck is intended to allow the operator to climb stairs easily and smoothly while maintaining a safe robust operation. The user should exert minimal effort during operation.

Related Work and State of Practice
Design classes at WSU helped with the development of this design idea and structure. Skills learned in this design contributed to the team knowledge with testing, troubleshooting, and validating design components effectively.

Technical Approach, Accomplishments, & Results
Our design process took on multiple variants. Through the use of Pugh analysis, we were able to chose a design that met our criteria the best. Simplicity, cost, ease of use, and weight were all critical factors. We have chosen a design that would only cost 30% more than the average hand truck. It has added safety functions and can be used in a multitude of scenarios.

Next Steps for Development and Test
Product development is a crucial part of a system design and marketing. Currently the team is spending time manufacturing and assembling system parts, with the help of the university machine shop. We will have a completed prototype within two weeks.

Commercialization Plan & Partners
- Steps to Commercialization
  Finalize and optimize design to match the voice of the customer
- Series of utility and design patents
- Feasibility study to research supply logistics and target demographic
- Licensing agreement with big name tool manufacturers

Conclusion
Our three wheeled energy storing hand truck provides a simple solution to a daunting task. Its hand crank design allows it to be used in a variety of situations. The compact and simple design means it is rugged and suitable for both industrial and residential usage.
**Super Thin Ultra-Light Posttensioned Flat Plate Floor Systems for Affordable Urban Housing**

**College of Engineering**

**Zuzanna Sobczak**

**Fatmir Menkuleshi, PhD, P.E.**

**Civil and Environmental Engineering**

## Introduction and Research Motivation

Median housing prices in many big cities are well above the national average. In Boston, New York City, Washington DC, Denver, and Seattle median housing prices are between $300k and $400k. Cities in the west coast such as San Francisco, Los Angeles and San Diego feature median housing prices that are well above $400k. (Clear Capital 2015). Accordingly, urban housing is still not affordable for many people. The combinations of high construction cost due to the inability of traditional materials to provide efficient and sustainable structures and land use regulations create challenges for architects who are trying to provide affordable housing and maximize profits. To address these issues, this research will present several super thin lightweight posttioned floor systems that can be used in midrise and high-rise construction to accommodate the growing demands for affordable urban housing while complying with existing regulatory limits on building height (Fig. 1).

However, Ram Concept ignores the contribution of the tensile strength of concrete, which is significant for the HPC mixes. A more accurate vibration performance will be conducted using nonlinear dynamic analysis in Abaqus and the behavior is expected to be improved significantly.

## Technical Objectives

The objective of this research is the development of super thin ultra-light posttioned flat plate floor systems by using high performing ultra-light cementitious composites that lead to slender, sustainable structures to remove the limitations imposed by commodity materials on midrise and high rise construction. This objective will be achieved by investigating the full-scale behavior of these super thin floor systems using high fidelity finite element analyses in terms of flexure, punching shear, long term deflections, and vibrations.

## Research Approach

To demonstrate the benefits of super thin ultra-light posttioned floor systems, a typical floor plan featuring 3 bays with 20 ft by 2 ft maximum bay sizes was designed using traditional and high performance concrete mixes. The design for stresses at service, flexure and punching shear was conducted using hand calculations according to ACI 318-14. Load demands were determined using a column strip approach and were later verified with those obtained from linear elastic finite element analyses software (Ram Concept). Vibrations performance was quantified using linear elastic dynamic analyses. Long term deflections were determined using linear elastic analysis using cracked sections properties. Creep was considered using the age adjusted effective modulus approach.

## Material Properties

The material properties for the traditional concrete mix as well as high performance concrete mixes are presented in Table 1. The HPC mixtures feature unit weight as low as 116pcf and compressive strength as high as 21 ksi. Additionally, tensile strengths are as high as 2.91 ksi.

### Table 1. Material properties at 28 days

<table>
<thead>
<tr>
<th>Mix</th>
<th>Unit Weight</th>
<th>Tensile Strength</th>
<th>Flexural Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>Load = 19</td>
<td>σt (ksi)</td>
<td>f_{ct} (ksi)</td>
</tr>
<tr>
<td></td>
<td>ft (lbs)</td>
<td></td>
<td>First crack</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ultimate load</td>
</tr>
<tr>
<td>Load = 19</td>
<td>116</td>
<td>0.38</td>
<td>2.90</td>
</tr>
<tr>
<td>Load = 24</td>
<td>116</td>
<td>0.38</td>
<td>3.00</td>
</tr>
<tr>
<td>Load = 28</td>
<td>116</td>
<td>0.38</td>
<td>3.00</td>
</tr>
</tbody>
</table>

## Flexural and Punching Shear

Flexural strength of the floor featuring the traditional mix was quantified using Whitney’s stress block. Whereas the flexural strength of the floors with the HPC mixes was calculated using experimentally obtained stress strain curves. Punching shear strength was based on ACI 318-14 equations.

### Table 2. Deflections

<table>
<thead>
<tr>
<th>Mix</th>
<th>ΔL</th>
<th>Limit</th>
<th>Ratio</th>
<th>ΔL</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>0.125</td>
<td>0.18</td>
<td>1.46</td>
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## Conclusions and Recommendations for Future Work

The utilization of HPC mixes results in floor weight and floor thickness reductions as high as 50% and 38%, respectively. Additionally, gravity loads demands on columns and walls, and seismic loads demands on lateral load resisting systems are significantly reduced.

The behavior of the super thin floors was investigated using linear elastic finite element analyses and hand calculations using strength prediction equations based on ACI 318-14. Full scale nonlinear finite element analyses will be employed in the future to capture the true behavior of the slabs. These investigations will consider the contribution of concrete in tension after cracking occurs, which is expected to reduce long term deflections and improve dynamic behavior in terms of vibrations.

## Acknowledgements

This research was sponsored by the College of Engineering as part of Undergraduate Research Opportunities Program. The authors are thankful for the opportunity to work on this project.

## References

1. ACI 318-04 (2014) “Building Code Requirements for Structural Concrete and Commentary”, American Concrete Institute, Farmington Hills, MI.
Surgical RoboVision
Tareq Dardona, Vinodhini Pandiselvan
Advisor: Abhilash Pandya

Opportunity and Significance
- Robot-assisted laparoscopic surgery (da Vinci®) has brought minimally invasive surgery to more than 3 million patients worldwide [1]
- The da Vinci Surgical System is entirely controlled by the surgeon using hand controls and foot pedals to manipulate a camera arm and instrument arms, but not both simultaneously
- Pausing the operation to move the camera arm interrupts the flow of surgery, and may cause medical errors [2]

Technical Objectives
- To reduce surgeon interruption, we maneuver the robot’s camera arm based on sensors [3] within a virtual reality headset
- The surgeon puts on a virtual reality headset (e.g., the Oculus Rift), obtains a stereoscopic view, and controls the camera with simple head gestures

State of Practice and Related Work
- In current non-robotic minimally invasive surgery, a separate person operates the camera arm
- In current robotic surgery (da Vinci Surgical System), the camera arm is controlled by the surgeon using a clutch and hand controllers
- In related work, research is being performed to move the camera arm autonomously based on the position of the instrument arms

Technical Approach, Accomplishments and Results
- We used a simulation platform of the surgical robot (Fig. 1)
- The virtual reality headset (the Oculus Rift) provided the position and orientation of the user’s head [4].
- We moved the camera arm based on the measured orientation of the headset (Fig. 2)
- The system was implemented successfully in the simulation environment to control the camera arm
- The 3D camera view of the actual robot was projected into the VR headset display (Fig. 3c)

References

Next Steps for Development and Test
- The next step will be to send the joint angles computed in the simulation to a real da Vinci’s camera arm
- The surgeon would be able to see the 3D camera view of the surgical worksite (Fig. 3b) inside the headset and control the viewpoint by adjusting the orientation of his/her head (Fig. 3a)

Technical Approach
- dVRK
- VR Oculus Rift
- ROS
- RViz
- Unity 3D Engine
- Python
- C#
- Ubuntu/Windows OS
- Windows server
- Linux client
- Open server socket
- Open client socket
- Send data of Oculus Rift
- Receive Oculus Rift data
- Move the camera arm using ROS
- Wait for command to terminate the process

Tools

Programs

Next Steps
- Commercialization Plan & Partners
- Our da Vinci system was donated by Intuitive Surgical
- We are planning to work with Intuitive Surgical or another industry partner to commercialize this system.
- One challenge is integrating the developed system with an existing commercial surgical robot
- We will have surgeons evaluate the system to make sure it is effective, robust, and easy to use
Opportunity and Significance
This device results in the simplification of the mixing process for those who desire small batches of concrete. Since it requires no electrical power it may be used both by first world DIYers and third world builders to accomplish their objectives at a low cost.

Technical Objectives
1. Be able to amalgamate up to 20 pounds of fluid and powder
2. Require no electrical power source
3. Function independent of external environment
4. Have an expected lifespan that exceeds that of the initial consumer
5. Be highly robust and resist any noise factors
6. Be versatile enough to mix other user inputs within the same style vessel

Next Steps for Development and Test
Need to perform amalgamation on various amounts of cement mixture. The design will be tweaked further for a greater cost efficiency.

Technical Approach, Accomplishments and Results
- Uses multiple gears to facilitate mixing.
- Fits on any regular 5 gallon bucket.
- Easy to use, clean, maintain and store.

Commercialization Plan & Partners
- Commercialization via bearing suppliers and injection-molding/3D printing & assembly manufacturer
- Challenges with commercialization include:
  1. Finding quality, cost-efficient suppliers and manufacturers
  2. Initial cost of steel die tool or 3D printer
  3. Labor costs for assembly
  4. Effective advertising

Sponsorship/Funding:
- Mechanical Engineering Department
- Wayne State Machine Shop

Bill of Materials
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376.25
The Effect of TGFβ-1 on Adipose-derived Stem Cell (ASC) Ring Constructs

Opportunity and Significance
Coronary heart disease (CHD) is the most common type of heart disease. One current method used to address CHD is Coronary Artery Bypass Grafting (CABG). CABG is an effective method, with a 95-98% success rate. However, the procedure could be optimized by eliminating the need for the invasive dissection of a healthy vein or artery and the risk of rejection in the cases with a donor vessel.

Technical Objectives
Adipose-derived Stem Cells (ASC’s) provide an optimal source for potentially graft replacing, tissue-engineered vessel constructs due to their ease of extraction and ability to be patient-specific. In order to make ASC ring constructs a more viable replacement for grafts, they need to have mechanical properties similar to native arteries, which is largely influenced by the extracellular matrix protein collagen. TGFβ-1 is known to stimulate collagen production in ASC’s, so this study explores the effect that TGFβ-1 has on the resulting thickness and tensile strength of ASC ring constructs.

Related Work and State of Practice
Dr. Mai T. Lam’s Cardiovascular Regenerative Mechanics Lab has outlined a method with which scalable ring constructs can be formed with polydimethylsiloxane (PDMS) center posts and seeded fibrin hydrogel. This work has been expanded to include 3D-printed inserts as the center posts and has been published in JOVE. Their published work has been done using Smooth Muscle Cells (SMC’s). This project uses the scalable ring construct method, shown in Figure 1, with ASC’s.

Results: Thickness Measurements and Stress-Strain Curves

Method: Ring Construct Seeding, Tensile Testing and Thickness Measurements

Figure 2: A – Seeding Method, 2 million cells seeded, B – Tensile Test Setup, C – Tensile Testing Failure Point

Figure 3: Sample Microscopy Images Taken for Thickness Measurement

Next Steps for Development and Test
In order to make the ring constructs a more viable replacement for grafts, they need to have mechanical properties similar to native arteries. The tensile strength data collected indicates that the ASC rings need to be stronger. The tensile strength of the rings is largely determined by the collagen content of the rings because collagen is an extracellular matrix protein that has high structural properties. Collagen production can also be stimulated in ASC’s with the growth factor of Ascorbic Acid (AA). The specific effects of those two growth factors on ASC ring constructs is still unknown. Future development of this project will focus on different iterations of TGFβ-1 and AA and their effect on the mechanical properties and structure of the ASC ring constructs.

Commercialization Plan & Partners
This project was done under the guidance of Dr. Mai T. Lam and her Cardiovascular Regenerative Mechanics Lab. Dr. Lam and her lab will continue to guide the project as it moves forward. The main target consumer for a successful ASC Ring Construct would be a cardiovascular surgeon. Moving forward to commercialization, other cardiovascular surgeons would be approached to confirm the handling ability of the rings. Clinical trials would also have to be conducted in order to validate the long-term durability of the ring constructs prior to commercialization.

References

Acknowledgements to Dr. Mai T. Lam, Cameron Pinnock, Bijal Patel, Zhengfan Xu, and Elizabeth Meier for their support and guidance throughout this project.
The effects of exercise and an enhanced nerve conduit on peripheral nerve injury

Anthony R. Mora, Tonya J. Whitehead, Harini G. Sundararaghavan PhD

Opportunity and Significance
Induced regeneration and reinnervation of peripheral neurons post injury remains a challenge [1]. This study examines the effects of exercise combined with a multimodal scaffold on recovery from peripheral nerve injury. Currently, the gold standard is the autograft in which a nerve is severed elsewhere in the body and used as a replacement segment for the damaged nerve of interest [1]. This study examines a hypothesized alternative to this current standard that does not involve harvesting a preexisting nerve segment.

Technical Objectives
The primary objective of this effort is to quantify peripheral nerve recovery as a result of exposure to a multimodal conduit in addition to exercise. Quantification was based on behavioral data collected from a rat sciatric nerve model.

Related Work and State of Practice
A multimodal scaffold incorporating:
- Topographical cues: aligned MeHA fibers
- Mechanical cues: soft material
- Adhesive cues: fibronectin
- Chemical cues: glial cell derived neurotrophic factor (GDNF). Was developed in the Sundararaghavan lab and tested in vitro prior to this animal study. This in vitro study yielded promising results that were the impetus that led to the animal study

Technical Approach, Accomplishments
- This study utilized a rat sciatric nerve model in which a 10 mm section of the sciatric nerve was removed, and the gap bridged in various ways.
- Scaffold efficacy was measured by examining the following five groups:
  - Autograft with no exercise
  - Bare conduit (fibers only) with no exercise
  - Bare conduit with exercise
  - Multimodal conduit with no exercise
  - Multimodal conduit with exercise
- Weekly behavioral tests were conducted:
  - Footfall
    - Animals walk across a ladder and the number of footfalls is recorded
  - Static Sciatic Index (SSI)
    - Measurements taken from images of feet and functionality estimated based on SSI calculation
  - Von Frey Filament Test
    - Force required to elicit response is measured
- Data analysis is still in progress

Results

![Figure 1: Rat sciatric nerve](image)

![Figure 2: User interface based code developed for SSI data anonymizing – used to crop images and encrypt filenames to remove bias during measurement](image)

![Figure 3: User interface based code developed for SSI measurements – used to take measurements of anonymized images for calculation of SSI](image)

![Figure 4: Preliminary 3 point SSI data – 0 represents normal and -100 represents complete impairment](image)

![Figure 5: Footfall data, lower scores indicate higher functionality](image)

Conclusion
The multimodal scaffold shows results that are competitive with the autograft gold standard. The benefits of exercise seem questionable, however this may be due to the gender of the animals chosen [2].

Next Steps for Development and Test
- Fine tune the microsphere growth factor delivery system
- Investigation of other growth factors (i.e. nerve growth factor (NGF) or brain-derived neurotrophic factor (BDNF))
- Investigation of the effects of scaffold stretching

References
Instructor: Mohammad Ali E. Ozbeki

Problem Statement
Currently used methods of evaluating tire temperature are either inaccurate and inefficient, or prohibitively expensive.

Technical Objectives
- Accurately track and store temperature values across a formula tire
- Use an inexpensive, Arduino based system
- Enable rotation of the unit with the turning of the tire

Technical Approach, Accomplishments and Results
- Uses low resolution thermal sensor array to view temperature without contact
- Designed to mount on the Wayne State Formula SAE team's car directly to both the front and rear tires
- Able to recall and monitor temperature data
- Has the capability to be used on the current car and all future iterations

Impact and Value
- Ability to better monitor and improve suspension tuning of the Formula SAE car
- Modularity of design can be adapted for other vehicles
- This is a tool to better help the FSAE team perform in competitions against other universities

Next Steps for Development and Test
- Working with the Wayne State Formula SAE team to further improve the accuracy and modularity of the system
- Integrating a wireless aspect to the system for faster data collection and real-time analysis

Community Engagement
- Wayne State Formula SAE Racing Team
- Wayne State Mechanical Engineering Department
- Wayne State Engineering Technology Machine Shop

Team Members:
Justin Bekker, Anthony Kanakri, Noah Lovins-Wilusz, Matthew Turnbull

Sponsored by Wayne State University College of Engineering
TTF-X Nanorods For Enhanced Gas Sensing Applications

Opportunity and Significance

- Tetrathiafulvalene charge transfer salts (TTF-X) can form rods at nanoscales. Large surface area to volume ratios allow for measurable gas surface interactions.[1]
- TTF-X nanowire sensors exhibit high selectivity, high sensitivity, and low response times and can serve in environment/industry safety and military defense uses.
- Potential sensitivity in parts per billion (ppb) range and potential cost lower than current conventional devices.
- Significant market growth in nanosensors expected from 2014 to 2021. ($26.9M in 2014 → $1,500.9M in 2021, 80.7% compound annual growth rate).[2]
- Expected growth in the chemical industry (automotive, housing, shale gas, etc) will increase demand of gas sensors for safety applications.[3]

Current Technical Objectives

- Design and fabricate different sensor patterns to determine optimal pattern for nanowire growth.
- Control the quantity and length of TTF-X nanowires on substrate by studying applied voltage, time of applied voltage, and solution concentration during electrodeposition.

Related Work and State of Practice

Nanotechnology gas sensors have employed the use of organic (conducting polymers), inorganic (ZnO, SnO₂, WO₃), and hybrid nanocomposite materials. Organic sensors have been found to be unstable whereas inorganics have been found to be cost prohibitive for large scale production.[4]

Technical Approach, Accomplishments and Results

Each one of the four design variations is created with 2, 5, 10, and 20 µm spacing for 20 total variations to study.

Square Designs (Straight / One-Pointed Edge / Two-Pointed Edge)

Circular Designs (Smooth / One-Pointed Curve & Optical Image)

Prototype Designs For Portable Devices
- Left: Nine uniquely configurable sensors available per chip.
- Right: 3D Printed Prototype Wearable.[6]

TTF-Br Rods on Bare HOPG / Deposition of Nanowires[6]

Next Steps for Development and Testing

- Study the effect of different counter ions (X = counter ion).
- Incorporate sensor technology into portable devices (wearables, smartwatches, etc).
- Create an accurate “fingerprint” of desired gases by utilizing an array of sensors and develop signal analysis software with the aid of machine learning to increase accuracy of gas identification.

Commercialization Plan & Partners

- We are working with two serial entrepreneurs: Edward Kim and Nicholas Cucinelli. They act as commercialization advisers from Wayne State’s Technology Transfer office.
- Our group is going through the NSF I-Corps program for a customer investigation process. Currently we are trying to work with sensor manufacturers to look at scalability.
- Our team has a proof of concept and a basic prototype. Next steps are to evaluate the prototype via customer discovery, improve the sensor/prototype, develop a scalable process, and mass produce the sensor or license the technology to a third party.

References

ABSTRACT

285 million people are estimated to be visually impaired worldwide. This condition has an impact on the quality of life of those affected especially in the area of mobility. Currently, some individuals use a form of echolocation to orient themselves. However, this method takes years of practice to accurately utilize. The overall objective of this project is to develop a sensory substitution device for visually impaired users, which will gauge distances and the placement of objects. This will help to increase the user's independence and mobility.

BACKGROUND

- Ultrasonic sensors are used in rangefinder systems to determine noncontact distances and object detection. Current applications include automobile parking assistance and edge detection in automated manufacturing processes.
- Haptic feedback aims to communicate sensory information to the user via complex vibrational patterns.

TECHNICAL OBJECTIVES

- Use ultrasonic technology for echolocation to determine the distance of nearby objects.
- Relays distance information to the user via haptic feedback.
- Miniaturize the device components via PCB design and programming of an Attiny85 microprocessor.

PROGRAMMING

- Reads voltage from analog input of the ATtiny85.
- Calculates distance in inches based on time between ping sent and echo received.
- Scales readings based on voltage supply.
- Evaluates distance to determine proportional vibration intensity.

PROTOTYPE 1

- The first prototype we constructed used an Arduino board and a bulky ultrasonic sensor.
- This served as a proof of concept and also let us build early versions of the code.

PROTOTYPE 2

- Taking the concepts from the first prototype, we aimed to construct a new prototype with the purpose of shrinking the technology and making it easier for user interaction.
- Computer methodologies employed include programming in Arduino, 3D Modeling in NX, and designing PCB in Altium.

IMPLEMENTATION

- A 3D model has been created for the device housing and was printed using the BME 3D printer.
- The housing holds all of the components together and is mounted to the wrist via a watch strap.

PCB DESIGN

- A PCB was designed to accommodate the microprocessor and connect the battery, motor, and sensor.

VALIDATION TESTING

Comparison of distance readings vs actual distance using 3.3V supply voltage.

References


Next Steps for Development and Test

- Validation testing with end user
- Create aluminum housing
Utility of Ultrasound/Photoacoustic Imaging for Accurate Catheter Tracking and Temperature Monitoring During Endovenous Laser Ablation

Ayushi Jharia1 | Keerthana Palani1 | Yan Yan1 | Loay S. Kabbani2 | Nicole Kennedy2 | Mohammad Mehrmohammadi2

1Department of Biomedical Engineering Wayne State University, Detroit, MI
2Department of Vascular Surgery, Henry Ford Hospital, Detroit, Michigan

Introduction

• Laser ablation is a treatment method that uses light energy through a catheter inserted into a vein to induce localized heat to close the diseased blood vessels.

• Ultrasound (US) imaging has been used for catheter visualization and tracking. US has limitations for tracking the accurate location of the fiber tip inside small perforating veins such as angular dependency and comet tail artifacts.

• We propose a robust and accurate method for fiber tip tracking using combined US and Photoacoustic (PA) imaging to overcome the existing limitations.

Figure 1: Image of ultrasound-guided catheter insertion between anterior (ASM) and middle (MSM) scalene muscles. BP stands for the anatomical structure brachial plexus. (Adopted from NYSORA)

Methods & Experimental Set Up

Experimental Setup:

• PA experiments were performed with a pulsed laser (SpectraPhysics - PRO290) laser energy at 3.760 mJ/pulse.

• A linear array ATL L7-4 US transducer was utilized for acoustic signal acquisition.

• The optical fiber (multimode, 1000 μm core) was used to transfer the laser energy into the system and a custom-designed mechanical arm was used to tilt the fiber at 0, 5, 10, 15, 20, 30, 40, 50, and 60 degrees.

• Imaging medium was sterilized, heparinized sheep blood.

Data collection:

• A programmable digital US research platform (Verasonics, Vantage128) was used to record PA and US data.

• Data processing include selecting the ROI of each US and PA image, calculating the signal strength and the background noise.

Figure 2: (Left) Diagram of experimental setup for fiber tracking. (Right) Photograph of the setup

Results and Discussions

Ultrasound and Photoacoustic for Catheter Localization

(a) Normalized Mean Intensity (Signal)

(b) Normalized Standard Deviation (Noise)

(c) SNR (Linear)

Figure 3: (a) Normalized mean, (b) Normalized standard deviation (noise), and (c) SNR comparison between US and PA imaging for localizing fiber optic with angular variation of 0 to 60 degrees.

Results and Discussions

• Quantitative comparative analysis between US and PA methods indicate that the photoacoustic has superior abilities for laser ablation catheter localization and tracking.

• Photoacoustic images of fiber optic are shown to be independent from the angle of the fiber with respect to US transducer.

Figure 4: Photoacoustic signal amplitude increment by increasing ambient temperature.

Conclusion

• Combined US and PA imaging can provide a suitable platform for visualizing tissue structure and the location of the ablation catheter.

• Robust and highly localized temperature monitoring by PA is a promising tool for more accurate management of therapy procedures.

• Our results show that PA provides more accurate platform for tracking laser ablation catheter
  • Angular independent
  • Speckle-free
  • No comet-tail artifact

• Since laser ablation catheter includes fiber optic, the choice of PA for tracking the fiber does not require major change in existing ablation catheters.

References


Opportunity & Objectives

The duck-billed speculum, used industry wide, does not provide sufficient retention of lateral vaginal walls when used for the growing demographic of obese women and those who have born multiple children, whose walls lack the tone to support themselves. To address this demographic, the new design will support the walls, providing sufficient view and access during examinations.

Related Work and State of Practice

A vaginal speculum is a medical instrument used to open vaginal walls in order to gain access to the cervix. Common exams include pap smears, colposcopies and biopsies. Women that fall in either of these categories stated above don’t have the strength in their vaginal walls to hold open when the speculum is in use. Doctors currently use “tricks” to overcome this obstacle such as using a glove or a condom around the duck billed speculum to try to gain 360-degree retention.

Commercialization Plan & Partners

The team plans on working with Wayne State University’s Intellectual Property division to secure a patent on the final design. Next steps include further testing on volunteer patients and partnering with manufacturers to produce fully functional prototypes. The team is partnered with Wayne State OBGYN, Dr. Maurice Recanati, as the SME, in order to fine tune specifications, along with Dr. Mohammad Ali Ozbeki to help refine the design process.

Technical Approach

A rolled sheet method was determined to be the preferred approach, based on the following criteria through a Pugh analysis: sufficiently restrains lateral walls, disposable/single use, safety, ergonomic, intuitive operation, low cost, biocompatibility.

Features of the rolled sheet method:
- Shaft to drive sheet expansion and retraction
- Rubber coating or o-rings in place of gears allow for self-locking, removing need for locking mechanism
- Single-piece main body and shaft injection molded
- Sonic welding sheet to main body

Simulation Results

The simulation results comply with the system’s mechanical requirements set by the team and recorded in the DVP&R. The Food and Drug Administration (FDA) does not have specific requirements for vaginal specula other than physical safety and biocompatibility.

References

Opportunity and Significance
- Virtual reality technology has garnered vast attention in recent years and a clear interest by companies to advance the technology for commercial application.
- The viewing of live events in virtual reality has been explored, but little attention has been given to the immersive experience, as many current technologies are only in two dimensions.
- This project explores the potential to increase this immersive experience through use of video and audio hardware, processing elements, virtual reality technology, and the software needed for control.
- Main goal: Develop a working prototype as a step to solution of the aforementioned problem.

Technical Approach
- A total of eight Raspberry Pi computers and camera modules are used as camera feed, along with a microphone for audio.
- Cameras are divided into four left and right “eye” pairs.
- Cameras one, three, five and seven and two, four, six and eight are stitched together respectively using the developed software.
- Each panorama is then directed over the system to be viewed in the respective eye in the virtual reality head mount display to achieve stereoscopic vision.

Technical Objectives
- Combine disparate technologies for capturing audio and video components.
- Develop a software solution to guide the audio and video data from source (camera rig) to destination (virtual reality head mount display).
- Develop a software solution to process video and audio components, particularly to create panoramic, stereoscopic 3D video.
- Develop a software solution to stream live events as well as record these events to allow for later viewing.

Accomplishments and Results
- Near 180-degree panoramic video capture.
- Stereoscopic (3D) video playback.
- Audio capture and playback.
- Virtual reality head mount display compatibility.
- Streaming of live events.
- Recording of live events.
- Playback of recorded content.
- Simple GUI for front-end application.

Technologies Used
- Raspberry Pi computers.
- OpenCV (Open Source Computer Vision).
- Unity3D.
- Oculus Rift.

Hardware equipment provided by VirtualTronix, LLC.
Wearable Connected Health Platform

Opportunity and Significance
Infants and elderly can benefit from wearable real-time health monitoring and communication to caregivers.

Technical Objectives
1. A wearable device that can host different health monitoring sensors.
2. Wireless communication to a caregiver’s cellphone.
3. An App to convert the data to actionable information.
4. Work with Physicians and Medical Scientists to define specific applications, sensors, and logics.

Related Work and State of Practice
- There are wearable devices that provide health-related data but they do not have the app or the logic to produce actionable intelligence.
- The platforms need to integrate other sensors for specific needs.

Technical Accomplishments and Results

Next Steps for Development and Test
Work with Physicians and Medical Scientists to define high value applications to integrate the relevant sensors and to specify the processing logic and to test the system in a healthcare environment.

Commercialization Partners
- WSU Health Connect initiative
- Physicians: Patrick Hines, CEO of Functional Fluids, WSU faculty member, TechTown
- Chris Gibbons, CEO of the Greystone Group, Johns Hopkins faculty member
- Jonathan Knoche, Pediatrician in MSU hospital
- Paul Thomas, CEO of Plum Health

Team
- Emily Baughman, Johns Hopkins, Public Health
- Mojgan Mehrabi, WSU Engineering Technology Department
- Brandon Wong, Electrical & Computer Engineering Department
- Kamaljit Chahal, Electrical & Computer Engineering Department
- Dr. Gary Witus, Advisor
- Dr. Gerald Roston, Commercialization Mentor