THE DESIGN LAB at Rensselaer

2015-16 Capstone Projects Portfolio

Biomedical
Computer & Systems
Electrical
Industrial & Management
Materials
and Mechanical
Engineering Programs

O.T. Swanson Multidisciplinary Design Lab
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Welcome to the 2015-16 Projects Portfolio of the O.T. Swanson Multidisciplinary Design Laboratory at Rensselaer (The Design Lab).

In 2015-16, The Design Lab engaged over 390 senior-level students in real-world design challenges, the largest number of students to date and including students studying biomedical, computer and systems, electrical, industrial, materials, and mechanical engineering. These students graduate with the ability to work on teams to solve real problems with multifaceted constraints and deadlines, due in a large part to their activities in the Design Lab. They rise to meet the challenges posed in the Design Lab through their hard work, intellect, and creativity but also through the dedication and engagement of our industrial and individual sponsors, for whom we are grateful for their investments.

This year was particularly exciting. We were fortunate to work on engineering problems relating to a wide range of technologies and industries. Examples include the design and manufacture of innovative products, developing environmentally friendly technologies, driving efficiency in manufacturing processes, and improving health and wellness for individuals and groups. Please enjoy this 2015-16 Design Lab Projects Portfolio, highlighting some of the past year's projects. The technical breadth and depth of projects presented in this portfolio is impressive.

Our sincere thanks to our sponsors, partners, friends, students, staff, and faculty for their time, effort and support of the Design Lab. We look forward to working with you in the very near future.

Matthew Oehlschlaeger, Ph.D
Associate Dean, School of Engineering
Acting Director
O.T. Swanson Multidisciplinary Design Laboratory

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2015-16 Capstone Design Projects

ENERGY AND THE ENVIRONMENT

Ecosystem of Systems Testing Platform

Fall 2015 Team: Anthony Ugarte (ME), Belvia Huo (ME), Kevin Mullin(ME),
Lydia Rebehn (ME), Nicholas Woolf (ME:BME), Yue Yu(ME)

Background Information

- RPI CASE collaboration focused on improving building practices
  - Energy consumption
  - Sustainability and resource management
  - Health and quality of indoor air
- Improvement of indoor air quality using biomaterials

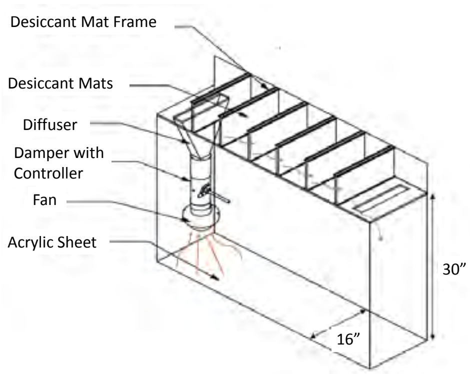


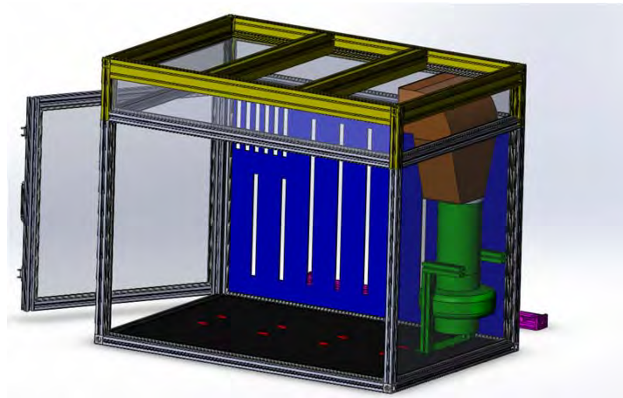
Figure 1: Desiccant absorption test set up

Objectives

- Analyze the effect of fan location and design on air flow
- Design and fabricate traverse insertion panel
- Update LabView code for the traverse movement and sensor analysis
- Design, construct and perform thermal analysis on a scaled occupied office setting
- Design and fabricate a raised plenum ceiling for multiple configurations
- Simulate airflow and pressure drop ratings of ceiling panel models

Purpose

Our purpose is to provide CASE with a modular test bed to assess a variety of new technologies and provide infrastructure to perform further expected tests.



- Heating Elements
- Diffuser and Plenum Inlet
- Fan
- Traverse Panel
- Traverse
- Ceiling Plenum

Figure 2: ESOS Chamber Elements

Future Plans

- Integration of Velmex hardware into the chamber for tests
- Fabrication of the diffuser and acquisition of inlet for the plenum
- Transient analysis of thermal layering effects
- Further infiltration testing to improve chamber performance
- Design and construct a slotted ceiling panel for further testing with the traverse

Results and Accomplishments

- Fabricated a airtight panel for the traverse to perform its measurements
- Design and fabricated two versions of plenum ceilings
- Ran infiltration analysis on the fully constructed chamber
- Applied the simulated designs for airflow trajectory and pressure effects for a fan, diffuser and plenum inlet
- Rewrote the LabView code to enable three-axis movement by the traverse as well as the data acquisition program
- Simulations and models for surface roughness to assess the effects on airflow
- Performed temperature and relative humidity testing on the effect of heating elements

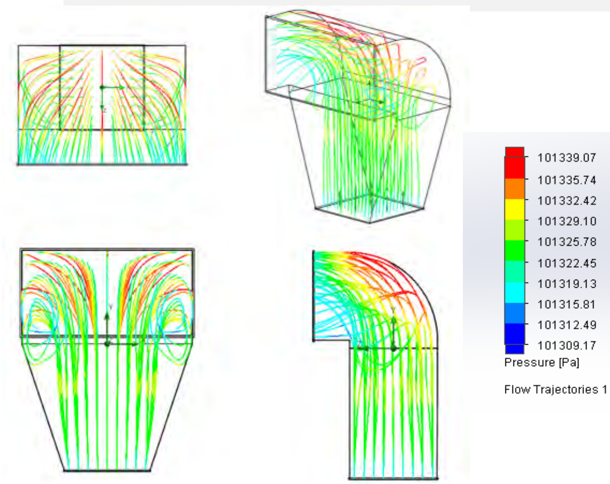


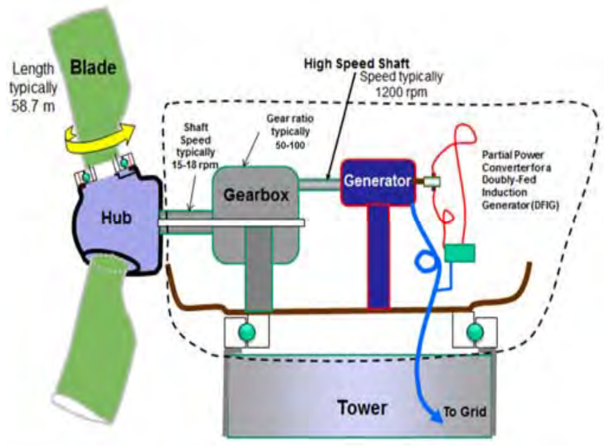
Figure 3: Pressure simulation of final inlet duct and diffuser design (pressure drop= 9.62 Pa).

Low RPM Wind Generator

Fall 2015 Team: Anton Andriyanov (MECL), Lauren Brady-Haskell (ELEC), Thomas Kelly (ELEC), Mike Scocozza (MECL), Arjun Sharma (MECL), Andrew Skywark (ELEC), Andrew VanBezooijen (MTLE), Christina Vasil (MECL)

Purpose

- Increasing turbine rotor size leads to slower shaft speeds pushing the envelope of current GE design practice



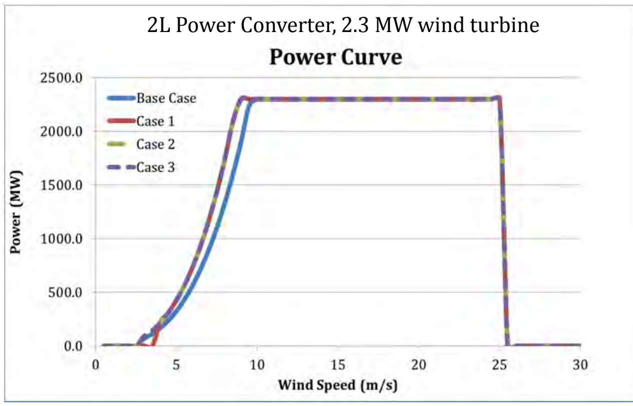
Wind turbine schematic. Courtesy of Bharat Bagepalli.

Semester Objectives

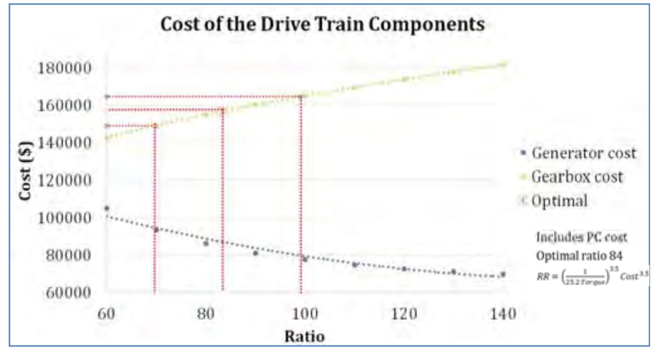
- Consider topology changes to drive train systems
    - Gearbox
    - Doubly-fed induction generator (DFIG)
    - Power conversion system (PC)
- Compute performance for increasing power conversion
    - Annual Energy Production (AEP)
    - Wind turbine cost
- Compare configurations using revenue-cost metric

Technical Approach

- Model cost of each component
    - Gearbox : torque, gear ratio, types of stages, number of stages
    - DFIG: increase partial power conversion on rotor, full power conversion on stator
    - PC: 2 level versus 3 level
- Develop cost constitutive relations
- Evaluate economic tradeoff between gearbox and DFIG
- Compare configurations and determine model with lowest change in cost per change in revenue



Case	Blade length (m)	PC%	Gearbox Ratio	AEP (MWh)
Base	56.9	30	84	8292
1	65	30	84	9340
2	65	40	84	9441
3	65	40	83 (cost optimal)	9441



Technical Results

- Case 1 gave lowest change in cost per change in AEP (increasing only blade length)
- No topology change for any level of power conversion
- Reduction ratio and fatigue life impact cost and selection of gearbox configuration
- Methodology can be applied to any name-plate rating, blade size, or PC%

Accomplishments

- Developed methodology to create and analyze cost tradeoff between drivetrain components
- Evaluated sensitivity of gearbox ratio for $\pm 5\%$ in gearbox cost, as shown above

Next Steps

- Consider change in number of generator poles
- Expand models to account for bearings, blades, cooling, tower, bedplate, and noise

Cross-Flow Wind Turbine

Spring 2016 Team: Siegfried Boyd Isidro-Cloudas (MECL & ECSE), Danielle Tavel (ECSE), Kevin Prosicki (MECL), Kyle Pollard (MECL), Matthew Chaet (MECL), Nicholas Blumling (MECL), Thomas Baken (ECSE), Tyler Kessler (MECL)

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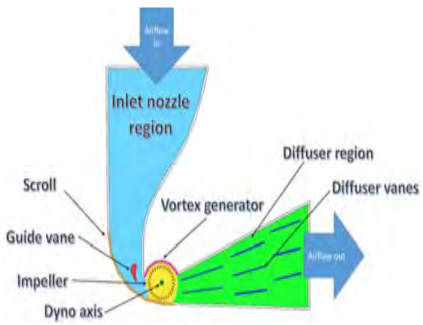
PURPOSE

To develop a wind energy harnessing device that performs well in urban environments by minimizing upfront costs and limiting space consumption, noise pollution and rooftop stresses.



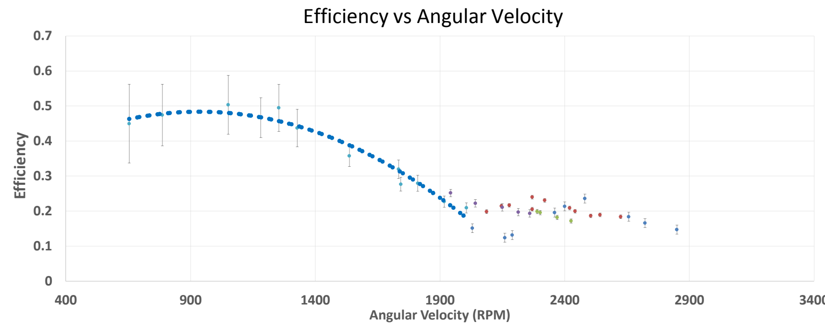
Example of an Impeller for a Cross-flow Wind Turbine

PROJECT HISTORY

- Inherited a benchtop model from previous semester
- Inherited a test site on Folsom Library for final deployment with a Tycon ProWeatherstation deployed on it to collect wind data.
- Previous semester's group had begun development on a pressure sensor telemetry system.

ACCOMPLISHMENTS

Benchtop Model Improvements and Efficiency Testing

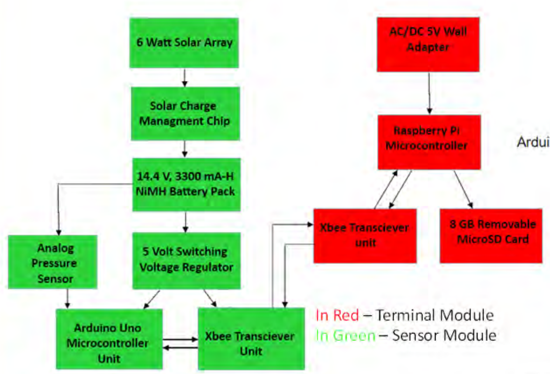


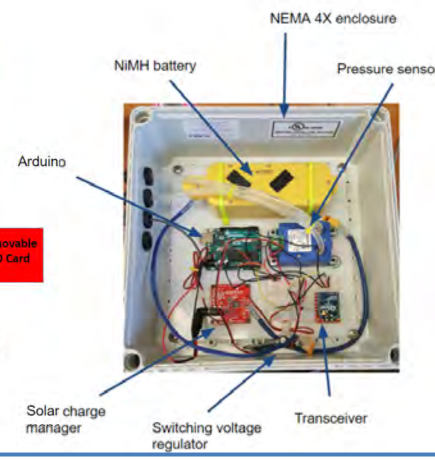
$$\frac{\left(\left(KE_{motor} * I_{loop}\right) + T_{friction}\right) * \omega}{\Delta P * V_{ave} * \rho * A} = \frac{Power_{mechanical}}{Power_{fluid}}$$

Where: $KE_{motor} = motor\ torque\ constant, T_{friction} = \ friction\ torque$
$\omega = angular\ velocity, \Delta P = change\ in\ pressure, \rho = density, A = area$

Pressure Sensor Telemetry System

Design and construction of the remote pressure differential measurement system is complete. The system was developed for deployment to the southern wall-to-roof edge of the Folsom Library. The system is currently undergoing a series of environmental and site tests to prove expected functionality.





SEMESTER OBJECTIVES

- **Increase system efficiency**
- Improve inlet geometry to increase airflow to impeller fins
- Design and implement guide vane to control angle of attack
- Improve diffuser design to decrease air separation and improve pressure recovery
- **Improve measurement accuracy**
- Finish and test pressure sensor telemetry system to capture data at test location
- Make improvements to current dynamometer system to decrease measurement error

Future Work

- Perform additional round of efficiency testing to validate established data and technique
- Quantify individual efficiency contribution of guide vane and diffuser fins
- Decrease telemetry system net power consumption and deploy at testing location on Folsom Library
- Deploy benchtop model at test site location

Wind Turbine Blade De-Icing with Microwaves

Spring 2016 Team: Henry Choi (EE), Mengqian Gao (MECL), Kevin Hritz (MECL), Yuyu Hsueh (EE),
Ryan Jenkins (MECL), Kelly Pifer (MECL), Yuhan Shi (EE), Alex Wholey (MATL)

[1]

Customer: GE Power and Water

Benefits: Increased blade life & efficiency, safer operation of cold weather turbines; decrease turbine down-time

[2]

Purpose: Investigate the use of microwave de-icing technology to enhance the performance of wind turbine blades operating in cold environments

Background and Objectives

Spring 2015 Feasible Study

- Deicing requires: surface heat flux of 1.4kW/m^2 ,20-25 minutes of test period and microwave interactive material
- Options: horn antenna and slotted waveguide antenna at 2.45 or 5.8 GHz

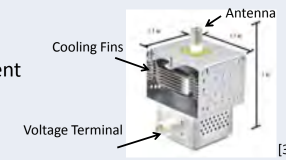
Semester Objectives

- Design and test blade-compatible microwave susceptor coating layer
- Demonstrate effective microwave delivery at 2.45GHz
- Build a microwave laboratory test facility and collect de-icing data

Microwave System

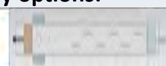
Microwave generation:

- Operates at 2.45 GHz
- Microwave Power – ~ 1 kW : 60% efficient
- Cheap – around $50
- Easy to drive – circuits already exist
- Air cooled



[3]

Microwave delivery options:

		
Type	SWA	Horn Antenna
Profile	Low (planar form)	High
Manufacturing	Good	OK
Bandwidth	Narrow	Broad
Gain	15dBi - 20dBi	15dBi - 30dBi
Pattern	Highly directional	Moderately directional

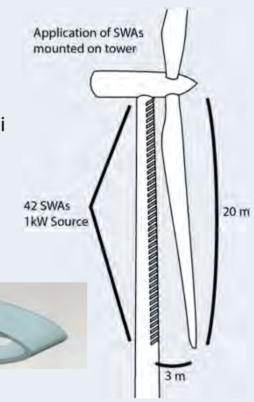
Practical Application

Tower Configuration

- Arrays of SWAs
  - 42 SWAs needed for gain of 9 dBi
- Arrays of horns
  - 110 horns needed for gain of 10 dBi
  - 40 horns needed for gain of15 dBi

Blade Configuration

- SWA incorporated inside the blade



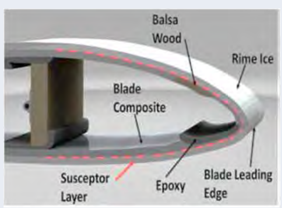
Microwave Absorbing Materials

Problem

- G10/FR4 and Ice are transparent to incident microwave radiation

Solution

- Susceptor coating on blade surface



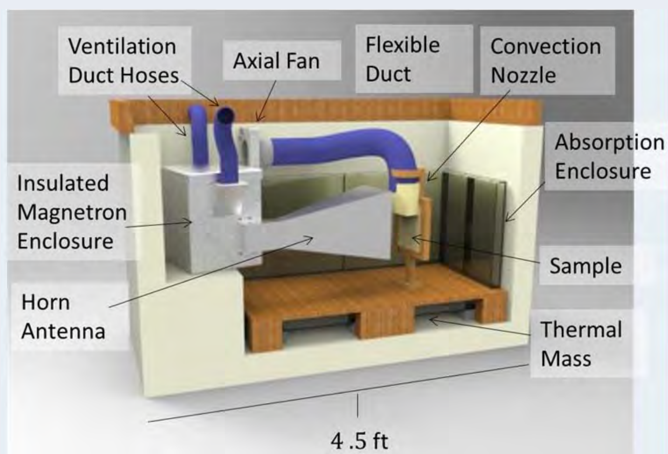
Requirements

- Maximize conversion of absorbed microwave radiation to heat
- Withstand cyclic thermal stress
- Resistant to UV degradation

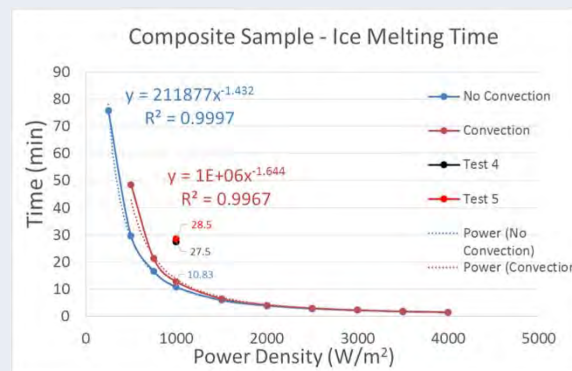
Comparison of Coating Methods

	Uniform surface?	*Easy to apply to blade?*	*Resistant to Degradation?*	*% Absorption?*	*Rate of Heating*	*Max Temp.*
Sputtered Al Film	Yes	No	No	Up to 50%	< 3 min	200 °C
Absorptive Paint	Yes	Yes	Yes	Up to 40%	N/A	900 °C
Dielectric Coating	Yes	Yes	Yes	Up to 99%	< 1 min	800-950 °C

Testbed Diagram



Microwave Deicing Test Results



Results:

- Ice melted within 30 mins
- Test bed ambient temperature remained below freezing

1.) "GE Logo." *CleanTechnica*. N.p., 29 Mar. 2013. Web. 07 Oct. 2015. <http://cleantechnica.com/2013/03/29/new-ge-wind-turbine-prototype-revs-up-in-netherlands/ge-wind-turbine/>.
2.) ReNEWS. "GE Toasts Brazil Milestones." N.p., 26 Aug. 2014. Web. 07 Oct. 2015. <http://renews.biz/73071/ge-toasts-brazil-milestones/>.
3) "Magnetrons for Microwave Ovens." - *850W & 1000W Magnetrons*. N.p., n.d. Web. 15 May 2016. <http://www.kitchenwareonline.com/magnetrons-for-microwave-ovens-c102x2263126>.

Wind Turbine Reliability Analytics

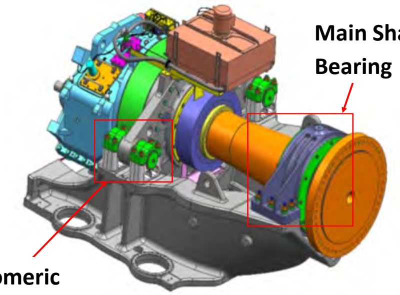
Spring 2016 Team: Yaarub Alnaabi (ME) | Danning Chen (ME) | Ben Coble (ME) | Jeff Daring (ME)
Sam Dickinson (ME) | Peiyang Ding (IME) | Nicole Mowder (ME) | Dillon Scribner (ME)

Motivation

- GE monitors the operational data on thousands of wind turbines
- GE wants to:
  - Minimize maintenance costs: service contracts
  - Identify upgrade opportunities
  - Improve utility of operational data

Customer Requirements

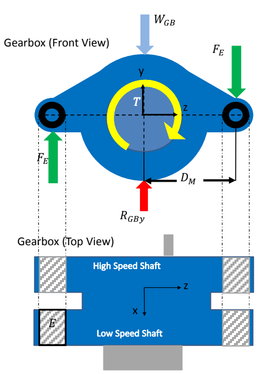
- **Drivetrain components**
- System ranking the turbines' need for maintenance based on accumulated damage



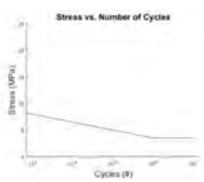
Semester Objectives

- Develop accumulated damage and lifetime algorithms for:
  - Main shaft bearing
  - Gearbox elastomeric mounts
- Integrate algorithms into operational data
- Use models and data to rank components' accumulated damage

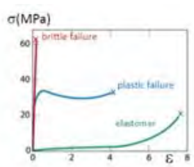
Elastomeric Gearbox Mount



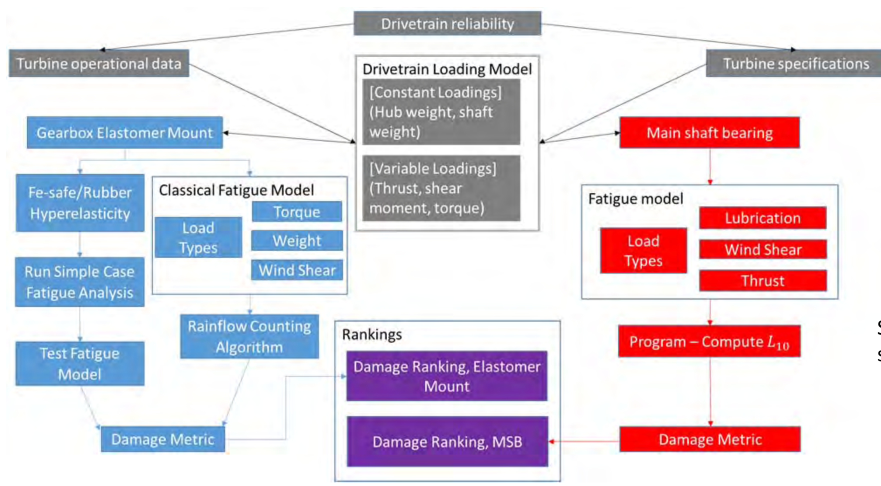
Calculate stress on elastomer using loading model

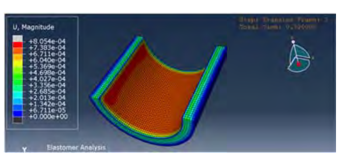


Approximated S-N curve used for calculating cycles to failure

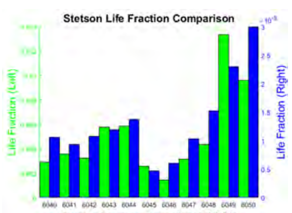


Comparing stress vs. strain curves of various materials



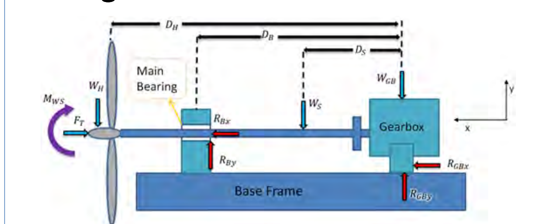


FEA model of elastomer crescent moon shape

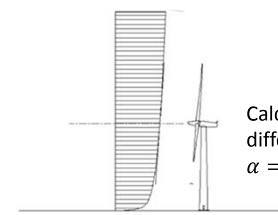


Results: Elastomeric Mount Damage Metrics on Stetson Turbines

Loading Model



Main Shaft Bearing

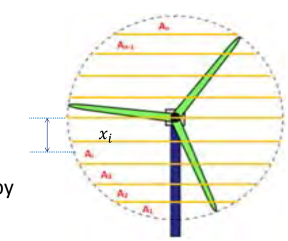


$$\frac{U_2}{U_1} = \left(\frac{H_2}{H_1}\right)^{\alpha}$$

Calculate wind speed at different heights with $\alpha = 0.302$

Sum incremental forces over swept area for thrust force:

$$C_{T_i} = \frac{F_{T_i}}{\frac{1}{2}\rho U_i^2 A_i} \longrightarrow F_T = \sum_{i=1}^{n} F_{T_i}$$



Wind shear moment given by incremental forces:

$$M_{WS} = \sum_{i=1}^{n} F_{T_i} \cdot x_i$$

Results: MSB Damage Metrics on Stetson Turbines

$$L_{10} = \frac{10^6}{N * 60} * \left(\frac{C}{P}\right)^{10/3}$$

L10 = expected lifetime [hours]
N = shaft speed [rpm]
C = basic dynamic load rating [kN] (given constant)
P = equivalent dynamic bearing load [kN]

Health & Wellness

My Mobility Test

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Spring 2016 Members: Nicholas Fay (CSE/CS), Alec Vogel (BME/ME), Nicholas Grippo (CSE), Zachary Shute (CSE), Dan Shanley (CSE), Trevor Corrao (IME), Carson Hynes(CSE), Ryan Delaney (CSE/CS)

ALBANY GUARDIAN SOCIETY
ALBANY NEW YORK

Background

- Over 1/3 of all people over 65 fall each year
- Falling is the leading cause of death among seniors
- 30 billion dollars spent per year in medical expenses resulting from falls
- 25% of seniors have a smartphone

Project History

- Android and web application developed and functioning, iOS application not fully implemented
- Step counting algorithm implemented
- Security issues identified
- Timed Up and Go Test successfully used for analysis

Purpose

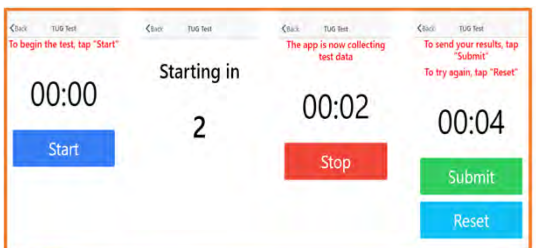
- Provide an application that collects accelerometer data while taking a TUG test
- Provide a website to access the data collected by the application

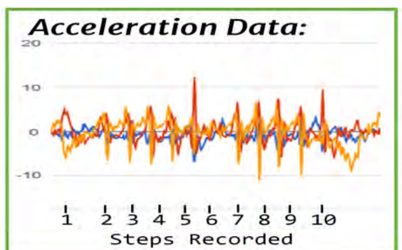
Semester Objectives

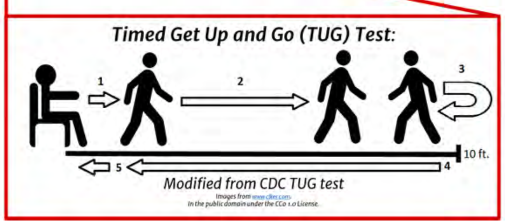
- Deploy website to AGS server
- Create cross-platform application with Ionic
- Update MyMobilityTest.com to fix bugs & failures
- Strengthen website to ensure compliance with HIPAA Title II
- Collect experimental data from senior citizens

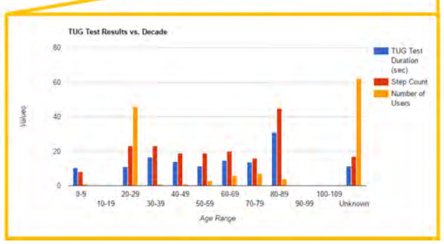
Technologies

Twitter Bootstrap | Django Framework | Ionic Framework | MySQL









Technical Accomplishments

Testing/Marketing

- Performed tests on senior citizens before IRB expiration
- Created a marketing video to showcase the My Mobility Test platform
- Collected UI feedback from senior citizens

Apps

- Created a hybrid app for iOS using Ionic
- Implemented all Android functionality
- Superseded the existing Android application

Server

- Transferred the Django website to an external server
- Purchased and set up a valid SSL certificate
- Performed security testing using OWASP ZAP and patched security issues

Website

- Fixed all outstanding security issues
- Properly implemented SSL and HTTPS
- Updated content on out of date pages
- Fixed UI bugs
- Added new functionality such as filtering and password reset

Aids for People with Physical Challenges

Sam LaChance(CSYS) Sarah Bogdan(ME/DIS) Taylor Anderson(IME) Chuxuan Chen(CSYS) Arren Bustamante(ME/DIS)
Joe Mauriello(IME) Tom Vaccaro (EE/BME) Wenjun Jiang(ME) Sam Hoenes(ME)

Purpose

- *Long term:* Design devices to aid disabled persons
- *Current team:* Build a gripper arm prototype to inherently increase David's independence

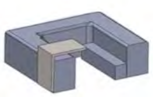
Term Objectives

David will be able to:

- Use arm attachment with more control
- Control gripper via voice control
- Independently use device
- Have an improved functional device

Past Work

- Designed arm attachment to be operated independently by David

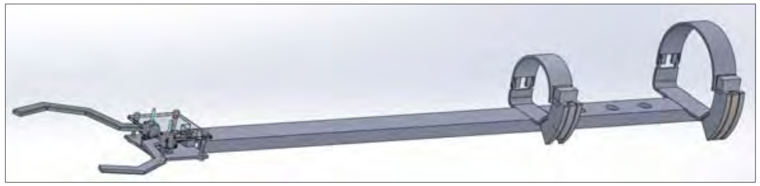

Difficult to:

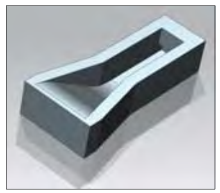
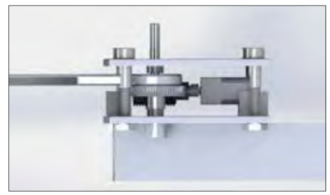
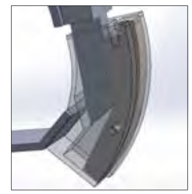
- activate gripper
- put device on
- lift heavy objects

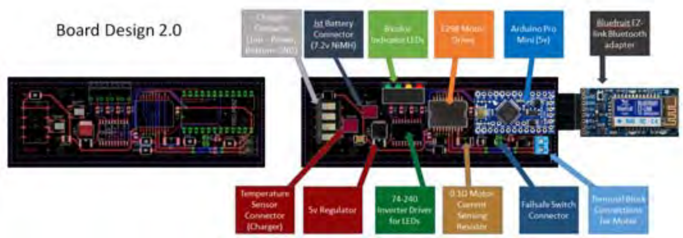
Customer Requirements

Requirements	Metrics
ability to reach floor	29"
hold a gallon of milk	4lb
fast reaction time (from sensing to closing)	4 sec
attached independently	No hand use

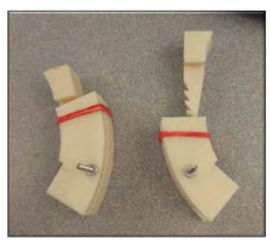
System Overview





Physical Prototypes




Arm Attachment

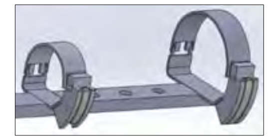
- Material
- Latching
- Padding
- Dock & Charger

Requirements

- Independent use
- Withstand 32lbs

Engineering Tools

- Force analysis
- Materials selection
- Torque analysis



Control

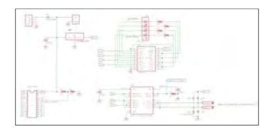
- Voice Recognition
- Wireless Compatibility
- Driver Control

Requirements

- Detect client signal
- <1% false positive
- <2sec response

Engineering Tools

- Muscle model
- Sample code



End Effector

- Mechanical Gripper
- Actuator
- Extension Arm

Requirements

- Hold 8lbs
- Full range in<1s
- Open 4in.

Engineering Tools

- Torque calculation
- Circuit analysis
- Torque analysis

Future Work

- Further testing with David
- Manufacture with final materials
- Deliver assembled device
- Redesign for universal use

Vertical Knee Raise Machine

Spring 2016 Team : Ralph Bonilla (ME), Ryan Buchovecky, (ME), Jeremy Carr (ME),
Maeve Conway (ME), Michael Croke (ME), Chris Holomakoff (ME), Tim Maisonet (ME), Michaela Mariquit (ME), Madhav Venkaswamy (IME)

Purpose: Design a home VKR machine that allows for easy storage and set-up. Workouts on the machine increase abdominal girdle strength, which decrease chronic lower back pain that 80% of Americans experience during their life.

Customer Requirements:

Requirement	Spec Value	Test Value
Machine Weight	< 50lb	60lb
Max User Weight	275lb	285lb
Set-Up/Break Down Time	< 15sec	11.7/10.6 sec
Folded Dimensions	1' x 4' x 6'	0.67' x 1.88' x 5.67'
Manufacturing Cost	$250/unit	
ASTM Standard Loading	300lb dynamic load with a safety factor of 2.5	Passed according to FEA
Fatigue Life	10 years	11.36 years
Deflection	< 0.75" total, < 0.5" in arms	0.737"

Project History:

- Alpha prototype is a single upright beam design
- Design and material issues causing the base to bend when under loading
- Arms of the machine need to be completely removed for storage

Figure 1: Final Design

Semester Accomplishments:

- Defined "stability" in the context of this project
- Evaluated two preliminary designs: upright beam and tripod
- Presented a recommendation to the sponsor based on analysis of customer requirements
- Pursued final design in accordance with the sponsor
- (Figure 1)
- Used FEA to confirm the machine meets ASTM Standard F2276: Standard Specification for Fitness Equipment
- Constructed a beta prototype of final design
- Performed cost analysis and created a comprehensive business plan for 10,000 units

Recommendations:

- Find a manufacturer and facility
- Determine most cost effective production and shipping methods
- Find laboratory to conduct physical ASTM testing
- Develop pitch for potential investors

Figure 2: Side View of Tripod

Figure 3: FEA Results of Max Deflection

Figure 4: Folded Side View of Tripod

Wireless Assistive Technology

Spring 2016 Team: Jason Flanagan(EE/PHY), Yuhong He(EE), Toshimitsu Kishi(MECH), Ziheng Li(EE), Emily O'Neill(EE), Erik Vink-Lainas(EE), Talha Yilmaz(EE), Alexander Yin(MECH)

BACKGROUND INFORMATION

- New project stemming from previous projects assisting the disabled and elderly
- Based on 2012 disability study

  -- 7.8 million have a self-care disability

  -- 16.2 million have independent living disability
- Typically disabled and elderly individuals have a fixed budget

CUSTOMER REQUIREMENTS AND PAYOFFS

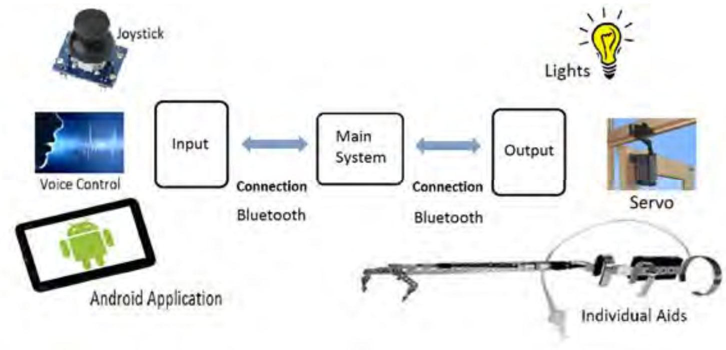
- Seamless connection between inputs and outputs
- Ability to be implemented into current systems
- Modular system that can be customized for a multitude of unique disabilities
- Support the independence of elderly and disabled individuals
- Customers will gain their independence to accomplish simple everyday tasks

SEMESTER GOALS

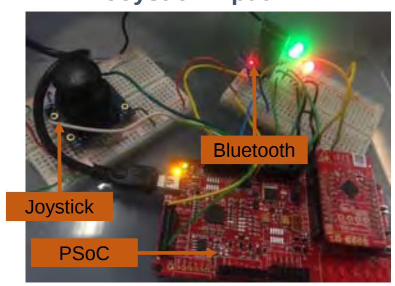
- Design and build an Android application for command of output system
- Implement two input methods to control the same output.
- Have Bluetooth communication between input and output methods.
- Integrate inputs with designed and already existing outputs
- Work with the Gizmo team to integrate two projects

DESIGN SOLUTIONS

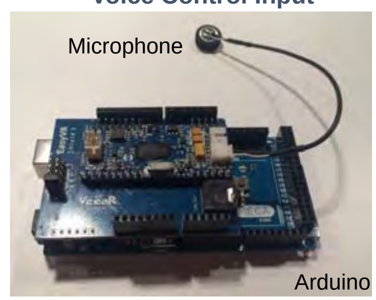
System Architecture



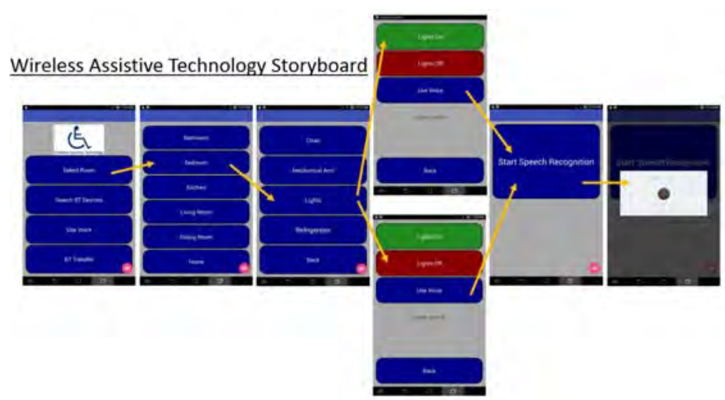
Joystick input



Voice Control Input



Application Development



APPROACH

- Incorporate various input methods including a joystick and voice control
- Use commands received from an Android application to control output devices
- Design and utilize "off the shelf" output devices
- Implement wireless communication with Bluetooth

RESULTS AND ACHIEVEMENTS

- Wired joystick control on PSoC and could wirelessly control output devices
- Demonstrated wired voice control on Arduino with selectable outputs
- Android application could wirelessly control output methods using a voice control and touchpad interface
- Design of refrigerator opening mechanism

FUTURE PLANS

- Examine the possibility of combining the main system and Android so that the Android acts as the main system
- Implement cloud storage of input and output device states
- Use Wi-Fi to provide wireless connectivity between input methods and output devices
- Continue system integration with new input methods and output devices

MANUFACTURING AUTOMATION AND CONTROL

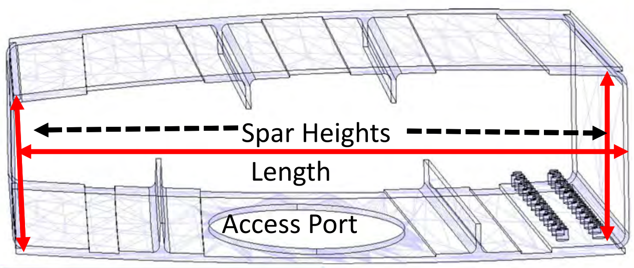
Boeing Wingbox Assembly

Fall 2015 Team: Zach Baierl (MTLE), Connor Finnell (CSE), Michael Macarevich (CSE), Samuel Nathanson (ME), Robert Orban (ME), Abdulaziz Shamsah (ME), James Whelan (IME)

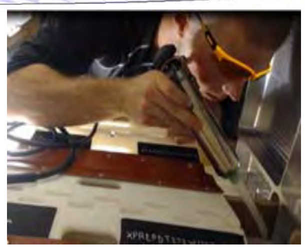
Purpose and Motivation

Develop an autonomous or semi-autonomous system to perform various tasks required for the manufacture and maintenance of airplane wingboxes. Reduce need for human work inside wingbox, increasing efficiency, safety and decreasing costs.

Confined Space: The Wingbox



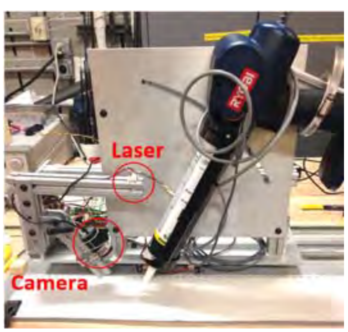
Approximate Dimensions	
Length	33" – 187"
Wing Boxes Per Wing	20 – 30
Front Spar Height	7" – 34"
Rear Spar Height	6" – 42"
Access Port	18" x 10"



The small dimensions of the wingbox make human performance of tasks such as laying and inspecting sealants difficult.

Inherited System

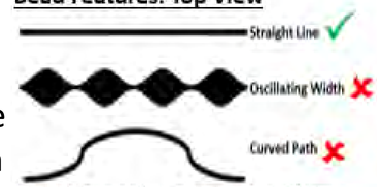
Utilizing a separate camera and laser, a foundational bead analysis system was created by previous teams with width analysis capability.



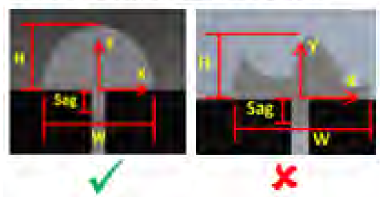
Main Semester Objective

Design and build a prototype end effector, to house and expand upon the inherited system, for post application analysis of bead sealants as applied to butt seams.

Bead Features: Top View



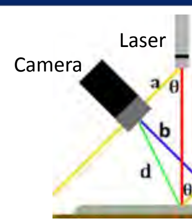
Bead Profile: Cross Section



Sub Systems

- Computerized Visual Inspection System
  - Computer analysis of bead geometry
- Housing
  - Contain camera, laser, and supporting hardware in one unit.

Technical Approach



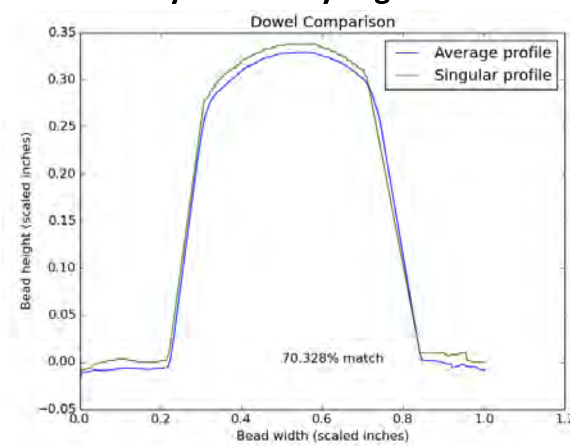
Known: a, a', θ (with calibration of camera; pixels to inches)

Want to know: d

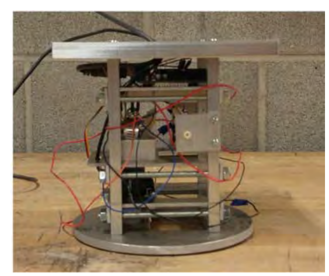
$$d = \sqrt{a'^2 + \left(\tan^{-1}(\theta) \cdot \left(1 + \frac{a'}{a}\right)\right)^2}$$

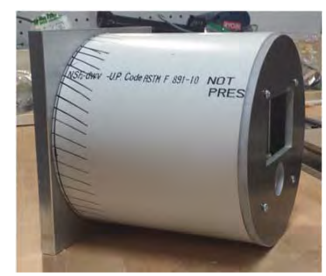
CVIS Results and Final Housing

Combined system analyzing a sealant bead.



Final System





Additive Manufacturing

Spring 2016 Team: Tim Faulkner (ME), Antonio Fernandez (EE), Kevin Guo (ME), Marty Hoskins (ME), Stanly Mathew (EE), Jay Reddick (ME), Michael Robinson (ME), Natalie Tremblay (ME)

Purpose:

To develop a robust selective laser melting (SLM) 3D printer that implements a closed loop feedback system to produce high quality, repeatable 3D parts.

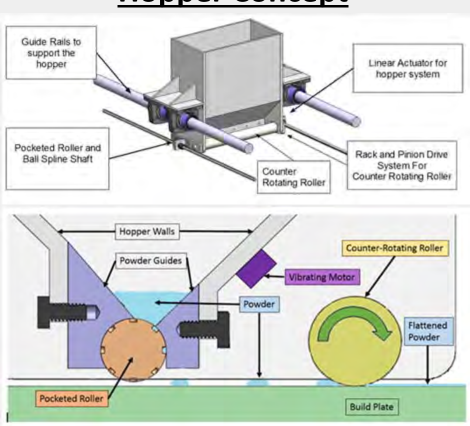
Semester Objectives:

To design and prototype a functional powder handling system concept that distributes metal powder to produce a repeatable, thin layer and measures the powder layer to detect irregularities.

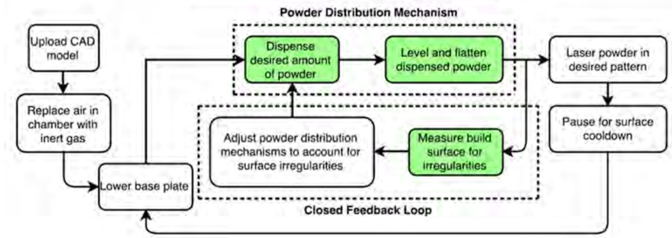
Past Work

- Narrowed Additive Manufacturing to powder-based SLM 3D printer
- Comparison of various powder spreading techniques for cost, dealing with irregularities, compaction, complexity, lifetime, and maintenance
- Wiper blade failure analysis

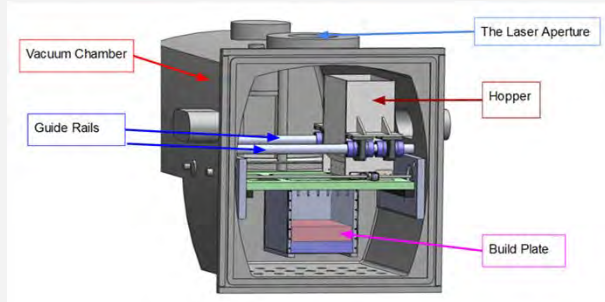
Hopper Concept



3D Printer Flow Chart



Physical System and Design Constraints



Additional Requirements

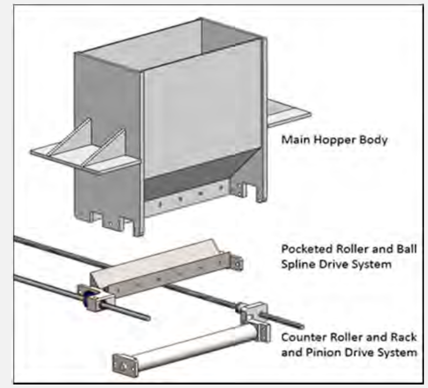
- Parking location and attachments do not interfere with laser path
- Spreading device rides above Top Plate
- Parts survive vacuum pull, chamber temperature 40 C - 300 C
- Spreading system integrates with existing installation plan
- Design motor controller to position spreading device with ball screw
- Team semester budget of $1000

Measurement system for Surface Irregularities

Laser Point Profilometer

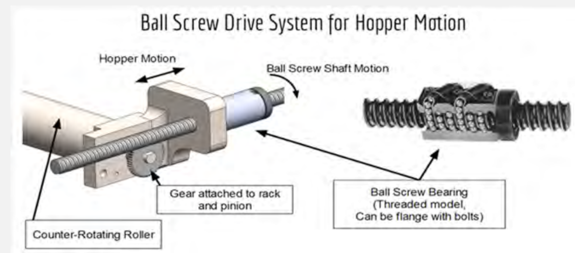
- Uses Cmos technology and lasers to recreate a 3D plot of the build surface for deformities
- The most accurate sensor among those considered
- Easily modified to withstand chamber conditions

Design and Research



- Main Hopper Body for Transport and Storage of Powder
- Pocketed Roller for Powder Dispensing
- Counter Roller to Level Powder
- Rack and Pinion to move the hopper one direcion and create a reverse direction rotation for the counter rotating roller

Motor and Ball Screw to Drive Spreading Device



Future Recommendations

- First construction of design should be made out of aluminum for initial testing and demonstration of functionality
- Narrow down the necessary requirements expected for the measuring system
- Develop velocity profile based on system load for accurate motion control
- Need to figure out temperature at locations within the vacuum chamber

Optical Inspection for Cosmetic Defects

Spring 2016: Gregory Grebe (EE/CSE), Huiye Liu(EE/CSE), Mengziying Tu(EE), Stefan Ryan(EE), Tyler Murtha(CS/CSE), Victor Yu(EE), Youxin Li(EE)

Purpose

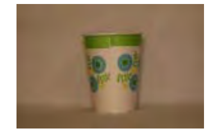
Jabil, the world's third largest supply chain management and manufacturing company, seeks a recommendation for a real time system to inspect products for cosmetic defects in an attempt to reduce inspection time and cost.

Semester Objectives

To formulate a recommendation on the use and implementation of a neural network software on the production lines of Jabil for defect detection

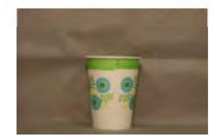
Accomplishments

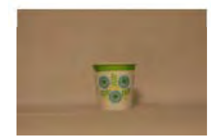
Task	Why important	Results	Conclusion
Deterministic Test	Test to explain the deviation in the output of ViDi's neural network	Output varied by 1-2%	ViDi is non-deterministic
Training Set Variation Test	Test for if random selection is as effective as specific selection for image variance	Results improved when selecting images to train on a wider image variation	It is advisable to select images in order to capture variations between images
Orientation Test	Test to see if ViDi can handle different views of a product	Error rates were very high	When including many views of a round, patterned object, ViDi has a hard time differentiating between images
Parameter Test	Test 5 important parameters to see how they affect processing time and error rate	Gained characteristic trends for each parameter with error rate and processing time per image	Feature size was the most important parameter to tune
ViDi Blue Rotation Test	Test ViDi Blue's capability of rotating images to align feature points to increase image consistency	Rotation is possible	For round patterned objects, rotation can be done using feature points
ViDi Blue cropping Test	Test ViDi Blue's capability of isolating feature points for cropping in ViDi Red	Cropping is possible, error rates and processing time per image much lower	Isolating features in ViDi Blue and cropping around them with a predefined box is very advisable
Database Export Custom App.	Evaluate the API by creating an application to process a large dataset of images	API is simple to use, and the results received are the same as seen in the GUI	The API must be used in order to process a single new image. Custom applications can streamline the process.
Camera Capture Custom App.	Determine how to integrate a camera with ViDi through a custom application	OpenCV can be used to interface a camera and process the images captured	A custom application must be created in order to interface ViDI with a camera, but it is not difficult to accomplish


Data Set 1; G 167 B 44


Data Set 1; G 95 B 48

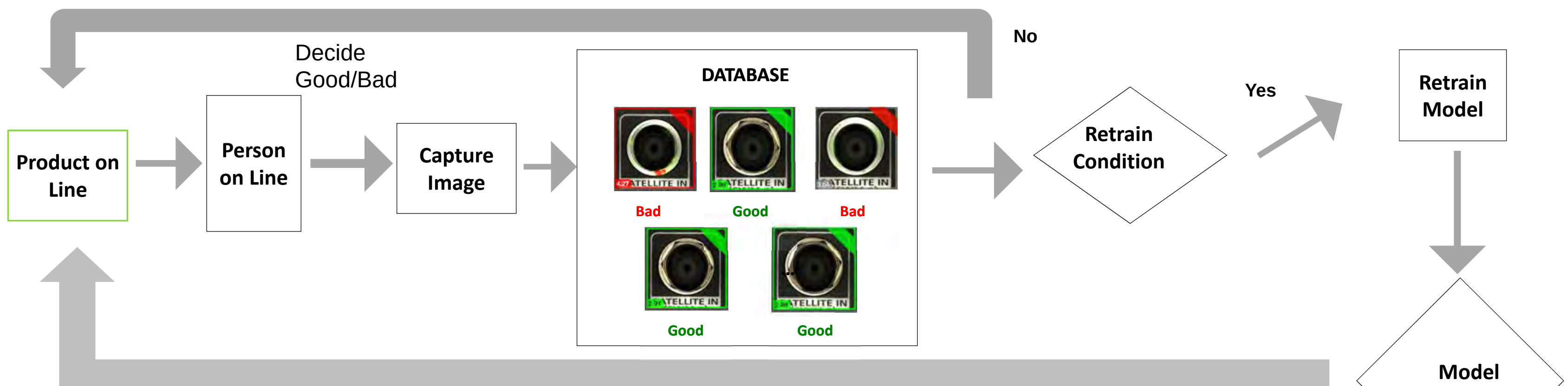

Data Set 1; G 100 B 50

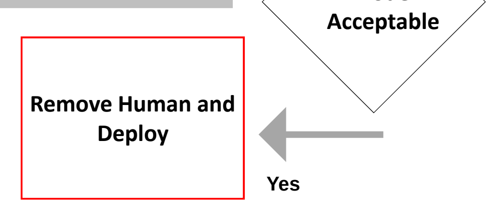

Data Set 1; G 100 B 50


Data Set 1; G 267 B 44


Data Set 1; G 50 B 50


Data Set 1; G 50 B 0





Recommendation of Future Steps

- Test ViDi Red Supervised and compare to Unsupervised
- Test with Jabil's products, or products that more closely simulate the defects Jabil is looking to find
- Implement/Evaluate a custom application using the Training API
- Build an application to simulate training and processing on a production line environment

NABA WIP and Zipper Sewing

Spring 2016 Team: Eric Benaim (IME), Eric Acchitelli (IME), Christopher DiNicola (IME), Ethan Wolf (IME), David Hecht (IME), Jonathan Underwood (MECH), Peter Hudson (MECH), Paul Lentine (MECH)

Background

- Northeast Association of the Blind at Albany (NABA) provides employment and rehabilitative services to visually impaired individuals.

Purpose

- Design, test, and implement a sewing fixture that enables visually impaired employees to attach zippers to vests.
- Improve NABA's workforce to 80% visually impaired employees.
- Make EOY inventory counting process take less time and counting easier.

Semester Objectives

- Zipper
  - Integrate a solution to allow all zipper sewing to be carried out by visually impaired employees.
- WIP
  - Update Bill of Materials
  - Update WIP Inventory Spreadsheets
    - Vest Styles 707,719
    - Neck Tab Styles 1620, 1649, 2215, 8105
  - Create Tally Sheets for Inventory Count
  - Assess Mfg. flow and identify improvement areas

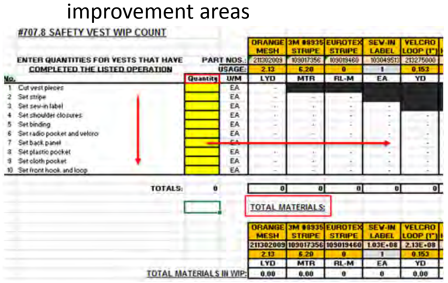
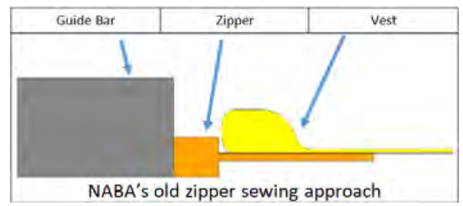


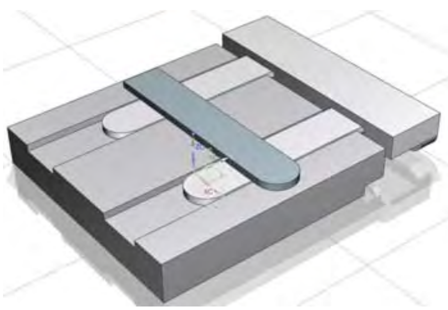
Figure 1: Screenshot of 707 WIP Spreadsheet

Design Requirements	Auto Aligning Design	Carriage Design	Bristle Guide Design
Ease of Use	3	2	3
Simplicity	5	3	3
Consistency	2	4	2
Total	10	9	8

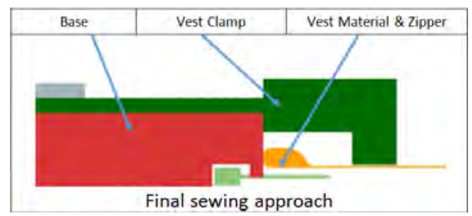
Table 1: Decision matrix for final design.



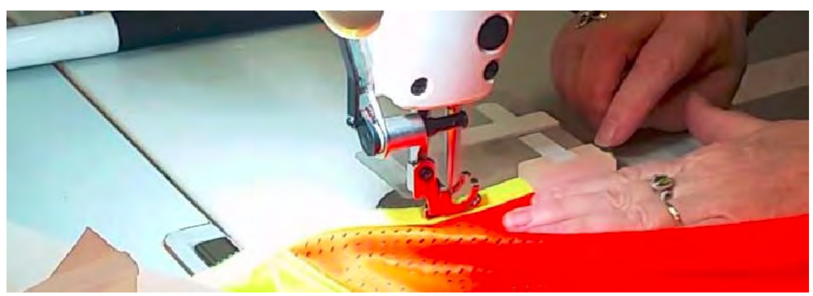
NABA's old zipper sewing approach



Final Guide with long vest clamp



Final sewing approach



Final Guide in use at NABA

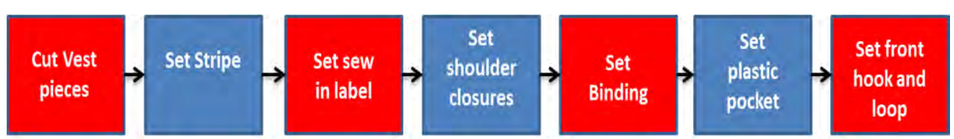


Figure 2: Visual of Vest Workstations, in red, that should have accumulated WIP inventory during EOY count

Technical Approach

- Zipper
  - Design, build, and quantify success for zipper attachment guide.
  - Decision matrices and prototype iteration.
- WIP
  - Verify BOM, test WIP inventory spreadsheets.
  - Reduce number of workstations with accumulated WIP inventory during a count

Accomplishments

- Zipper
  - Final guide implemented at NABA
  - More guides ready to be made as NABA needs
- WIP
  - Spreadsheets for Raw Materials, 707 & 719 Vests and 1620, 1649, 2215 & 8105 Neck Tabs

Recommendations

- Zipper
  - Look for a better way to feed pull tab zipper into guide
  - Use experienced sewers to teach less experienced sewers to use the guide
- WIP
  - Incorporate 5S/Lean Manufacturing principles to better organize bins of WIP goods
  - Count Inventory multiple times a year

Quench Variability

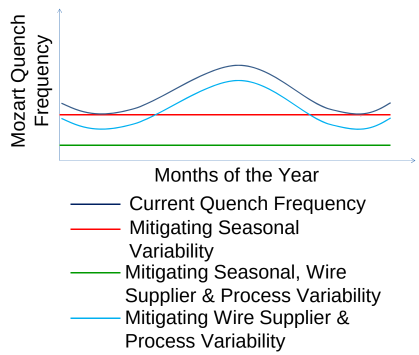
Spring 2016: Adnan Alodaini (ME), Austin Amery (ME), Olaf Bergeson(MTLE), Gregory DiGuido (ME), Shams Khondkar (MTLE/BMED), Colin Krum (ME), Beth Lotterer (MTLE), Nathaniel Miller (ME)

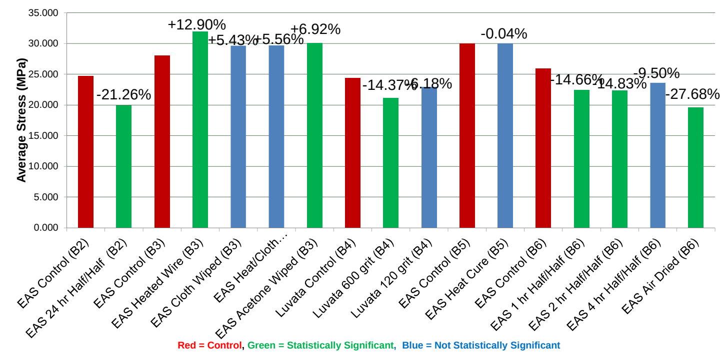
Purpose:

- Evaluate the reason(s) for increased quenching from June to September and provide suggestions/solutions to reduce/eliminate magnet quenching

Background

- MRI Superconducting magnet cooled with liquid helium to 4K
- Quenching is a massive helium boil off
- Caused by small increase in temperature
- Slips in wire-epoxy create frictional heat
- More common during humid summer
- Quenching costs time and money

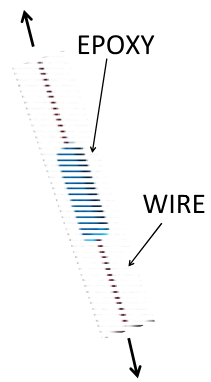




Slip Test Underway

Semester Accomplishments

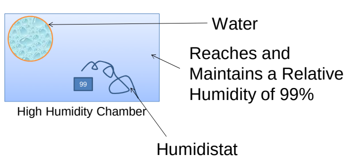
- Statistically supported hypotheses for quench variability
- Determined how the surface finish of the wire correlates to slippage
- Analyzed how environmental humidity affects the wire-to-epoxy bond strength
- Measured moisture build up within the epoxy and test how this affects bonding capabilities

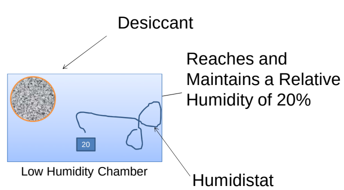


New sample design for Tensile Test

Technical Results

- Humidity is absorbed into epoxy and DMD
- Humidity reduces wire-epoxy bond strength, determined by slip testing
- Wire suppliers have chemically similar surfaces, determined by spectroscopy
- Supplier with roughest wire provided highest bond strength, determined by microscopy





Philips Core During Manufacturing

Recommendations

- Reduce local humidity around cured/curing magnet
- Finish winding magnet in one session
- Switch to wire supplier with roughest surface
- Blow heat on wire to remove adsorbed water

Augmented Reality System

Spring 2016: Michael Albert(CSE), Thomas Eyre(CSE), Dan Foster(EE/CSE), Michael Li(CSE), Jaylen Thompson(EE), Luke Travis(CSE), Yilan Xu(EE/CSE), Zhengjie Zhang(CSE**)**

Purpose

Aid Raytheon technicians in assembly, and repair of circuit card assemblies (CCA's) by providing a system that will track the CCA's, identify and locate any selected parts on the board, and provide instructions for installation of selected part. This will increase efficiency and reduce errors made by technicians, reducing the cost of CCA production

Technical Approach

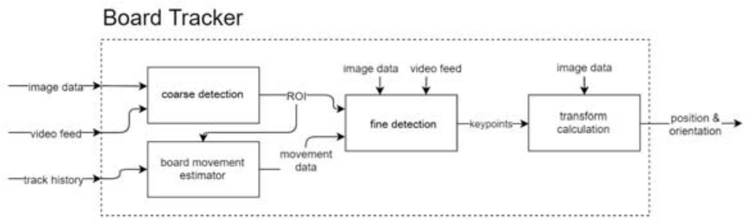


Figure 2: Diagram of implementation of Camshift tracking algorithm

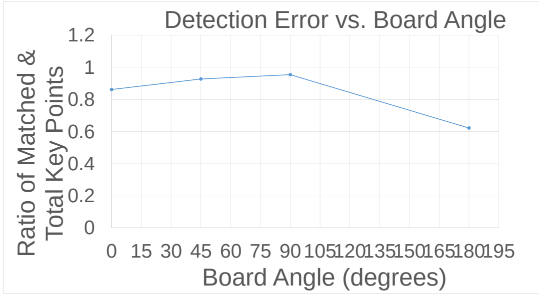


Figure 3: Detection Error Measurements as Performed on Arduino UNO

Current GUI

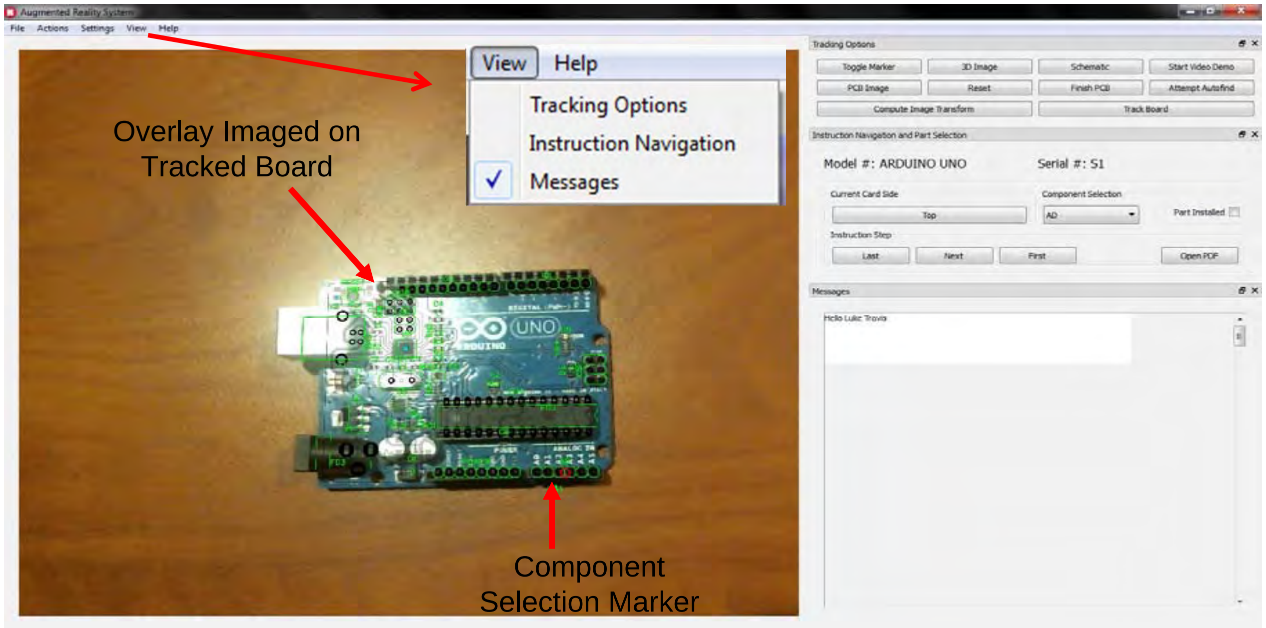


Figure 1: Current Interface layout

Accomplishments

- Updated GUI with resizable, moveable, and dockable tool windows for a more customizable user environment
- Replaced previous fiducial tracking algorithm with a combination of Camshift and feature detection for increased speed, accuracy and versatility
- Developed experiments to perform unit tests on tracking algorithms with minimal outside variability
- Created a new installer program that can install all necessary third party software, a compiled ARS program, and all associated files

Future

- Clean and polish the new GUI features
- Add unit testing for tracking speed and functionality of ARS
- Continued optimization to tracking speed

PRODUCT DEVELOPMENT

THE DESIGN LAB at Rensselaer

Peristaltic Pump

Fall 2015: Danielle Balzano (MECH), Saeed Hakim-Hashemi (MECH), Kori Heisler (MECH),
Zachary Konopaske (MTLE), Andrew Welsh (MECH), Lauren Oesterle (MTLE/BME), Kailei Xu (MTLE)

PerkinElmer For the Better

PURPOSE:

Create a mechanical design to support Perkin Elmer's conceptual plan for extending tube life of a Peristaltic Pump.

SEMESTER OBJECTIVES:

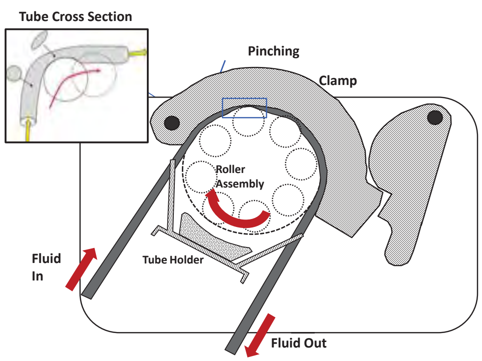
- Design and build a modified peristaltic pump with automated tube rotation during operation

Tube Rotation

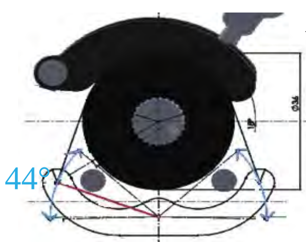
- Determine a viable concept for tube translation using the newest peristaltic pump model

Tube Translation

PERISTALTIC PUMP:



TUBE TRANSLATION CONCEPT:



See-Saw Design Features:

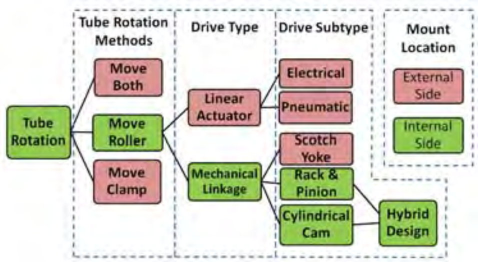
- Tube Travel Distance: **20mm**
- Range of motion: **44° (0.77rad)**
- Required torque of the new motor: **0.34Nm (single tube)**

TUBE ROTATION TECHNICAL APPROACH:

Engineering Requirements:

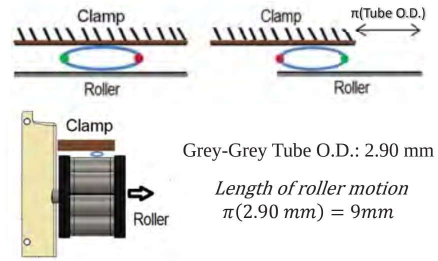
- Size Constraints:
  - X: 185 mm
  - Y: 156 mm
  - Z: 108 mm
- Tube rotation rate
  - No more than 180° tube rotation per hour
- Axial movement
  - Precision: Minimum step size 1mm +/- .5mm
- Prototype Lifetime
  - 6 months

Tube Rotation Concept Designs:



Final Design Down-Select

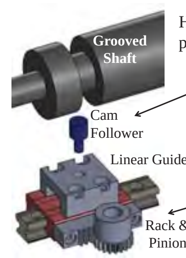
Tube Rotation Distance & Forces:



Grey-Grey Tube O.D.: 2.90 mm

Length of roller motion
$\pi(2.90\ mm) = 9mm$

Tube Rotation Drive System Overview:



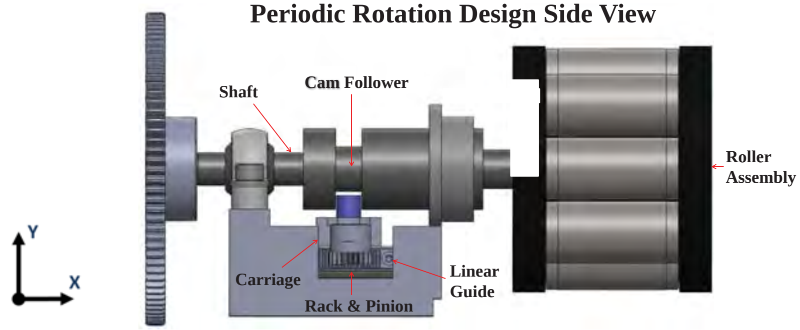
Hybrid approach between rack & pinion and cylindrical cam designs

Cam Follower transfers axial forces to rotating shaft

Linear guide transfers forces from Rack & Pinion to Cam Follower

Rack & Pinion provides independent, highly controllable axial motion

Periodic Rotation Design Side View



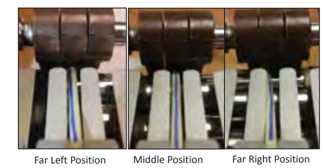
Design Features:

- Compact: Overall length increased by 2cm
- Front end components unchanged
- Adaptable Drive System: Can control distance, speed, position
- Retained existing shaft drive system for rotation

Ease of Manufacturing and Assembly

- 7 additional parts:
  - 4 off the shelf – High Tolerance
  - 3 manufactured – Low Tolerance
- Linearly stacked assembly

RESULTS:



Far Left Position | Middle Position | Far Right Position

- Tube rotated 100° while pumping water
- Rate of axial movement affected rotation

- Conducted a test using blue ink
  - Top picture indicates the control test
  - Bottom picture indicates tube rotation test
- Ink smears around the circumference of the tube indicate tube rolling

FUTURE WORK:

- Conduct tube lifetime testing
- Study the affect of the clamp material and the tube holder configuration on tube rolling
- Create tube translation prototype
- Engage in a manufacturability study

ACCOMPLISHMENTS TO DATE:

- Feasible tube translation concept design was created
- Tube rotation design overcame the challenges of integrating an independent drive system with a rotated shaft in a compact space
- Demonstrated a working prototype that achieved 120° tube rotation
- Adjustable prototype operation can evaluate test parameters for optimization

CHL Applications

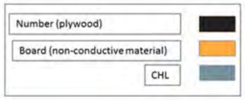
Fall 2015: Loren Cao (MGMT/MECL), Graham Harris (MECH), Tomas Gutierrez (MECL), Maureen Leavy (BME), Nolan Quinn (MECL), Julian Yuen (EE)

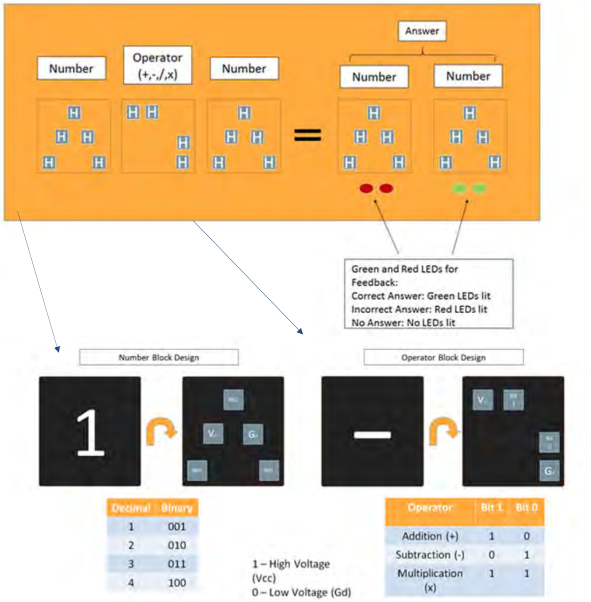
Purpose and Objectives

- Characterize and quantify the dynamic conductive hook and loop electrical and mechanical properties of VELCRO® brand fasteners to determine the potential of the material.
- Goal of this project is to utilize conductive hook and loop as a necessary component in a marketable product to be incorporated in the classroom.

Interactive Board Prototype

- Board utilizing CHL as both an electrical connector and a fastener
- Each connection connects to a Raspberry Pi utilizing digital inputs
- Digital inputs converted to decimal to perform operations
- Demonstrates a promising application of CHL for marketable use

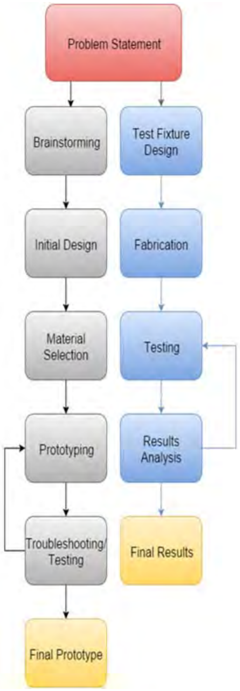




Decimal	Binary
1	001
2	010
3	011
4	100

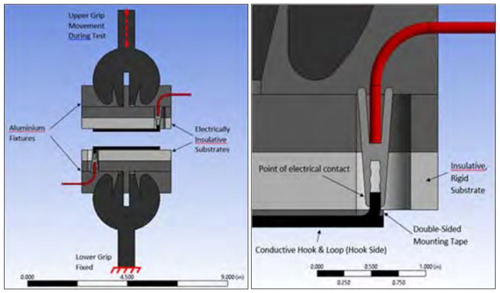
Operator	Bit 1	Bit 0
Addition (+)	1	0
Subtraction (-)	0	1
Multiplication (x)	1	1

Tech Approach

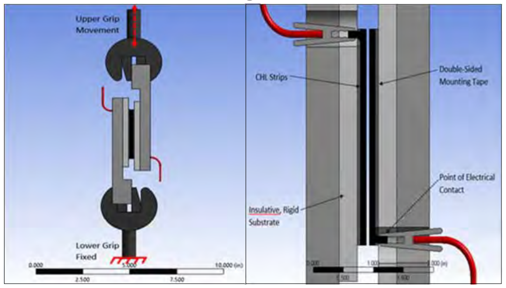


Test Fixtures

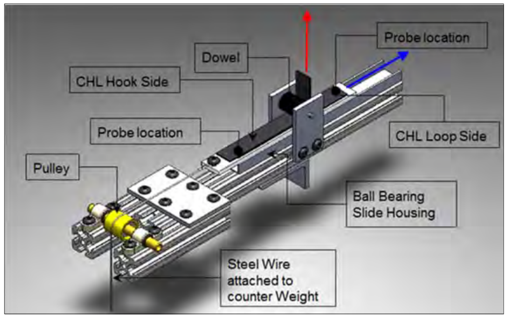
Tension (Normal) Testing Fixture



Shear Testing Fixture



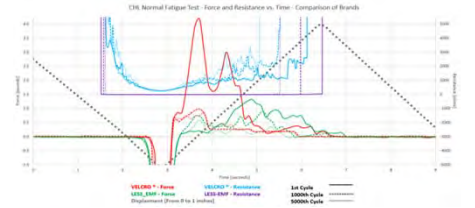
Peel Testing Fixture



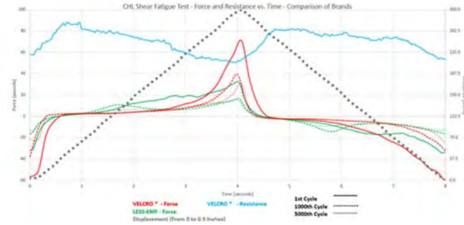
Future Work Suggestions

- Possible Tests: Thermal effects on mechanical testing, higher test count to formulate a standard deviation, maximum allowable current, testing different combinations of hook and loop types, mathematical governance of force and resistance, utilization as a piezoelectrical sensor
- Form a standard of product performance through the utilization of the peel fixture (cycles of usage, durability)

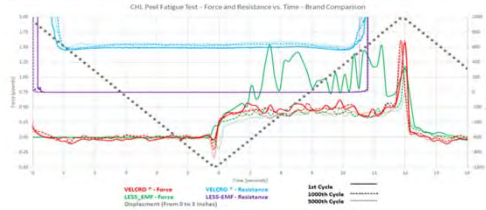
Test Results



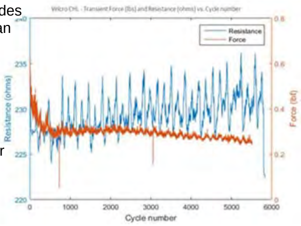
- Carbon Loaded Polymer (VELCRO®) CHL higher in resistance, higher in retention force than silver coated nylon (LESS_EMF) CHL
- Resistance minimum doesn't change, but low resistance retention degrades over cycles



- Carbon Loaded Polymer (VELCRO®) has a smoother shear force profile due to higher rigidity in hooks
- Resistance approaches a minimum when the shear force over CHL interface is at a maximum



- Replicates actual user interaction when and usage cycles
- Carbon Loaded Polymer
- (VELCRO®) CHL degrades mechanically much less than silver coated nylon (LESS-EMF) hooks in peel configuration
- Most retention forces stay above 50% of original value after 5000 cycles
- Carbon Loaded Polymer (VELCRO®) cyclical force averages and resistance relationship maps transient mechanical degradation to resistance increase.



Bath Toy

Spring 2016 Team: Andrew Brumer (MECL), Michael Leszczynski (ISYE), Elliott McFarland (MECL),
Taylor Miller (MECL), Jose Resendiz (MECL), Reid Roberge (MECL), Morgan Schweitzer (MECL), Sierra Weiss (MECL)

Project Purpose

- Create a water-recirculating toy that allows children to safely play with running water
- Toy is self-pumping and provides multiple water outlets, unlike competitors

Past Work

- Patent # 8156578 covers the concept of a recirculating bath toy with interactive features
- Computer models of casing and few interactive accessories

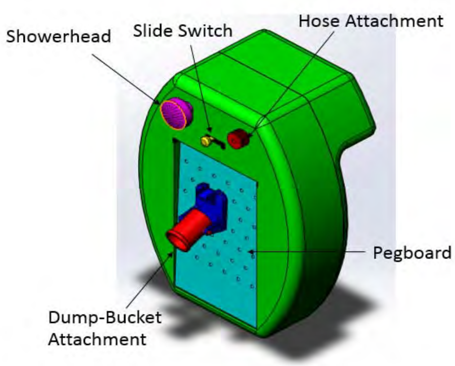


Figure 1 - CAD model of initial concept

System Requirements

- Normal Use and Abuse testing requirements and guidelines in ASTM F963-11
- 3 L/min to 12 L/min of waterfall
- A minimum of 3 interactive features to vary water flow

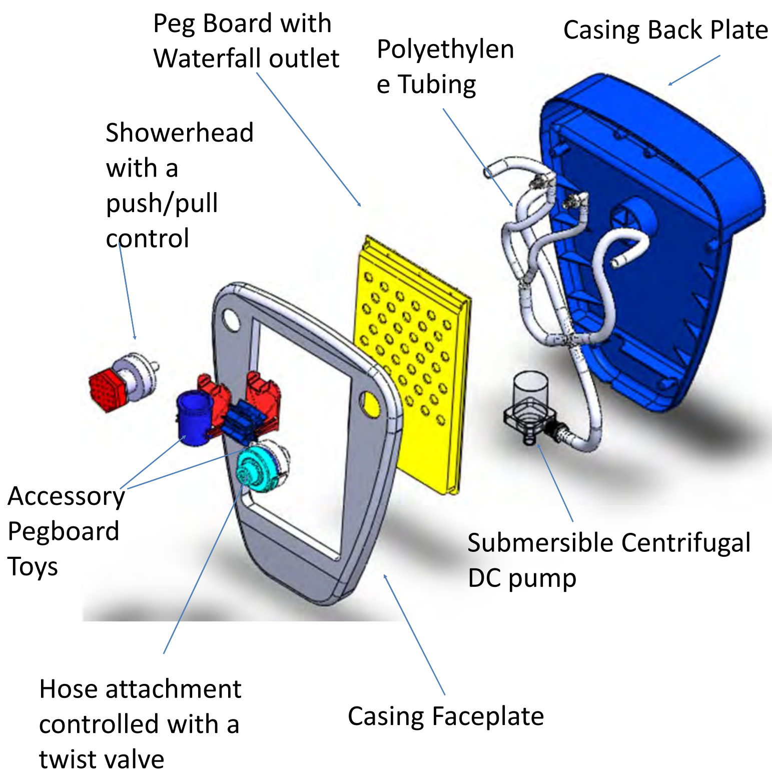


Figure 2. "Bath Toy" Exploded view of final design

Technical Accomplishments

Table 1 – Bath Toy Project Subsystem Accomplishments

Subsystem	Accomplishments
Casing	Modified profile of original design to add structural stability & internal geometries to aid in subsystem waterproofing
Inserts	Integration of functional snapfit to bucket and waterwheel assemblies
Showerhead	1.5 m/s velocity at outlet
Hose	2.5 m/s velocity at outlet
Pegboard/ Waterfall	Eliminated separate waterfall features– lowered PIM cost.
Internals	Final experimental water flow of 66.7ml/s was within the range stipulated by the patent (50-200ml/s)

Future Recommendations

- Change flow rate (1440GPH) to reflect intake from a ½" diameter 25' length garden hose to achieve desired feature effects
- Apply soap to outside surface of pegboard or prepare soapy water to break surface tension of hydrophobic polyethylene
- Apply dental or candle wax to hose and showerhead features to mitigate leaks
- Demonstrate the prototype in three stages: waterfall operational only, showerhead and waterfall operational only and water and hose operational only
- Select an appropriate medium to present the prototype (video vs. physical demonstration)

Design Applications for Light Diffusing Glass Fiber Optics

THE DESIGN LAB at Rensselaer

Spring 2016: Joel Ahearne-Ray (MTLE), Heather Danielsen (MECHE/DIS), Andrew Groskopf (EE/CSE), William Howard (MTLE), Levi Kennedy (MECHE), Jacob Morales (MTLE), Elena Steffan (MECHE/DIS), Juancarlos Vivar (MECHE),

fioluminescence weaving light into the world

CORNING

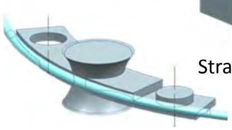
Purpose

To increase the customer base of Fibrance™ (Light Diffusing Fiber) for Corning, through applications in the automotive and architectural industries.

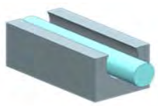
Project History

The Fall 2015 Fibrance™ Team:

- Developed a catalog of potential applications
- Investigated Fibrance™ applications in automotive and architectural markets
    - Wall decorating
    - Semi-Trailer Advertisement
    - Tabletop Decoration
    - Crosswalk Lighting
    - Foot Well Lighting
    - Chandelier
- Prototyped a laser control unit and an application deployment tool
- Designed components for mounting and researched methods of adherence



Curved Mounting Solution



Straight Mounting Solution

Hot Glue Deployment Tool

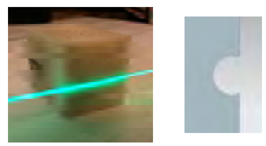
Semester Objectives

Develop Enabling Technologies

- Low cost, end of fiber reflector to achieve uniform light distribution throughout length: efficiency > 50%
- Practical mounting solutions to aid in Fibrance™ installation within architectural applications

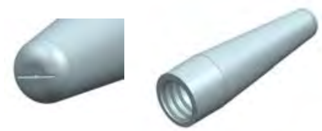
Mounting Solutions

Hook & Rail



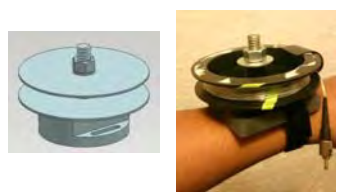
Pressure fitted shape with .030in diameter to hold Fibrance™ in place with friction

Applicator Tip



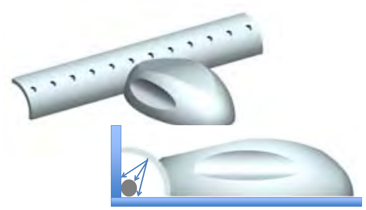
Attaches to tip of adhesive bottle to distributes glue evenly behind the Fibrance ™ in contact with the surface

Spool



Deployment device that attaches to arm to install Fibrance™ in a user-friendly manner

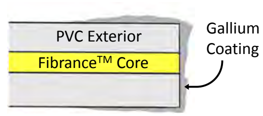
UV Curing



Ergonomic handheld device to cure Bondic™ to desired surfaces

Reflectivity Solutions

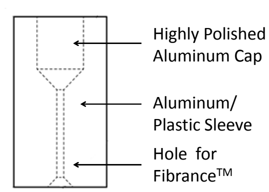
Gallium



Gallium Solidification Times

	Room Temp (22 °C)	Cool Tap Water (12 °C)
Solidification Time	>30 Minutes	1-2 Minutes

Reflective Sleeve



End of Fibrance™ lays flush against reflective cap

Mounting Testing Results

Adhesives

Shear and tensile strength tests on adhesive and material combinations:

- painted drywall, wood, vinyl plastic, and steel
- Super Glue, Epoxy, and UV Curing

Adhesive Testing Setup

Hook & Rail

Testing Plastic Coverings

Hook Corner Testing

Prototyped hooks to test the fit with Fibrance™. Learned that the Fibrance™ will require an adhesive to hold it in place based on the tolerances and compliance of both the fiber and hooks.

UV Curing

Tested for full curing of 12 LEDs, 30° viewing angle, spaced 0.609in at a velocity of 1.8 in/s

Reflectivity Testing Results

Gallium

30-53% Reflectivity

Reflective Sleeve

20-33% Reflectivity

Used a photoresistor to measure the light along the length of Fibrance™. Took multiple measurements at 6 inch intervals, averaged, and then graphed the results.

Wearable Technology for Pulse Rate Monitoring

Spring 2016 Team: Shane Conaboy (EE/CSE), Bingqian Dai (EE), Shuang Feng (EE/ME), Ato Fynn (EE), Ryan Gagnon (CSE), Gregory Herman (EE/CSE), Daniel Kloss (ME), Matthew Senneca (EE)

PURPOSE

Develop a reference architecture and prototype for a wearable heart rate detection device and prove that the PSoC4 BLE can successfully detect heart rate under real world conditions.

CURRENT SEMESTER OBJECTIVES

1. Design and implement a PPG signal filtering circuit to maximize the SNR
2. Develop a robust heart rate detection algorithm that functions with low SNR's
3. Creation of reference architecture and final prototype for the PSoC 4 BLE.

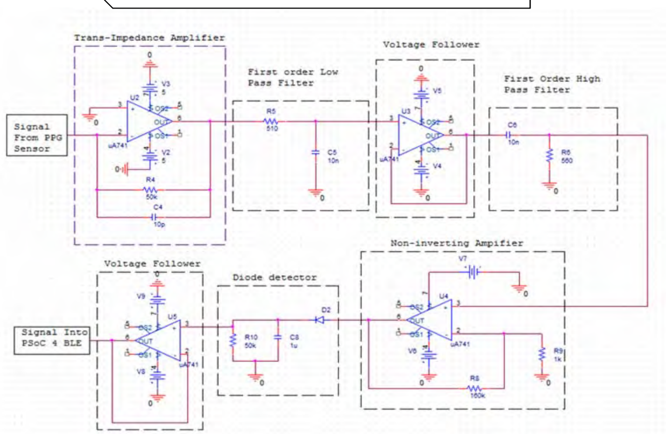
TECHNICAL RESULTS

- Design and test results of signal filtering circuit
- Algorithm design, simulations, and PSoC 5LP & 4 BLE testing with desired BPM output
- PSoC 5LP prototype

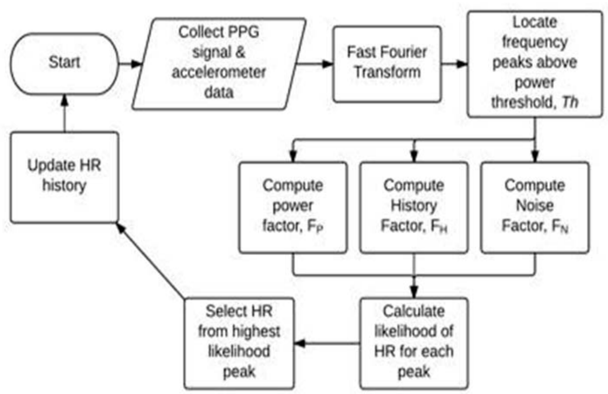
NEXT STEPS

- Continue filtering circuit tests to improve SNR
- Improve algorithm
- Finalize PSoC 4 BLE prototype
- Implement digital filtering

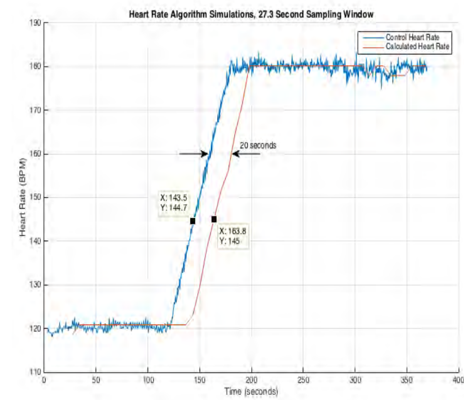
SIGNAL FILTERING CIRCUIT



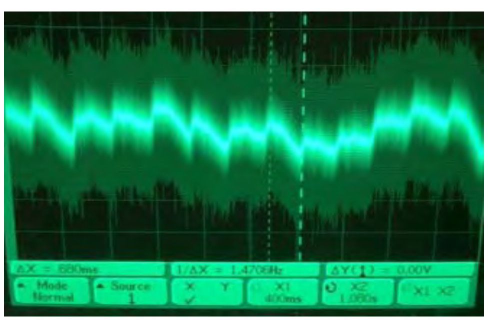
ALGORITHM FLOW DIAGRAM



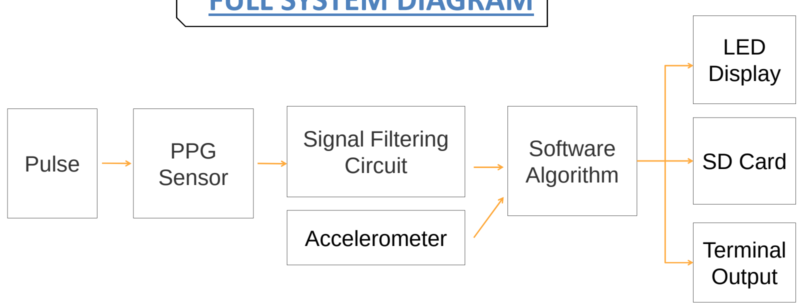
MATLAB SIMULATION OUTPUT



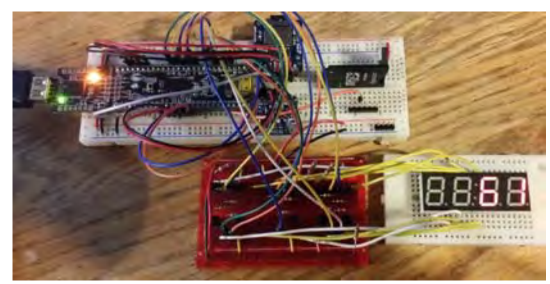
FILTERING CIRCUIT OUTPUT SIGNAL



FULL SYSTEM DIAGRAM



PSOC 5LP PROTOTYPE



CubeSat SADA Module (2)

Spring 2016 Team: Arnold Ahnood (EE/CSE), Alexander Buchholz (EE/CSE), Dylan Carberry (ME), Brandon Chun (ME), Niyati Desai (EE), Kevin Doremus (EE/CSE), WeiXuan Lai (ME), Christine Marini (ME)

Background Information

- CubeSats are compact satellites
  - Small size, low weight, lower launch costs, cheaper and faster development
  - 1U = 10 cm x 10 cm x 10 cm
- Solar Array Drive Assembly (SADA) is an option to maximize power generation for CubeSat

Purpose

- Design a SADA module using COTS components to NASA TRL 3:
  - A. Space-grade paper design
  - B. Prototype that demonstrates:
    1. Specified panel rotational speeds
    2. Sun and/or light tracking capabilities
- Allow for maximum power generation for CubeSat

Figure 1: Deployed SADA [IPSPT 2014]

Design Requirements

- Device mass: ≤ 1 kg
- Device Size: ≤ 1/4U (10 cm x 10 cm x 2.5 cm)
- Maximum total mass of solar panels: 3 kg
- Pointing Accuracy: ≤ 0.0175 radians (1°)
- Panels have continuous rotation about 1 axis
- Rotational Speed: Between 3.6×10^{-5} and 2.4×10^{-3} rad/s

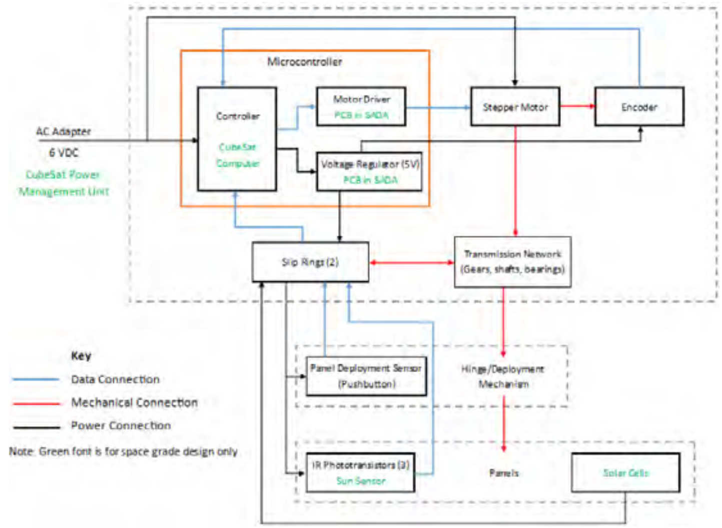


Figure 2: Device Overview Flowchart

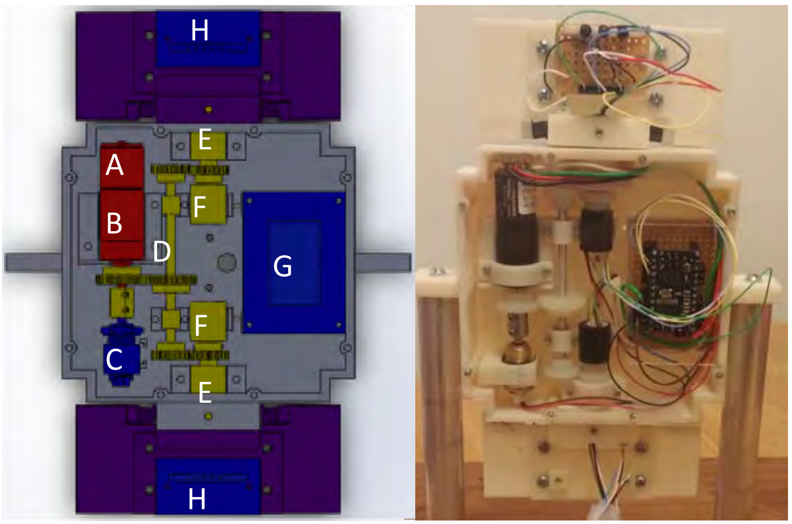


Figure 3: CAD Assembly (Left) and Assembled Prototype (Right)

Subsystems

- Motor/Gearhead **(Red)**
- Transmission (Yellow)
- Control **(Blue)**
- Chassis (Gray)
- Hinge/Deployment Mechanism **(Purple)**

Note: Colors correspond to Figure 3 – CAD Assembly

Testing/Simulations

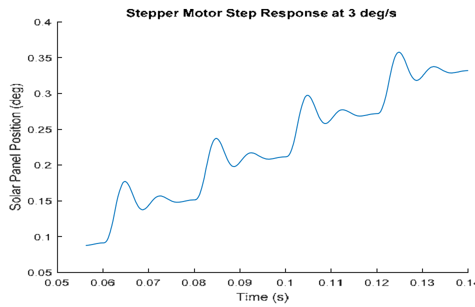


Table 1: Prototype and Space-Grade Parts/Materials Selection

Component	Prototype	Space Grade
Motor (A)	Micromo AM124 Stepper Motor	Micromo AM124 Stepper Motor
Gearhead (B)	Micromo 15A Planetary Gearhead	Micromo 15/10 Planetary Gearhead
Encoder (C)	US Digital MA3 Encoder	N/A
Primary Shaft (D)	6061 Al	6061 Al
Secondary Shaft (E)	Steel	6061 Al
Gears	Nylon	Bulk Metallic Glass
Sleeve Bearings	PTFE/Rulon J	PTFE
Slip Rings (F)	Adafruit (Prosper)	Electro-Miniatures or Cobham Aeroflex
Microcontroller/ Motor Driver (G)	Polulu B-328	CubeSat Controller/ International Rectifier RH Motor Control Module
IR Sensors (H)	LTR-4206E	N/A

Battle Control System

Spring 2016 Team: Daniel Baek (CSE), Hamilton Carpenter (CSE), Forest Crossman (EE), Alessandro Galli(CSE), Cyril George (EE/CSE), Abigail Gillett (EE), Nayo Ogilvie (EE/CSE), AJ Tate (EE), Mason Watts (EE/CSE)

Purpose

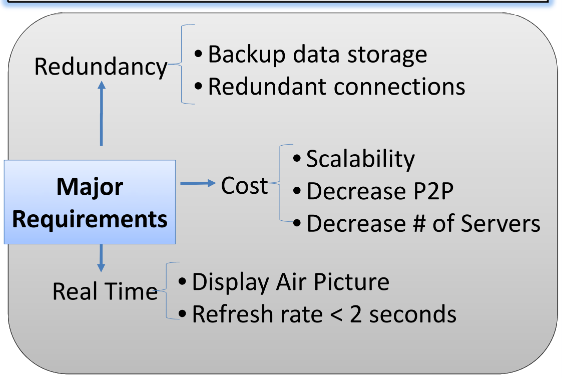
Design, build, and test an updated version of the North American Aerospace Defense Command's Remote Tactical Air Picture (RTAP). This system is used to monitor the airspace of the US and Canada. The existing system was built as a proof of concept and has high costs associated with adding new sites to its network.

Project History

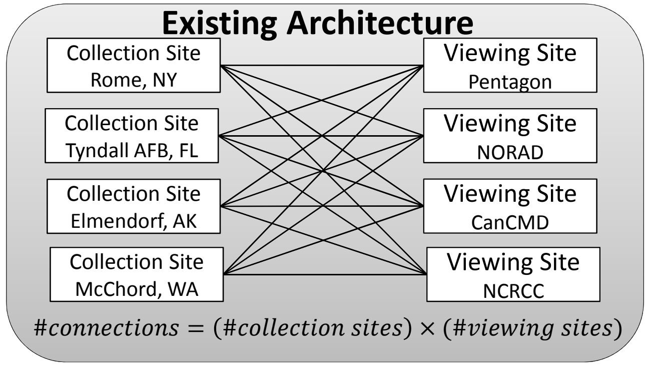
- NORAD has monitored US airspace since 1958 using various monitoring systems
- Existing system developed by Thales-Raytheon
- Current iteration finished in 2011

Semester Objectives

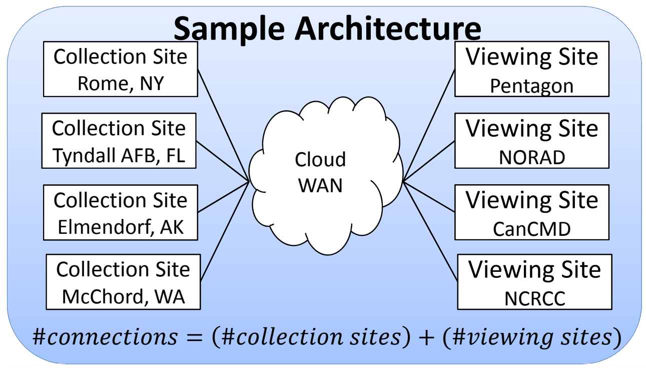
- Document and define System Requirements and system Use Cases
- Evaluate modern networking technologies to determine which may be valuable to the RTAP
- Implement software to demonstrate a working transfer of aircraft data and display a mock UI
- Write documentation for use of demo system



Existing Architecture



Sample Architecture



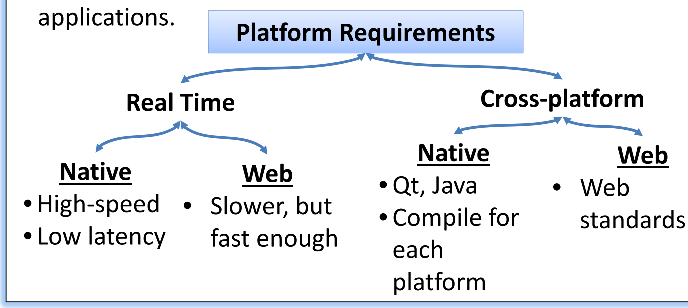
Networking Technologies

- OSI Model Layers 1-4 technologies were researched and analyzed based on System Requirements
- Coax and Fiber based transmission lines
- Cloud-based technologies: Multiprotocol Label Switching (MPLS) and Carrier Ethernet (CE)
- Standard Internet Protocols: User Datagram Protocol (UDP) and Transmission Control Protocol (TCP)

Layer 1	Coax	Fiber	
Layer 2	MPLS	CE	ATM
Layer 3			
Layer 4	UDP or TCP		

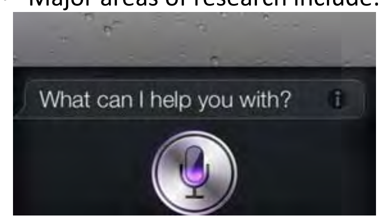
Platform Technologies

- The RTAP client application will need to run on Desktop and Mobile platforms.
- To fulfil this and other requirements, we have determined two possible solutions: Native applications and Web applications.



Workstation Enhancement

- Improving the user's workstation could help them complete their mission more effectively
- Major areas of research include:



Voice Recognition Software

Virtual Reality

onlinemarketinginct.com/wp-content/uploads/2015/07/Siri-Search1.jpg
d3nevzfk7ii3be.cloudfront.net/igi/in1WqvSDlbQLvTiM.medium

Project Future

- Further research into implementation/purchase of the investigated networking solutions
- User driven UI system design and implementation
- Creation of RTAP software based on the ideas and requirements recorded during this semester

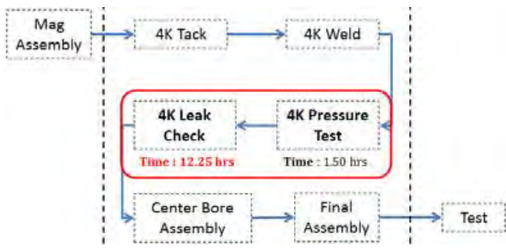
Reliability & Test Systems

Pressure Test & Leak Check

Fall 2015: Teo Camadella (ME), Tyler Cassidy (IME), David Dunalewicz (ME), Timothy Piette (MTLE), Connor Rhoads (ME), Patrick Strohbeen (MTLE), Elizabeth Wayne (ESCI/BMGT), Jonghyuk Yoon (ME)

Purpose: Design and deliver a streamlined and repeatable process that will reduce overall lead time variability across the 4K area: 4K Pressure Test (4KP), 4K Leak Check (4KL)

4K Magnet



Semester Objectives

Assess current equipment and methods during 4K test operations

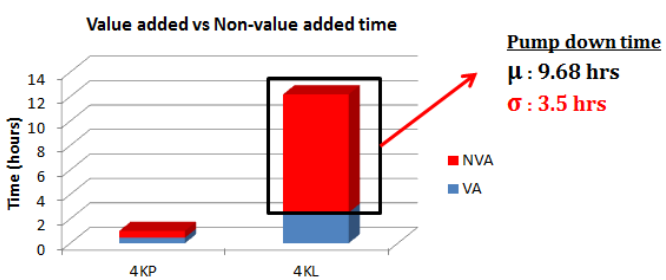
- Suggest equipment upgrades and process configurations
- Integrate 4K Pressure Test and 4K Leak Check stations

4KP Purpose:

- Structural integrity of magnet
- Detect gross leaks (> .1 mbar*L/s)

4KL Purpose:

- Structural integrity of magnet
- Detect smaller leaks (> 5 x 10^{-6})



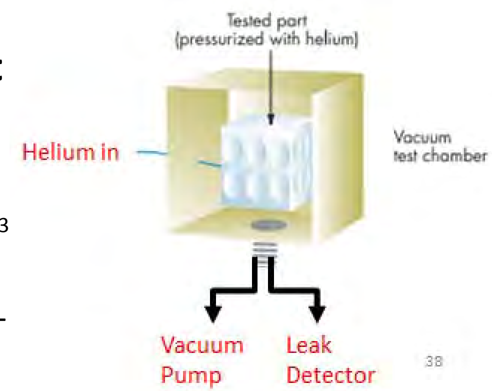
Current setup - Outside in

- Pump vessel down to 10^{-3} mbar – Vessel in helium rich environment
- Detect helium leaking into magnet
- Proposed upgrades with their respective time savings per magnet:

	Current	Plumbing Adjustment	Blower pump	Turbomolecular Pump + Plumbing Adjustment	Upgraded roots pump + Turbomolecular pump + Plumbing Adjustment
Total Time (hrs)	5.16	2.41	2.24	2.20	**0.97**
Time Reduction (hrs)	-	2.75	2.92	2.96	**4.19**

Future setup - Inside-out

- Simulate actual operating conditions of magnet
- Faster pump down time
  - Pump to 5 mbar vs. 10^{-3} mbar
- Ability to integrate 4KP and 4KL



System	Pump down time / magnet	Time savings / magnet	% time reduction / magnet	Total cost
Outside In[1]	0.97 hours	4.19 hours	81.2%	$135,300 - BP $146,290 - TP
Inside-Out	0.10 hours	5.06 hours	98%	$330,250

GE Sensor Kit

Spring 2016 Team: Abdul Fattah Mohamad Zaki (ECSE), Benjamin Roy (MECL), Christopher Ngai (ECSE), Joseph Morin (MECL), Kevin Shin (MECL), Marin Tudor (MECL), Simon Ohanian (MECL)

Purpose: Wind turbines contain several major mechanical components that experience displacement and rotation with respect to the bedplate. To improve current wind turbine designs, the motion of these components will be measured and recorded by a sensor kit, and the data will be received by GE.

Past Work/Project History:

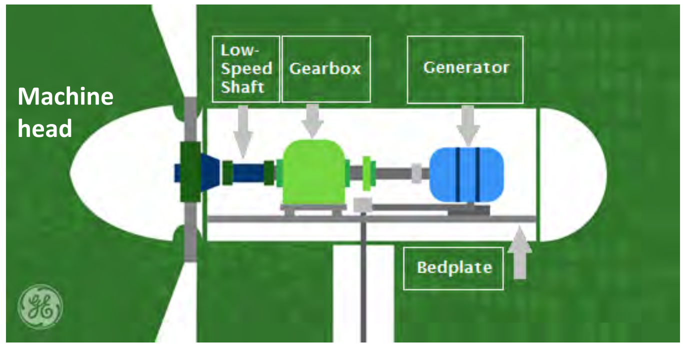
- Implementation of new trilateration algorithm
- Fabrication of string pot box enclosure (Figure 1)
- Initial trilateration qualification testing
  - x Missed some accuracy specs.
  - x Mechanical crosstalk implicated
- Initial system qualification
  - ✓ Translation axis
  - ✓ 1 pseudo rotation axis
- Software, DAQ and Signal conditioning

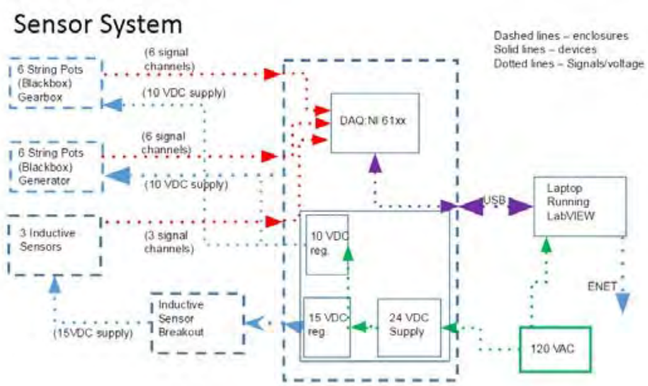
Semester Objectives

- Complete qualification testing
- Correct errors in trilateration
- Improved mounting plan for generator box and inductive sensors
- Create more compact design
- Deliver prototype to GE for field testing

Packaging

Package number	Package 1	Package 2	Package 3
Contents	• String pot box • Laptop • Laptop power cable	• Nema enclosure • DAQ	• Break out box • Inductive sensors • Brackets • Drill template • Adjustable Wrench • 5/32" Hex Wrench • 1 ¼" Hole Cutter
Recommended case	Pelican 1610	Pelican 1560	Pelican 1600



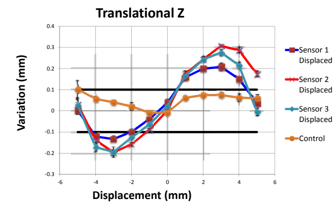


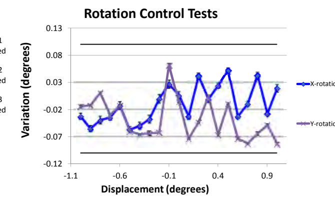
Generator Installation & Mounting

- New mounting method proposed combining quick-tight buckle straps and custom spacer frame.
- Generator testing rig designed and fabricated for test installation.
- Results of test installation show validity to proposed mounting plan.
  - Solutions to potential issues generated and proposed.

Low Speed Shaft Monitoring

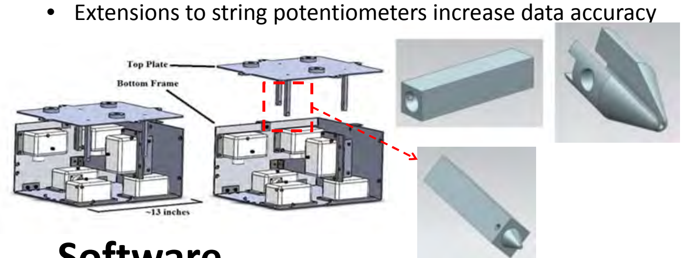
- Completed qualification testing
  - Rotational testing meets specifications
  - Translational testing meets specs provided accurate placement of the sensors.





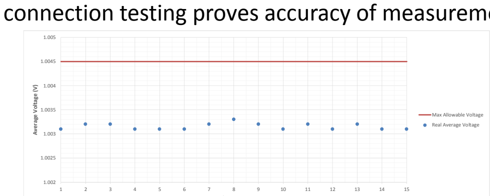
String Pot Box

- Magnets recessed, spacers and Velcro straps improve mounting design
- New post designs correct error in trilateration, pot strings terminate at single point.
- Extensions to string potentiometers increase data accuracy



Software

- Bugs and errors within LABVIEW code corrected.
- Software unit testing proves sensors perform with correctly. DAQ connection testing proves accuracy of measurements.



Strength of Materials Mini Lab

Spring 2016 Team: Richard Allard (ME), Donna Creighton (ME), Caleb Dieterle (ME), Tim Gibbons (ME), Kimberly Gomez (ME), Mark Grimes (ME), Alexander Malin (ME), Cecelia Muller (ME), Imannul Hakim Mohamad Zaini (ME)

Purpose

To develop a laboratory apparatus that will supplement the Strengths of Materials course by utilizing a physical model as well as a graphical user interface to teach deflection, shear forces, and bending moments to RPI engineering students.

Customer Requirements & Engineering Specifications

- Beam can create visible deflection up to 20 mm
- Capable of fitting in a backpack
- Overall weight less than 33 pounds
- Distributed load across entire beam
- Moveable supports in fixed positions every 2.5cm
- Different support types (simple & fixed)
- Interchangeable beams with different EI values
- Sensors: forces, displacement
- Arbitrary point loads
- Computer interface and simulation

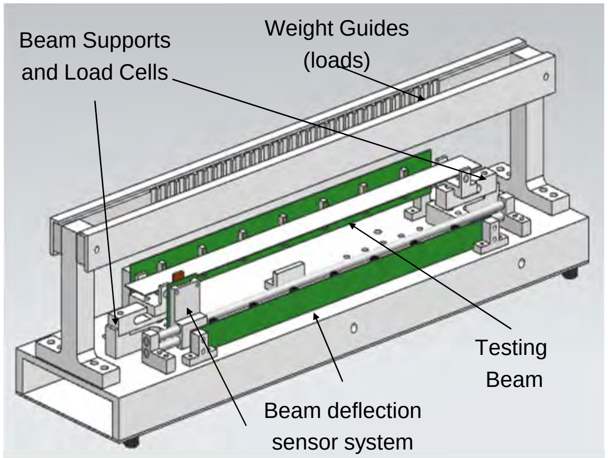
Semester Objectives & Requirements

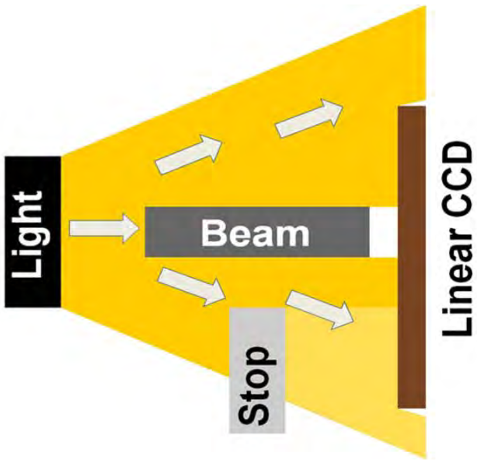
Mechanical design

- Create point loads and distributed loads
- Implement a moveable support system
- Create interchangeable loading beams
- New frame design to support data acquisition

Data acquisition

- Implement electronic deflection sensor
- Integrate load cells into beam supports to determine reaction forces
- Sensors for determining presence and magnitude of loads
- Manage all sensors and communicate data to user's computer with data acquisition system

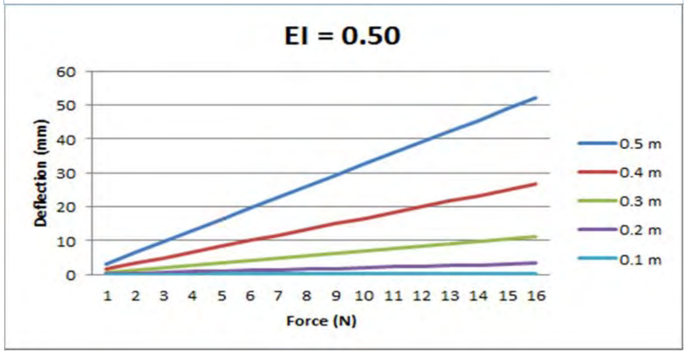




Deflection Sensor Concept

Technical Results & Accomplishments to Date

- Beam bending analysis
- Point & Distributed Loads
- Electronic deflection sensing
- Labview integration
- Frame concept
- Sensor data interpretation



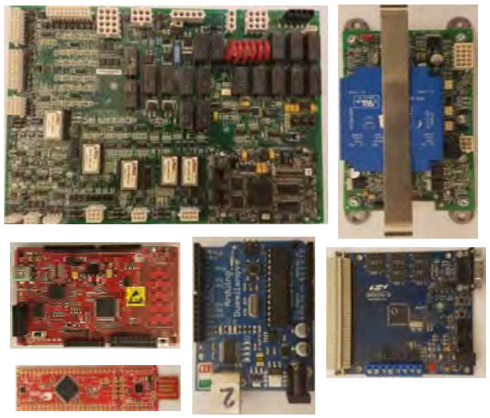
*Targeted deflection range of 1 to 20 mm highlighted in orange; Calculations done for EI from 0.25 to 1 to determine 0.33m as concept length, but 0.5 GPa*m^4 is shown on this graph*

Technical Approach & Plan

- Finalize designs
- Fabricate Parts
- Assemble initial prototype
- Integrate data acquisition system to mechanical model
- Revise initial prototype and data acquisition system
- Classroom testing

GE Smartphones Application

Spring 2016 Team: Daniel Fitzgerald (CSE), Matthew Holmes(CSE & CS), Charles Khachian (EE & App PHYS), Calvin Mangus (EE & CSE), Ian Marshall (EE & CSE), Renjie Xie (CSE & CS), Yiwen Zhang (EE & CSE)



6 Example Parts Used For The Project

Problem

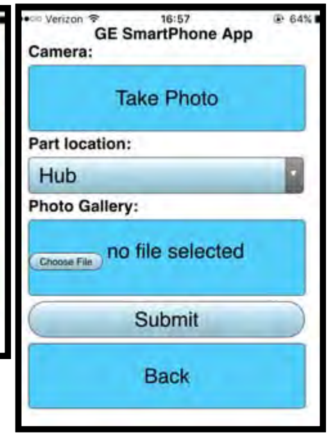
- GE Field Technicians need an easier way to identify parts found in wind turbine nacelles in order to ensure proper maintenance.

Purpose

- To develop a part identification system to be transferred to GE. Payoff is increased productivity of field engineers when maintaining wind turbines around the world.

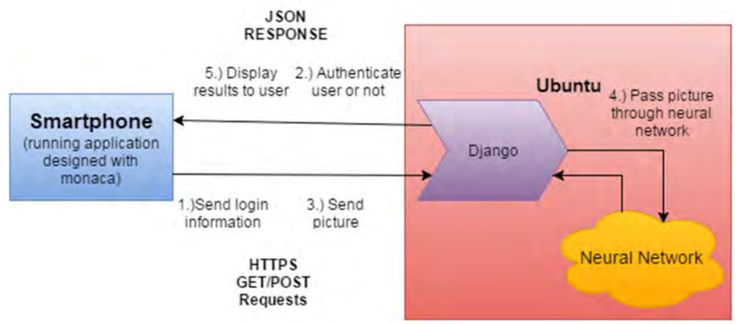
Past Work

- The Fall 2015 team prototyped five separate productivity apps. One of them was the Circuit Board Identifier application. The goal will be to transform this into a more general Part Identification system.
- Caffe implemented a demo on their website that identifies a picture of an animal from 999 different animal classes.



Smart Phone Application's User Interface

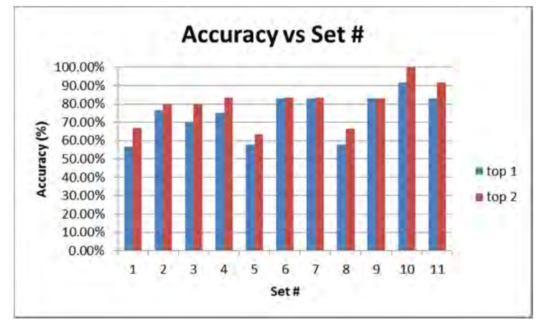
Technical Approach



- Use Monaca for cross platform application development; deployable to both iOS and Android.
- Develop a Django server that uses a neural network to analyze an image provided by the smartphone application.
- Create small sample training sets to test neural network capabilities
- Validate training sets based on analysis, with a target of over 90% accuracy
- Implement a neural network framework based off of initial analysis.

Semester Accomplishments

- Designed and produced a prototype system that can identify a part
- Developed and designed a RESTful server
  - Integrated with Neural Network
  - Validates user credentials
- Researched and tested the viability of using neural networks for identifying images
- Created more accurate training sets based off of initial training set analysis
- Achieved a part identification accuracy of 92%



Future Improvements

- Add additional images to each class
- Add additional classes
- Test additional data augmentation
  - Color jitter
  - Incomplete/Random cropping
  - Brightness
  - Process testing images similarly to training images
- Incorporate image pre-processing to end-to-end loop

Improved Hook and Loop Test Method

THE DESIGN LAB at Rensselaer

Spring 2016 Team: Elizabeth Gigandet (MECL), Mohd Arif Iza Mohd Shahrin Iza (MECL), Philip Lanieri III (MGTE), Hanna Lauterbach (MECL), Eric Morina (MECL), Ari Munic (MECL/PDI), Cesar Nunes (MATL), Bryant Rosato (MECL), Kevin Tucker (MECL)

VELCRO®

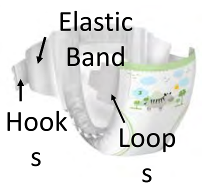
Purpose

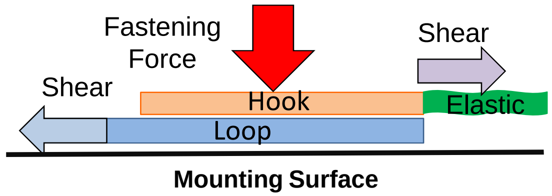
Develop test method to accurately predict performance of Velcro hook and loop fasteners in diapers

Semester Objectives

- Write test procedure for measuring peel and shear forces to simulate real world conditions of Velcro's hook and loop fasteners on baby diapers
- Design and build test fixture to measure peel and shear forces under varying elastic pre-loads on a surface that simulates the geometry and compliance of a baby's body

Problem Identification





Current Method	Diaper Fasteners	In Reality
• No shear force applied during fastening force • Mounting surface is a flat hard surface	• Velcro hooks attached to elastic band • Hooks stretch over baby's belly and attach to loops	• Shear pre-load resulting from elastic • Fastened on compliant and curved surface, not on flat hard surface

Project Approach

Problem Identification
- Characterize fastener behavior in diapers

Quantify Parameters
- Shape and properties of infant's waist
- Determine spring constant of elastic diaper band

Develop Test Platform
- Design fixture for peel and shear testing
- Develop test procedure using new fixture

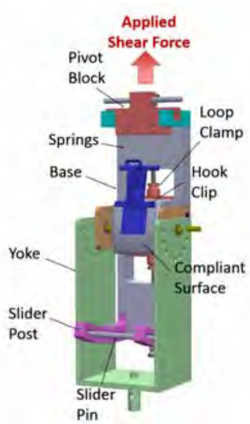
Verify and Compare Results
- Perform gage R&R study
- Gather data with new test fixture
- Compare results to existing tests

Design Requirements

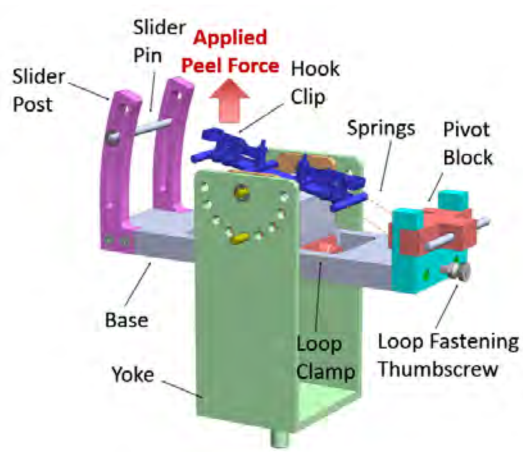
- Pre-loading system spring constant
  - 1.2 lbf/in
  - Determined from Load vs. Stretch tests of elastic waistband

- Testing surface Shore A hardness
  - 5A – 10A
  - Determined from durometer testing of team members' bodies
- Testing surface geometry
  - anatomically correct for baby in Size 3 diapers
- Normal mating force
  - 1.5 – 2 lbf
  - Determined from measuring force on scale when fastening diaper
- Fixture positions
  - 0➡ - 90➡ in 22.5➡ incrementS

Final Solution

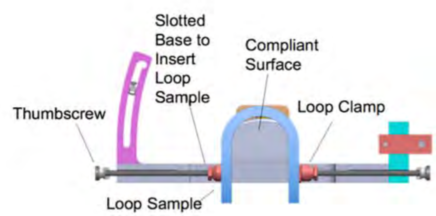


Fixture in Shear Mode

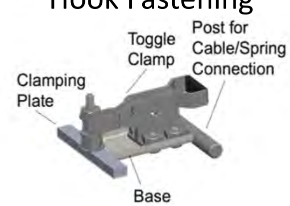


Fixture in Peel Mode

Loop Fastening



Hook Fastening



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