Force-Based Myoelectric Prosthesis Controller

Vanderbilt University

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Executive Summary

An adaptation is required for current myoelectric prostheses to allow for biomimetic muscle control of hand posture. Current systems allow for hand motion to fixate at the point when muscle activation ceases, rather than requiring continual muscle activation to maintain hand posture. To allow for more biomimetic control, a force-based controller is being created that can adapt these velocity-based systems and force a different course of feedback within the prosthetic hardware. This design is being incorporated into a cutting edge prosthesis system currently involved in in-home trials that restores neural-sensory feedback to amputees, but is not currently in the commercial space. Therefore, the novelty of the work described below will be maintained within the larger scope of this prosthesis development. The designed controller will be a universal and adaptable addition to myoelectric prostheses that will allow for amputees to obtain realistic hand function and motor control. This system is currently in development with defined hardware and algorithm relationships that will shape all design aspects moving forward. Using literature regarding algorithm development, mentorship from an advising team at Case Western Reserve University, and resources at Vanderbilt University we are confident that we can fabricate, test, and validate this controller. Myoelectric prostheses are not considered medically necessary, as there are options for prosthetics that do not restore sensory feedback and motor control to the patient. This will have to be kept in mind as the design process continues as cost effective materials and minimized hardware requirements will have to be incorporated for potential product market development. With the FDA classifying powered prosthetics as Class I devices, no premarket approval process is anticipated. This will increase the speed at which this

device could reach the 25,000 arm amputees in the U.S. (with the projected market size for myoelectric prosthetic arms being $276.9 million by 2025).

Description of the Problem

Widespread dissatisfaction can be observed among users of current commercially available myoelectric prostheses due to a lack of fine motor control and sensory feedback. These factors lead to a sense of disembodiment between the amputee and their prosthesis and often results in abandonment of the prosthesis. A team of researchers at Case Western Reserve University and Louis Stokes Cleveland VA Medical Center created a solution to this prevalent problem by successfully designing a prosthetic-integrated sensory system to restore natural neural feedback systems. This solution is currently transitioning to in-home experimentation.

Fine motor control is central to these in-home studies, and a prosthesis with a control system that replicates intact musculature is warranted. Current myoelectric prostheses operate on a velocity based system where hand posture is maintained by the cessation of active motor drive, which does not replicate the natural musculature control system. Because of this, velocity based commercially available myoelectric prostheses cannot be used as a fully accurate comparison for motor control functionality of these systems and a more biomimetic control system is needed.

Objective Statement

As stated above, the feedback system that currently exists between muscle contraction and the activation of a myoelectric prosthesis requires manipulation. The proposed design will allow for the control of any pre-existing myoelectric prosthesis to be converted into a force-based feedback loop where realistic muscle activation allows for biomimetic hand posturing and grip. By creating a force-based controller for myoelectric prostheses, several

different current prostheses shortfalls will be overcome. First, the natural muscle activation that is required for hand posture manipulation will be utilized for all hand positioning allowing its natural function to be maintained within amputees. Second, the force of contraction will be controlled by the user through continual muscle activation limiting unnecessary or excessive hand contraction during object manipulation.

Potential Market

The primary customers and end users of this device would be hand and arm amputees (at or below the elbow). Currently, there are approximately 2 million amputees in the U.S., with around 500 amputations occurring each day. Based on data from 2016, the powered prosthetic market size is about $760.9 million dollars and is predicted to grow to $839.2 million by 2025. Of this market, about 33% is for upper body prosthetics [6]. This could yield a $276.9 million dollar market for our force-based myoelectric prosthesis. As of 2014, there were around 25,000 arm amputees in the U.S., many of whom would could qualify as potential customers [7].

Myoelectric prostheses vary in cost, and can range from $9,000 to $40,000. Many advancements are being made in 3D printing and alternative, low-cost fabrication methods, so we could anticipate the price lowering [8]. Cost can be a major barrier to entry for many users. Since many amputees can still carry out the majority of necessary daily activities with their intact limb, they often desire prosthetics for aesthetic and cosmetic purposes, rather than for their biomimicry and functionality [8].

Based on the cost of materials for this product so far, we could imagine the entire artificial limb with our adaptor costing around $35,000/unit. Primary distribution channels would include medical device retailers, hospitals, and prosthetists. Ideally, we would want to keep

prices under $40,000 to make it more economically viable and medically efficacious in the eyes of our distribution channels . More fundamentally, we would want to keep costs reasonable so that a greater number of people could benefit from a more physiologically-accurate, force-based prosthetic.

Patent Search

Overview: A preliminary patent search yielded a fairly open patent landscape for this device. Among the patents found and considered relevant, the claims used were specific to the mechanical hardware design of the device or use nomenclature specific to their application (i.e. specific names for coordinate systems). Based on this, a system and algorithm described above can be developed that does not infringe on the found patents.

Search Terms Used: (upper limb prosthesis) AND (force controller); (upper limb prosthesis) AND (force-based controller) AND (pattern recognition); (upper limb prosthesis) AND (force-based controller) AND (hand posture); (continuous myoelectric control) AND (arm prosthesis)

Search Terms Reference	Patent Number	Analysis
1	US20160331561A1	The claims contained in this patent pertain to the sensory feedback aspect of the prosthesis instead of the controller, so it is not applicable.
2	US20120004736A1	The claims are worded towards a lower extremity prosthesis and pertain to volitional control of the prosthesis during non weight-bearing activities
3	**US20130338540A1**	**The claims surround the use of pattern recognition algorithms to interpret EMG signals and produce an more fluid-like motions than currently available prosthesis controllers.**
4	US7313463B2	The claims present a postural stability controller for a

		prosthesis or robotic appendage, but are more guided towards development of the linear model than their application to a force-based controller.
5	**US20160074181A1**	**The claims describe a method for mapping an EMG signal to a posture control space of a hand and a subsequent translation of that to a joint angle that is actuated by the prosthetic hand.**

Documentation of the final Design

This device will be utilized in the clinical in-home trial of a pre existing myoelectric prosthesis, therefore many different documentation methods will be required during and throughout the design process. A device master record, all instructions for product use, a device history file, step-by-step illustration of the design process, and a software design documentation file will be found at the following link: https://my.vanderbilt.edu/forcebasedprosthesiscontroller/. Each of these documents will be kept according to the FDA requirements regarding medical device design and implementation, with a device history record being created if this system were to begin manufacturing outside of the current project scope.

A risk analysis for the safety of the users of this device can be found below. The probability of the safety event occurring was ranked from 1, extremely unlikely, to 10, guaranteed occurrence. The severity of the safety event was ranked from 1, no harm to the user, to 10, fatal. The presented risks are outweighed by the increased posture control and biomimetic muscle activation that will manipulate the prosthesis. Each of the identified risks will be minimized by the correct documentation and standards testing as listed above.

Table 1: Risk Analysis of force-based myoelectric prosthesis controller

Risk	Cause	Consequence	Occurrence	Severity

Loss of Motor Control	-Incorrect translation of muscle activation through system -Disconnection between controller addition and prosthesis -Loss of power to controller	Amputee will lose all motor function supplied by the prosthesis causing day to day difficulties.	6	4
Interruption of Neuro-modulation	-Disruptive interaction between controller and implanted electrodes -Unnecessary manipulation of neuromodulator attachment	Loss of motor control from interruption in implanted EMG control. Possible health risks given internal interaction of implanted electrodes	2	7
Immunological Reaction	-Immune reaction to EMG electrodes or hardware addition around amputation	Discomfort to the user, as well as, possible inadvertent medical consequences from immune activation.	5	7
Electrocution	-Power source malfunction or unintended exposed wiring	Possible burns and/or other inadvertent medical consequences to the user	1	9

Prototype of final design

A prototype is not yet in development, but the following includes our initial design considerations. The myoelectric prosthesis being using for the process development is an Ottobock device obtained Case Western Reserve University. The current system of implementation was developed by the Functional Neural Interface Lab run by Dr. Dustin Tyler.

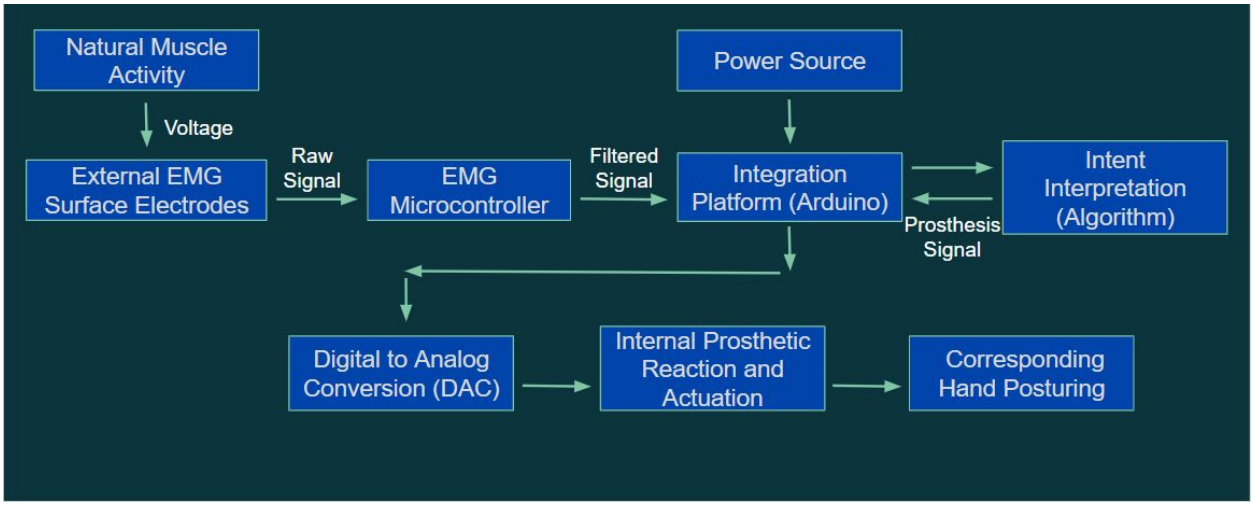

Figure 1: Block Diagram of initial design including EMG signal conversion and muscle contraction to hand posture relationship. This block diagram will translate into the hardware implementation of the prototype.

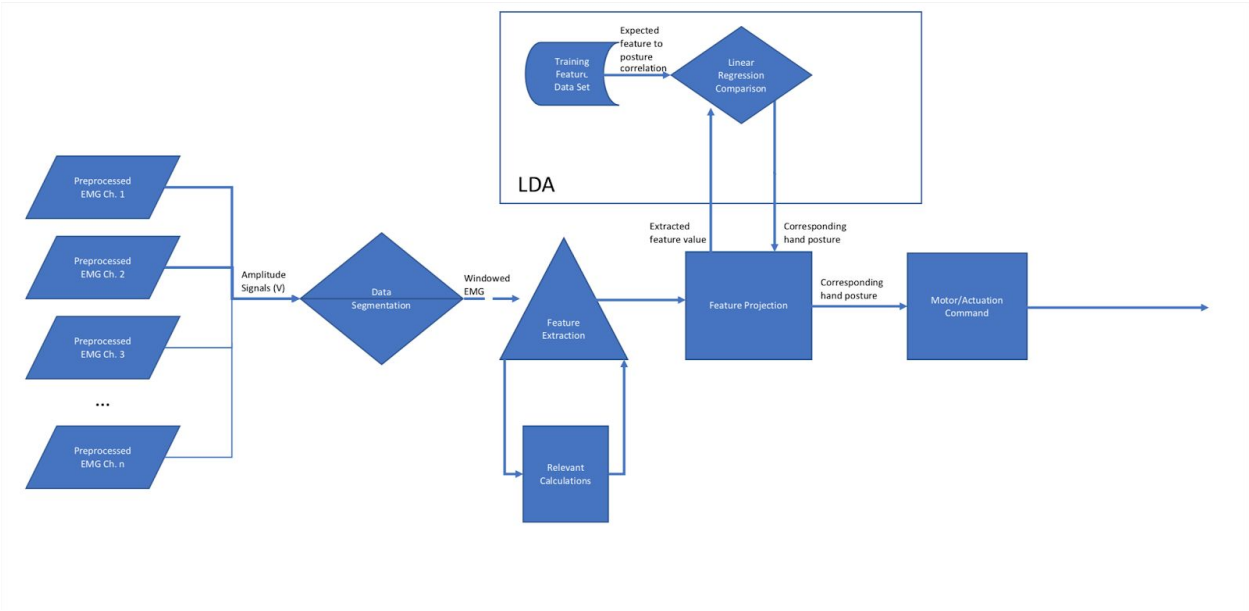

Figure 2: Flow diagram of possible Intent Interpretation Algorithm. This process involves data segmentation, feature extraction, feature projection, and actuation output in a self-contained algorithm.

Proof that Design is functional

If we were to prove that our design was functional, we would need data for each of the three main components. Firstly, for the EMG signal conversion, we would need to collect EMG data using the muscles of initial subjects. This data will be used to create the initial signal conversion. After this, we will need to create a way to form a phantom model to test these conversions. In this model, we will need to create a way to input signals of known hand posture intentions, and see if the correct output is achieved. Another way to accomplish this would be to use amputees as test subjects. This would allow amputees to move certain muscles and inform us of their intended actions. We could then use this to determine the outputted signal and how closely it models the intended output. Since this is a realistic scenario, it will be the best metric to test functionality; however, there are many guidelines and regulations for human testing. For

muscle contraction vs. hand posture, similar methods will need to be used to test for accuracy. First, we will need to map muscle contraction vs hand posture using initial subjects. Then, using either a phantom dataset or subjects with amputations, we will need to determine the accuracy of muscle contraction in relation to the corresponding prosthesis reaction. Finally, in terms of the algorithm, we will initially need to create it using a baseline dataset. Then, integrated with the hardware of the system, we will need to test how well this algorithm converts a digital input into an output in the prosthetic. We will need to make sure this algorithm works on multiple datasets. After we have confidence in the accuracy of the algorithm, we will need to see how well it converts the device input into an accurate output. To do this, we will most likely need to test the whole system on a human subject. This would allow us to see if the prosthetic as a whole actually reacts in the way we intended. Also, this would allow us to determine how large the learning curve of the device as well as how precisely the device can be used.

Estimated Manufacturing Cost

Expected costs involved in manufacturing our device currently include the purchase of an EMG microcontroller, an arduino, a 12V battery, and a 12V to 5V converter. Approximate costs for those materials include $40 for an EMG microcontroller [1], $35 for an arduino [2], and about $20 for the battery and converter [3]. With shipping, the raw cost of materials should be around $100. As we progress through the project, it is likely that we will need more materials for prototyping and modeling, but these should not present significant additions to the total cost. There is also a slight possibility that we will have to find an alternate way to charge the prosthesis, in which case there will most likely be a sizable addition to the expected cost. The

total prosthesis cost will not be accounted for within this project as it is being provided by an outside source.

Reimbursement

The prosthesis being modified by our device may be covered by insurance depending on whether or not the company deems the device a "medical necessity" based on references from a doctor or a certified prosthetist [4]. It is unlikely that our device will be considered "medically necessary" since the velocity-based myoelectric prosthetic systems that we are modifying can theoretically perform the same tasks even without the addition of our device. Because of this, our goal is to design this device in such a way that it will not present a significant financial burden to any patient that would prefer a force-based system.

Anticipated Regulatory Pathway

Because there are a variety of commercially-available powered and mechanical prosthetics, it is believed that this device should not require pre-market approval (PMA). Since this is a joint effort between our team and Case Western, it is understood that they will be responsible for bringing the product or certain components of this project to market. Many similar devices in this space have been approved in the past, so the process should be expedited. As of April 2018, the FDA classifies "external limb prosthetic components" as being Class I devices. These devices include but are not limited to "ankle, foot, hip, knee, and socket components; mechanical or powered hand, hook, wrist unit, elbow joint, and shoulder joint components; and cable and prosthesis suction valves [5]." Although this prosthesis mostly falls

under the criteria outlined above, it may require 510(k) approval because it will integrate and relay tactile feedback to the user via electrical stimulation.

Letter of Support-- Have asked sponsor and she is working on it

Sources

[1] MyoWare Muscle Sensor. (n.d.). Retrieved November 12, 2018, from https://www.sparkfun.com/products/13723

[2] ARDUINO MKR1000 WIFI Code: ABX00004. (n.d.). Retrieved November 12, 2018, from https://store.arduino.cc/usa/arduino-mkr1000

[3] 12 volt to 1.5V, 3V, 5V, 6V, 7.5V, 9V Volt automotive DC/DC Converter. (n.d.). Retrieved November 12, 2018, from https://www.powerstream.com/dc6.htm

[4] Financial coverage. (2017). Retrieved November 12, 2018, from https://www.ottobockus.com/financial-coverage/

[5] "CFR - Code of Federal Regulations Title 21." *Accessdata.fda.gov*, www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=890.3420.

[6] Robotic Prosthetics Market Analysis By Technology (Microprocessor Controlled, Myoelectric Prosthetics), By Extremity (Lower Body, Upper Body Extremity), By Region, And Segment Forecasts, 2018 - 2025. (n.d.). Retrieved April 06, 2018, from https://www.grandviewresearch.com/industry-analysis/robotic-prosthetics-market

[7] Statistics on hand and arm loss (2014). Retrieved November 14, 2018, from https://www.ishn.com/articles/97844-statistics-on-hand-and-arm-loss

[8] Lee, Kyu Ho, et al. “Hand Functions of Myoelectric and 3D-Printed Pressure-Sensored Prosthetics: A Comparative Study.” *Annals of Rehabilitation Medicine*, vol. 41, no. 5, 2017, p. 875., doi:10.5535/arm.2017.41.5.875.

Team Member Resumes

Allyson Rene King

10213 High Meadow Lane, Independence, KY 41051·(859)760-9117·allyson.r.king@vanderbilt.edu

Education

Vanderbilt University: School of Engineering — Expected Graduation May 2019
Nashville, TN
- Bachelor of Engineering: Chemical and Biomedical Engineering
- School of Engineering Dean's List Fall 2015-Spring 2018

The Carol Martin Gatton Academy of Mathematics and Science in Kentucky — August 2013 to May 2015
Bowling Green, KY
- Maintained a 4.00 GPA while earning 69 college credit hours.
- Graduate with Honors with Distinction
- President's List Western Kentucky University Fall 2013-Spring 2015

Research Experience

Advanced Therapeutics Laboratory — September 2016 to Present
(Dr. Craig Duvall, Vanderbilt University)
- Worked on developing an IL-6 signaling cell line for therapeutic method evaluation
- Currently developing an efficient and effective siRNA polymer delivery system
- Utilizing cell culture, gel electrophoresis, spectrophotometry, and different polymer synthesis techniques
- Presentations: *Vanderbilt Undergraduate Research Fair* and *Biomaterials Day*

Center for Fetal and Placental Research — May 2018 to August 2018
(Dr. Helen Jones, Cincinnati Children's Hospital Medical Center, SURF)
- Developed a protocol for the determination of protein targets for a peptide-decorated placental polymer plasmid delivery system
- Coordinated a collaboration for polymer development with the Advanced Therapeutics Laboratory
- Employed qPCR, standard quantitative protein assays, cell culture, and human tissue processing
  Presentations: Honorable Mention at Summer Undergraduate Research Fellowship Capstone

Biochemistry Research Experience — August 2014 to May 2015
(Dr. Rajalingam Dakshinamurthy, Western Kentucky University)
- Investigated a naturally derived antidiabetic drug to enhance and study the anticancer mechanism by capping the drug to gold nanoparticles.
- Used UV/Vis Spectroscopy, Transmission Electron Microscopy, and other analytical chemistry techniques

Communication Sciences Research Center — May 27, 2014 to July 18, 2014
(Dr. David Moore, Cincinnati Children's Hospital Medical Center, SURF)
- Studied the characteristics of children with Auditory Processing Disorder and contributing factors to the disorder to better diagnose and treat APD

Howard Hughes Medical Institute Science Education Alliance- — August 2013 to May 2014

Enrichment Activities

August 2015 to Present — **Society of Women Engineers** — Nashville, TN

January 2016 to Present — **Baptist Campus Ministries** — Nashville, TN

August 2015 to May 2017 — **Engineering World Health** — Nashville, TN

- Board Member (2016-2017): Service Chair
- Worked to organize events for engineering students to build low-cost ECG machines for third world nations

July 2014 to August 2014 — **Study Abroad** — Harlaxton, England

- Literature class taken and credit received while exploring many literary sites in England.

Miscellaneous

- Experience in the following computer languages: MATLAB, Mathematica, Aspen
- Biotechnology Certified

Christian Paul Stano

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2301 Vanderbilt Place
PMN 357461
Nashville, TN 37235

christian.p.stano@vanderbilt.edu
(440)821-4143

Home Address:
31856 Lake Road
Avon Lake, OH 44012

EDUCATION

Vanderbilt University, Nashville, TN **May 2019**
Bachelor of Engineering
Major: Biomedical Engineering; Minors: Computer Science, Engineering Management
GPA: 3.842/4.00
Vanderbilt College of Engineering Dean's List 2015-2018, Finalist for Ingram Scholarship, IES Madrid

Saint Ignatius High School, Cleveland, OH **May 2015**
GPA: 4.61
Valedictorian Finalist
Varsity Soccer Team, Policy Debate Team, Service (Cleveland City Mission, Labre Ministry, St. Joseph of Arimathea Pallbearer, Men of Regis (President), Snow Men (President), and mission trip to Appalachia)

EXPERIENCE

Deloitte Consulting—Washington, D.C. **June 2018- July 2018**
Business Technology Analyst Summer Scholar
- Supported database modernization efforts for the Internal Revenue Service (IRS)
- Automated legacy system orchestration tracing to improve process efficiency from days to minutes
- Developed decks, designing visuals, aided in daily Agile practices, and collaborated with leadership on new business development efforts

Vanderbilt University Center for Technology Transfer and Commercialization-- Nashville, TN **May 2017- November 2018**
Licensing Intern
- Assisted members of the licensing team with managing portfolios of Vanderbilt technologies
- Conducted prior art searches, created market research reports, and drafted non-confidential executive summaries
- Developed and implemented active marketing campaigns based on patent landscape and market research
- Presented recent intellectual property case law to the licensing team and led a discussion on related patenting strategies

Case Western University and Louis Stokes VA Medical Center-- Cleveland, OH **May 2016- August 2016**
Research Intern
- Independently researched in the Functional Neural Interface Lab concentrating on utilizing electrical stimulation to restore sensory feedback to the prosthetics of veterans with lower arm amputations
- Researched, designed, programmed, and tested optical tracking system utilized for measuring joint angle changes during motor function
- Completed two separate optical tracking systems and presented results to board of biomedical engineering graduate school faculty

Stano Law Firm-- Parma, OH **May 2015- August 2015**
Marketing Consulting, Sales, and IT
- Collaborated with head of marketing department to devise, develop, and implement strategies to reach potential and past clientele

Reduction Engineering-- Kent, OH **June 2014- August 2014**
Quality Assurance Intern
- Assembled and inspected pulverizing and pelletizing machines with the goal of ensuring safety and accuracy
- Attended weekly strategy meetings, collaborating with management to increase efficiency

NASA Glenn Research Center-- Cleveland, OH **September 2012- April 2013**
Environmental Engineering Research
- Performed research to develop alternative methods of creating biofuels through research on self-sustainable saline ecosystems

LEADERSHIP

Vanderbilt Undergraduate Intellectual Property Association, Nashville, TN **Fall 2017- Present**
Founder, President
- Started and managed an undergraduate organization partnered with the Vanderbilt Law School and Wondry Entrepreneur program with the goal of exposing undergraduate students to the field of intellectual property through speaking events and patent searching projects

Office of Undergraduate Admissions, Nashville, TN **Fall 2015- Present**
Tour Guide
- Serve as a representative and liaison of Vanderbilt University to prospective students to provide high school students with experiences and insights into student life

SKILLS

Experience in Matlab, Java, C++, JavaScript, Microsoft Office applications, visual design, and grant-based research. Excellent interpersonal, communication, and teamwork skills.

ACHIEVEMENTS AND INTERESTS

Third degree black belt in Taekwondo, World Champion and three-time National Champion in Taekwondo, 2014 OHSAA Soccer state champion. Enjoys playing guitar, fitness, cars, classic rock music, snowboarding, and wakeboarding.

SHAAN RAMAPRASAD

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(423) 736-8090 | shaan.ramaprasad@vanderbilt.edu

EDUCATION

VANDERBILT UNIVERSITY — Nashville, TN
Bachelor of Engineering (B.E.) Biomedical Engineering, Dean's List — May 2019

- Computer Skills: experienced in MATLAB, Python, Mathematica, MS Office Suite (Excel, Word, PowerPoint)
- Communication: public speaking for corporate events, social media marketing
- Media Skills: skilled in Logic Pro (audio), Final Cut (video), and Finale (music notation)

CAMPUS INVOLVEMENT/ LEADERSHIP

Melodores A Cappella, *Musical Director & Marketing Chair* — August 2016 – Present

- Arrange music, lead practices, and coordinate events for Vanderbilt's all-male a cappella group
- Planned performances with *NSYNC's Chris Kirkpatrick and for NBC's TODAY Show
- Turned a $1000 deficit into over $20,000
- Currently planning an international tour through Dubai, Seoul, and San Francisco

Vanderbilt Office of Undergraduate Admissions, *Tour Guide* — April 2016 – Present

- Lead diverse audiences on weekly campus tours to communicate world-class value of the Vanderbilt experience
- Vanderbilt Admissions ambassador during annual Melodores "Fall Tour"

WORK EXPERIENCE

JW GREEN VIOLIN SHOP — Morristown, TN
Apprentice — May 2018 – August 2018

- Built a violin under the supervision of the acclaimed 95 year-old fiddle-maker and WWII veteran, J.W. Green.
- Studied, documented, and videoed the entire violin-making process, in hopes of carrying on the unique tradition
- Learned invaluable life lessons about patience, service, and how to live a full life.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) — Gaithersburg, MD
Summer Undergraduate Research Fellow — May 2017 – August 2017

- Simulated semi-crystalline polymer mechanics through Molecular Dynamics and Monte Carlo methods
- Spoke with Senators Bob Corker (TN) and Lamar Alexander (TN) about the importance of funding scientific research
- Gained experience with Bash (Unix Shell) commands, Python, and giving weekly oral presentations

VANDERBILT SOCIAL COGNITION LAB — Nashville, TN
Research Assistant — January 2016 – December 2017

- Worked with children to learn about their intuitions about invisible entities
- Gained experience in many facets of the research process

PROJECTS AND EVENTS

CEREBRAL PALSY MOBILITY DEVICE — Nashville, TN
Team Member — December 2017

- Designed and built a mobility device for a child with cerebral palsy by modifying a ride-on toy
- Taught executives at Permobil how to build such devices as a service and team-building exercise

LONG JOHN SLIVER'S — Atlanta, GA
Featured Artist — October 2017

- Performed a solo musical act during the COO's presentation in Atlanta
- Unveiled Pepsi's Spire 6.0 machine through an original "beatbox"/rap demonstration

MELODORES BENEFIT CONCERT — Morristown, TN
Main Event Organizer — December 2017

- Remotely crowd-funded over $10,000 in one week from corporate sponsors
- Sold out show of a ~1000 people, total revenue of over $18,000

Rebecca Jones

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Biomedical Engineering senior at Vanderbilt University

EDUCATION

Vanderbilt University, Nashville, TN
Bachelor of Engineering, May 2019
Major: Biomedical Engineering
Minors: Engineering Management, Materials Science and Engineering

RELEVANT CLASSES

Bioacoustics and Ultrasound imaging, Nanobiotechnology, Introductory biomechanics, physiological transport phenomenon, systems physiology, biomedical instrumentation, analysis of biomedical data, circuit analysis and design, materials science, project management, technology strategy

PROFESSIONAL EXPERIENCE

RESEARCH ASSISTANT, Vanderbilt University **January 2017 – Present**
Research Assistant in the BEAM Lab
Vanderbilt Institute for Surgery and Engineering Summer Research Program **Summer 2017**
Vanderbilt University School of Engineering Summer Research Program **Summer 2018**
Responsibilities:

- Run research project with input from the principle investigator and multiple graduate students
- Present research update at summer seminar (2017) and poster presentation (2018)
- Attend weekly lab meetings
- Attend seminars where graduate students and professors share their research

Papers: https://doi.org/10.1007/s00240-018-1036-z
https://doi.org/10.1371/journal.pone.0203138

UPCOMING EXPERIENCE

SPIE Medical Imaging Conference Presentation, San Diego, CA **February 2019**
Will give a 20-minute presentation at the 2019 SPIE Medical Imaging Conference, including a submitted conference proceedings

EXTRACURRICULAR ACTIVITIES

Vanderbilt Phi Sigma Rho **Spring 2017 – Present**
Secretary
Vanderbilt Baptist Collegiate Ministry **Spring 2016 - Present**
Vanderbilt Institute for Surgery and Engineering–Women in Engineering **Summer 2017- Present**

ADDITIONAL SKILLS

- **Software/languages**:
  - **Proficient in**: Microsoft Office suite, MatLab, Mathematica
  - **Familiar with**: Java, Python, LabView, Fusion 360
- **Operating systems:** OS, Windows, Linux
- **Imaging:** ultrasound imaging, beamforming, phantom creation and analysis, field-II simulations
- **Cell culture:** feeding and passaging cells
- **Certifications:** FEMA emergency planning

Kaitlyn Ayers

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Education

Vanderbilt University - Nashville, TN — Expected Graduation: May 2019

Bachelor of Engineering, Biomedical Engineering

Honors: Dean's List | Fall 2015 – Spring 2018

Relevant coursework: Introduction to Programming (MATLAB), Introduction to Biomechanics, Biomedical Materials, Systems Physiology I & II, Circuits I & II, Physiological Transport Phenomena, Analysis of Biomedical Data, Biomedical Instrumentation, Medical Device Innovation, Biosensors, Ultrasound Imaging, Program and Project Management

Academic Projects

Senior Design | Project to convert a velocity-based myoelectric upper limb prosthesis into a force-based system by manipulating both the software and hardware components | Year-long | Group of five | Fall 2018 – Spring 2019

Program and Project Management | Design of an inventory tracking system that alerts the user when certain items need to be re-stocked | One semester | Group of three | Fall 2018

Medical Device Innovation | Design of a futuristic all-encompassing upper limb prosthetic device that included brain interface technology and an active haptic feedback system. Process to have technology cleared by the FDA also explored | One semester | Group of three | Spring 2018

Biomedical Instrumentation | Measurement of blood volume using photoplethysmography and electrocardiogram sensors | One semester | Group of three | Spring 2018

Professional Experience

Miss Rodeo Missouri | Ambassador and spokesperson for the Professional Rodeo Cowboys Association | 2019

Vanderbilt Hospital | Anesthesiology | Shadowing | Fall 2018

Missouri Delta Medical Center | Orthopedic Surgery | Shadowing | Summer 2017

The Surgical Clinic Prosthetics Group | Internship | Spring 2017

Involvement

Sigma Phi Lambda | Fall 2017 – present

Sigma Alpha Pi, National Society of Leadership and Success | Spring 2017 – present

Baptist Campus Ministry | Fall 2015 – present

Vanderbilt Equestrian Team | Fall 2015

Skills

Proficient in MATLAB, Mathematica, LabView, Fusion 360, and Microsoft Office

FEMA Emergency Planning Certified