New Frontiers in Biomedical Engineering

Organized with help from the undergrad students in the course **BME3101 Introduction to Biomedical Engineering**

Hand Prosthetics and EMG Signals
Spencer Warshauer, David Considine, Donald McMenemy

We propose to evaluate the signal reception issues for hand prosthetics. We intend to improve the quality of these prosthetic hands. This includes reception of signal through the tissue, processing/interpretation of EMG signal types, and time elapsed between signal reception and hand movement. The benefit of high density electrodes will be considered to enhance EMG information propagation. Conic models that discriminate for the desired motion will be discussed in terms of high density electrode grid use. The increased complexity of this model will challenge the rate with which a motion may be initiated and completed. Therefore, processing power of the prosthetic system should be enhanced to accommodate the proposed system.

**Finite Element Analysis : As Method of Calculation of Stress and Strain In Femur Bone**
Sana Serhane, Tarun Banda, Matthew James Schneiderhan, Jerry Sokllal

Due to the resolution of the calculated mechanical parameters, stress and strain, the results get more accurate the more elements the analyzed structure is divided into. The frequent failure of Femurs fatigue or loosening occurs; computer representation of the physical interaction occurring in a total joint has been undertaken. To help further our knowledge of the stress distributions across the bone implant interface in order to understand the reason for artificial hip failure and loosening after eight to ten years.

**Use of Stem Cells for Tissue Regeneration**
Brian Hennessey, Jon Kaplan, Maya Simons, Patrick Garzon

Stem cell research is a controversial and relatively new approach to medicine. If investigated to its full potential it could be a breakthrough in the world of medicine. Stem cells have the ability to differentiate into a multitude of cells types. This makes them a very valuable resource in the area of tissue regeneration. Within the area of stem cells, there are many types that are all capable of differentiating into specific types of cells. For example Mesenchymal Stem Cells (MSCs) are stem cells found in the bone marrow and can potentially be used for the regeneration of bone marrow, bone tissue, cartilage, tendon and other connective tissues. These stem cells are also useful in that they release bioactive molecules that are immunosuppressive. With this advance in medicine, many sports injuries that would once cripple a being can be reversed and improve their quality of life. Through the potential use of stem cells, certain medicinal ailments that currently prove not to have solutions will prove solvable.

**Discover Artificial Disc-Depuy Spine**
Michael Gerhard, Andrew Vicki, Michael McDermott

The focus of our project will be the Discover Artificial Disc made by Depuy Spine. It is a version of the Charité Artificial Disc and is a total disc replacement. More and more medicine is turning to science in order to come up with new ways to help patients. The artificial disc is a composite device using high density polyethylene and metal alloys. The disc is in use in Europe but awaiting FDA approval here in the United States.

**Bone Remodeling of the Sternum After Open Heart Surgery**
Alison Welch, Shruti Kuzhippat, Rodney Sutherland

During open heart surgery the sternum must be cut in order to have access to the heart; refusing the split bone is essential to protection of the healing heart. In order to make the regeneration of the sternum more efficient, we need to find a method to increase the rate of regeneration in a way that is safe for the surrounding tissue and for the bone itself. In addition to the efficacy of the method in terms of long term bone remodeling, the procedure to implement this technology must also be as quick as possible as there is a limited timeframe in which surgeons can have access to the bone after open heart surgery.

**Wireless Implantable Glucose Sensor**
Yu Zhang, Bryant Heimbach
The focus of this research project is based on the conception of sensor technology to its eventual application in glucose sensors for use in diabetes. In this project we will explain how wireless, real time monitoring sensor system would be of use, and especially in diabetes where the monitoring of metabolic analyte that control the physiology of human body is critical for patients with Type I and II diabetes.

**Gender Differences Regarding Pacemaker Implementation**  
Bozhidar Barakov, Michael Bula, Alex Gaydeki

We are going to analyze how gender plays a role in the effectiveness of a pacemaker, and what will cause the gender variation. We will then determine areas of improvement to compensate for the gender differences.

**Comparison of Scaffolding Materials for Tooth Regeneration**  
Mikhail Rudinskiy, Akeama Hill and Tyler Stahl

Tooth loss and decay affects a large portion of the population; since we use our teeth everyday for both communicating and chewing- the discomfort is omnipotent. Current methods of repair and replacement do not replace the biological functions of teeth and are not as comfortable as the originals. Dental pulp stem cells are being investigated as an option to grow human teeth if a viable scaffold can be developed to provide the shape and orientation needed.

**Lumbar Disc Replacement**  
Tyler Moxam, Orest Paslavski, Smitkumar Patel

Currently individuals undergo spine fusion surgery in order to treat the degeneration of the lumbar portion of the spine. Yet recent studies have developed alternative ways to better treatment results through the lumbar disk replacement. The goal of our research is to determine how lumbar Disc Replacement improves lives of individuals suffering from degenerative disk disease. We would also like to explore a different approach of the materials the replacement is composed of and try to come up with a longer lasting, cost effective material.

**Capsule Endoscopy**  
Cheng Yang, Alekhya Revur, Kassandra Lai

This topic sparks interest for us because it is a new approach to diagnosing diseases such as cancer in the digestive tract. Capsule endoscopy is interesting because it is a less invasive way of locating the pin point of the disease without causing extra discomfort or inflammation compared to the traditional methods/ approach of endoscopy. This topic is very captivating because it motivates us to think of newer technologies, and it was able to broaden our view of the possibilities.

**Prosthetic Knee Proposal**  
Kristen Colberg, Mireille Kelley, Chanel Williams

Our group would like to study the motion of prosthetic knees to make knee prostheses more patient friendly and individualized. To do this, we’d like to look at what other experiments have been done to improve the performance of the gait and the pattern of movement. Our goal is to find ways that make tailored alterations to enhance the mechanics of the gait to suit the patients’ needs, lifestyle, and expectations.

**Reverse Anatomy Shoulder Replacement**  
Dylan Freund, James Bickerstaff, Keenan Tschauder

As more and more replacement surgeries begin to take place, one of the newest to emerge on the scene is the shoulder replacement. Still more cutting age is the reverse shoulder replacement, which attempts to reconstruct the shoulder with the ball section attached to the shoulder blade and the socket molded on humerus. Although it has been in use for quite some time, its biomechanical aspects have still not been fully analyzed. The following research provides an in depth look into the inner workings of the mechanism as well as the benefits that come along with it. Our data gives a comparison of the range of motion of a shoulder with rotator cuff atrophy and that of the replacement shoulder. It not only gives an idea of the effectiveness of this new age replacement, but the problems associated with it as well.

**Investigating Implantable Orthopedic Devices Used for Dogs**  
Rebecca Nowak, Lauren Kuzdeba, Milanel Perez
We will be researching orthopedic devices used for dogs with issues related to lumbosacral stenosis. We'll be comparing this device to other orthopedic devices used for humans that have problems in the lumbar region of the spine. We will compare factors such as range of motion, materials used, structure and cost.

**Visual Prosthetic**
Joe Fonseca, Alex Gaffney, John Williams, Wiley Shi

We will be analyzing and comparing the many different kinds of visual prosthesis in an attempt to classify which ones are most efficient and have the lowest associated risks. There are several types of visual prosthetics (bionic eye) on the market and in development currently. The multitudes of these prosthetics exist due to the nature of an individual’s condition and the needs for augmentation. For instance the optical nerves, and their health, are vital in determining the proper course in choosing a prosthetic. Currently the metrics used in determining the success and functionality of the visual prosthetic are not standardized however, one research team scored a particular prosthetic as effective due to a 96% accuracy in image acquisition with respect to the users unaided eye. There still remain many hurdles in the development of a visual prosthetic with the dexterity and functionality equivalent to the human eye. However, with the advent of more advanced anti-rejection medication, the increasing sophistication of semiconductors and microprocessors a suitable replacement for a damaged human eye is in the not so distant future.

**Neuroprosthetic Arm Design**
Lia Bonacci, Thomas Capuano, Julia Ariola

We are investigating mechanical prosthetics that communicate with the human body and the nervous system to create an arm that functions as close to a real arm as possible. We are looking for the challenges that need to be overcome in the developmental process. Finally, our goal is to see how the current design of robotic prosthetics can be improved upon to increase effectiveness of the devices in the future.

**The Jarvik 2000 Flowmaker**
Michael Stellon, Michael Gallie, Joshua Dobbins

The Jarvik 2000 Flowmaker is a device that is used to assist someone with a weak or defective heart muscle. Its function is to assist the heart rather than take over for it. It uses a spinning rotor to propel blood from the left ventricle into the aorta. But the natural heart continues to contract and relax, and the volume of blood moved by the spinning rotor rhythmically increases and decreases in synchrony with those contractions, as to mimic a natural heartbeat.

**Interpreting Neural Impulses to control Hand Prosthetics with Electromyography**
Gregory Johnson, Jason Meyer, Dipanjah Saha

The focus of our poster is to investigate how prosthetics acquire and process neural impulses to manipulate a hand prosthetic. We are focusing on the hand because it has more degrees of freedom than other limbs and therefore its prosthetics require finer control; in addition to making it easier for us to see the shortcomings of signal detection and manipulation technology. Of course this is a very multidisciplinary field since the skeletal, muscular, integumentary, and nervous systems are involved; thus, neural manipulation of prosthetics is a field that has a lot to be developed.

**Are we really one step closer to creating a super human?**
Kelsey Welling, Ardheeshan Selvachandran, and Yangyang Zhu.

It was recently announced that people with prosthetic limbs were allow to compete in the olympics and handicapped track star Oscar Pistorius has already qualified. This made our group want to explore the possibility that prosthetic limbs can enhance athletic performance, mainly running. This is a controversial topic where both sides have solid arguments. Are we really one step closer to creating a super human?

**Biomaterials of an Artificial Knee**
Neyati Patel, Kristen Rosa Mannuzzi, Rockwell Anyoha

For this poster, we will look into various materials that the knee replacement can be made out of. We will also research the coatings that are best suitable and durable for the environment inside the human body. Some of the organ systems that this incorporates are the skeletal system, nervous system and the muscular system. We want to see the effects of different materials for knee replacements on some of these systems of the human body