UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	UNCC Biomedical Engineering	**Date Submitted**	07/31/2018
Project Title	A comprehensive design and analysis of 3D printed upper limb prosthetic devices (BIO_LIMB)	**Planned Starting Semester**	Fall 2018

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project. 250 hours are expected per person. Complete the following table if this information is known, otherwise the Senior Design Committee will develop based on the project scope:

Discipline	Number	Discipline	Number
Mechanical (BioMed)	2	Electrical	
Computer		Systems	
Other ( )			

Company and Project Overview:

Provide background information about the company, and an overview about the context for the project.

The U.S. Centers for Disease Control and Prevention estimates that each year about 1,500 babies in the United States are born with upper limb reductions. Limb reductions may also be amputations acquired during childhood as a result of blood/nerve abnormalities, disease, or trauma. One of solutions for function restoration is 3D printed prosthetic devices. Dr. Chi established the Helping Hand Project at UNC Charlotte in January 2017 and has delivered 5 devices. However, many of the most popular designs have been created by volunteers acting as amateur engineers or designers with very little formal training in Orthopedics, Biomedical engineering or Material Science. While providing these devices have been well received by both the children and families of limb differences, there have been no formal studies to understand their structural limitations or potential for physical harm on developing joints of these children. Dr. Zheng and Dr. Chi are now working together to improve the design of 3D printed prosthetic devices.

A 3D printed hand is designed to help children who are born with upper limb reductions. It is low cost and easy to use for family members to make at home. The 3D printed hand is controlled by either the wrist or the elbow movement. The wrist or elbow flexion pull strings attached to the 3D printed fingers to generate a grip motion to hold an object. Rubber bands are used to keep the 3D printed hand in an open position until fingers pulled by the strings cross over the 3D printed wrist or elbow joint.

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Project Requirements:

The 3D printed hand had a shell partially covering the wrist and/or elbow. The rotating axis of the printed wrist or elbow may not align with the rotating axis of the wrist and elbow which will cause some rubbing motion between the printed shell and wrist and forearm. Improper string knots may make all fingers to have different grip motion. A poor rubber band may keep the hand in a closed position which prevent a child to grip and hold an object.

Expected Deliverables/Results:

- Design a simulation system to cyclically testing 3D printed hand
- Fabricate several commonly used 3D printed hands for fatigue tests
- Conduct cyclic fatigue test (3000 – 5000 cycles) and monitor changes of the grip force
- Identify the weakest parts in the 3D printed hand and propose an improvement plan.

Disposition of Deliverables at the End of the Project:

Hardware developed is the property of the Industry Supporter. Please specify what disposition you would like for the hardware developed by the Project team. Typically the work product is displayed at the last Expo then immediately handed over to the supporter unless arrangements have been made to deliver at a future date.

At the end of this project, a simulation system for fatigue test is developed and validated for physiological range of motion and other variables. The changes of the grip force during cyclic fatigue test is determined and the weakest parts are identified. An improvement plan and new design are proposed.

List here any specific skills, requirements, knowledge needed or suggested (If none please state none):

- Familiar with VICON motion capture system
- Familiar with grip force sensor
- Familiar with 3D printing
- Familiar with Arduino code and control.
- Knowledge of human body movement and joint biomechanics