NORTHERN ILLINOIS UNIVERSITY

University Honors Program

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Senior Capstone Application

No later than Friday of week #2 of the semester the student **MUST** complete and submit to the University Honors Program the Senior Capstone application (including the signature of the professor), along with a typed, approximately **three page** proposal describing the work to be completed and evaluative criteria.

This proposal must include:

1. The topic, purpose, and/or hypothesis of the project
2. A brief description of your project articulating its importance
3. The methodology of your project
4. A complete timeline demonstrating how the project will be completed and evaluated
5. A reference page for any cited works listed in the proposal in a style appropriate to your discipline (e.g., APA, MLA, Chicago, etc.)

***Note:* Students must also register for a three (3) credit hour Capstone course.**

Student name: Nicole Hoffmann ZID: Z1764815

Year in school (e.g., Senior): Senior Capstone semester(s): Spring 2020

Student email: nicole@niu.edu Student Cell #: (847) 445-5598

Read and sign: I understand that enrolling in a Senior Capstone requires my submission of the final capstone (in PDF form) and faculty-signed cover page to honors@niu.edu no later than *the Sunday before finals begin (by 11:59 pm CT)*. Failure to meet this deadline will result in the rejection of my Senior Capstone and prevent me from earning Honors recognition for the project.

Student Signature: [signature] Date: 1/14/20

Information / Signatures required for approval

Course department: ELE Course number: 496

Course title: Senior Design 2

Course section: 00H1 4-Digit class (**NOT SECTION**) number: 7925

Faculty name (print): Dr. Donald Peterson

Faculty email: drpeterson@niu.edu

Faculty signature: [signature]

Department Chair/Director signature: [signature]

University Honors Program (print): Edye Cowan

University Honors Program signature: [signature]

Senior Capstone Proposal

Robotic Exoskeleton for Neuromuscular Rehabilitation and Exercise (4th Generation)

ENGINEERING SENIOR DESIGN TEAM #30

Nicole Hoffmann, Aletta Johnson, Moises Reynoso Jr.

Faculty Contact: Dr. Donald Peterson, Northern Illinois University

1. TOPIC AND PURPOSE

As the number of stroke patients grows, the need for an efficient and convenient method of rehabilitation becomes increasingly vital. The Robotic Exoskeleton for Neuromuscular Rehabilitation and Exercise (4th Generation) involves the creation and enhancement of an exoskeleton used in assistive and resistive environments [1]. The device improves mobility of the elbow and helps the user regain muscle mass. This system is used to retrain and strengthen the upper extremity affected by muscular impairment.

Using technology to help strengthen and heal people is a more efficient and sustainable approach. A device to help restore mobility and strength can perform movements consistently and predictably by allowing patients to track their progress more accurately. Using a biomedical device allows for consistent movements and the flexibility to take the rehabilitation equipment home.

2. DESCRIPTION

The exoskeleton focuses on the rehabilitation of stroke patients as well as resistance training for astronauts in zero gravity. The future of limb rehabilitation and physical therapy lies in robotics. The system is non-invasive and allows the wearer to use their unaffected limb to control the impaired limb through a master-slave feedback loop. It also applies resistance to regular movements. For astronauts in a zero-gravity atmosphere, resistance training reduces the risk of muscular atrophy [2]. This system records the user's progress over multiple therapy/training sessions, allowing for innovative rehabilitation that evolves with the user.

In order to accomplish this rehabilitation, the device utilizes a master-slave setup. When a user flexes and extends the forearm on their side unaffected by stroke, the motor on the other extremity actuates. This mirroring allows the brain to rebuild neural pathways previously diminished by stroke and regain lost functionality [3].

On another setting, the motor resists motion to provide resistance training. This functionality is useful for individuals that need to rebuild muscle or prevent degradation, without necessarily having a neurological impairment. Astronauts, in particular, can use this compact and reliable device in a microgravity environment.

3. METHODOLOGY

One focus is stroke rehabilitation. The first goal of this design is to have a functional master/slave mechanism; the unaffected arm narrates the impaired arm's movements. The second goal is to be able to program specific movements for the affected arm so that the unaffected arm does not need to always be in use. The final goal is to have the ability to switch any of the previous functions between either of the two arms.

The master/slave mechanic allows for one side of the system to be used as a controller for the other arm. Comparatively, mirror therapy (MT) is when a mirror is placed between the arms so that the image of a moving unaffected limb can give the illusion of normal movement to the affected limb, creating stimulation in different brain regions as stated by Cochrane [16]. The study that was implemented found that MT moderately improved movement of the affected upper limb and the ability to carry out daily activities for the patients within six months of the stroke [4]. Having a system that can accomplish this without the need for a full-length mirror will be beneficial because it can be accomplished in a smaller space.

Programmable movements allow the patient to set a predetermined exercise for their rehabilitation so that they can allow their unaffected arm rest. The added feature of only allowing the affected arm to move allows for the brain to focus only on the affected arm [5]. Because a stroke can affect either side of the body, the ability to have an ambidextrous exoskeleton would eliminate the confusion involved in creating either a left or right-handed system.

4. TIMELINE

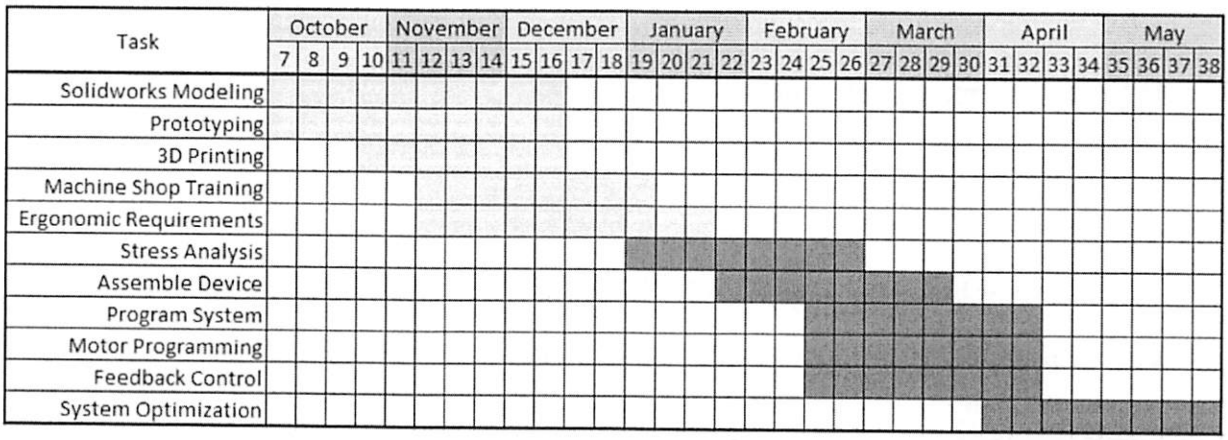

Figure 1 – Gantt Chart showing a tentative layout of the project schedule

5. REFERENCES

[1] Northern Illinois University. (2019). Donald R. Peterson - NIU - College of Engineering and Engineering Technology. [online] Available at: https://www.niu.edu/ceet/about/leadership/donald-peterson.shtml [Accessed 11 Oct. 2019].

[2] Rea, R., Beck, C., Rovekamp, R., Diftler, M. and Neuhaus, P. (2019). [online] Ntrs.nasa.gov. Available at: https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20140000694.pdf [Accessed 11 Oct. 2019].

[3] "15 Things Caregivers Should Know After a Loved One Has Had a Stroke." *Www.stroke.org*, 7 Dec. 2018, www.stroke.org/en/help-and-support/for-family-caregivers/15-things-caregivers-should-know-after-a-loved-one-has-had-a-stroke.

[4] H, Thieme, et al. "Mirror Therapy for Improving Movement after Stroke." *Mirror Therapy for Improving Movement after Stroke*, 11 July 2018, www.cochrane.org/CD008449/STROKE_mirror-therapy-improving-movement-after-stroke.

[5] Saebo. "Neuroplasticity: Stimulating Your Brain to Enhance Stroke Recovery." *Saebo*, 2 May 2019, www.saebo.com/neuroplasticity-stimulating-your-brain-for-stroke-recovery/.