A. JAMES CLARK
SCHOOL OF ENGINEERING

Course: ENPM 808J - Rehabilitation Robotics
Instructor: Dr. Anindo Roy
To be offered: Spring 2017

Course Description:
This course provides an introduction to a field of robotics dedicated to improving the lives of people with disabilities. The course is designed for graduate students wishing to learn more about the rehabilitation robotics, an emerging and one of the fastest growing fields of robotics. Rehabilitation robotics is the application of robots to overcome disabilities and improve quality of life. In contrast with other areas and/or courses in robotics, this course considers not only engineering design and development, but also the human factors that make some innovative technologies successful and others commercial failures.

Objectives:

- Identify the parts of the human rehabilitation system
- Have a basic understanding of brain neuro-plasticity and human motor learning
- Apply biomechanical methods including quantitative instrumentation and clinical scales to measure and analyze human movement, diagnose movement disorders, and assess rehabilitation outcomes
- Describe the features of healthy versus pathological human movement
- Discuss types of rehabilitation robots, their classifications, and their applications
- Develop an understanding of impairement- and task-based rehabilitation robotics design and development
- Discuss the sensing, actuation, and control principles deployed in various rehabilitation robotics
- Be able to use engineering design to identify and address a specific rehabilitation need, design and develop a rehabilitation robot (virtual), and defend the rehabilitation robotics solution.

Syllabus:
Human rehabilitation and biological concepts: Definition, concept and need for physical rehabilitation; Parts of the human rehabilitation system; Types of physical impairments; Concepts in neuro-plasticity; Principles and models of motor learning.

Characterization of human impairments: Engineering concepts in sensory and motor rehabilitation; Biomechanical measurements and analyses of human movement; Gait Analysis; Mathematical models for biological systems and for biomedical engineering systems.

Introductory concepts in rehabilitation robotics: Classification schemes of rehabilitation robotics (a range of robotics will be investigated: clinic, lab); Considerations for the human-robot interface; Sensing, actuation, and control principles deployed in various rehabilitation robotics.

Advanced concepts in rehabilitation robotics control: Control of actuators and manipulators: open and closed-loop control; Fundamentals on position, force, and impedance control; Control system design for safe, reliable, and robust control of physical human-robot interaction; Review interesting and unique challenges of interaction control: unilateral vs. bilateral; interactions; blending of precise (robot) vs. uncertain system (human); solutions for stabilizing contact; coping with (and taking advantage) of redundancy and selecting optimal behavior for different tasks; Mechanical physics of interaction: "ports" and its usefulness for establishing impedance or admittance control.

Grading Policies:
Homework (40%), Midterm (30%), Final (30%)

Reference:
Neurorehabilitation Technology by Volkier Dietz, Tobia Nef, William Zev Rymer (Eds.), Springer; 2012 edition. ISBN-13: 978-1447122760 ISBN-10: 1447122763

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