Course: ENPM 808J - Rehabilitation Robotics  
Instructor: Anindo Roy  
To be offered: Summer 2016

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 impairment- 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:**

**Code of Academic Integrity:**
The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.studenthonorcouncil.umd.edu/whatis.html.