Ain Shams University

Faculty of Engineering

Mechatronics Engineering Department

MCT444 Mechatronics in Rehabilitation Technology Project Description

Objective: The project aims are to utilize OpenSim and Python/MATLAB/opensim Creator/....etc. to develop a closed-loop simulation of a musculoskeletal biomechanical human model integrated with assistive devices and technologies such as unactuated device, robotics, functional electrical stimulations (FES), sensors, virtual reality, machine learning, ...etc. for either the upper or lower limb. This assignment will involve conducting a comprehensive literature review, developing a musculoskeletal model, simulation, interpreting results obtained from the simulation with assistive devices, and drawing conclusions on the effectiveness of the solution.

Project Steps:

1. **Literature Review:**
    - Conduct a thorough literature review to understand the usage of OpenSim, OpenSim API, and OpenSim creator, along with their applications in biomechatronics.
    - Explore the current state-of-the-art in assistive devices and technologies for either the upper or lower limb, and analyze the various control algorithms employed in these devices.
    - Investigate different musculoskeletal biomechanical models utilized in OpenSim and in the field of assistive technologies.
2. **Model Development:**
    - Develop a detailed musculoskeletal biomechanical human model specific to either the upper or lower limb using OpenSim.
    - Ensure inclusion of all relevant muscles, tendons, and bones in the model.
    - Develop any mechanical devices or robotics you may need using CAD and opensim creator or any other tool.
    - Develop control algorithms for the proposed system
3. **Data Processing and Analysis:**
    - Utilize motion capture data to validate the musculoskeletal biomechanical human model.
    - Process and analyze the data to verify the accuracy of the model in replicating human movement patterns.
4. **Interpretation of Results:**

- Implement assistive devices for either the upper or lower limb within the simulation.
- Interpret the results obtained to evaluate and compare the performance of different control algorithms.

5. **Conclusion:**
    - Summarize the findings of the project and draw conclusions regarding the effectiveness of the developed solution in addressing the targeted problem.
6. **References and Resources:**
    - List all references and resources utilized throughout the assignment.
7. **Report Writing, Presentation, and Video Submission:**
    - Prepare a detailed report documenting all aspects of the project, including methodology, results, and conclusions.
    - Submit a short video demonstrating the work and activities undertaken during the assignment.
    - Ensure proper formatting, quality, and representation in the academic report.
    - Present the findings and engage in discussions during the presentation session.
    - Responsibility sheet sowing the contribution of each team member.
    - Submit all the CAD and source files for your project

Useful Resources:

1. **OpenSim Website:**
    - Access the official OpenSim website for documentation, examples, tutorials, research projects ideas, and resources on using the software and its API.
2. **Internet Survey and Search and Publications:**
    - Conduct internet surveys and searches to gather information relevant to biomechanics, musculoskeletal modeling, and robotics. Utilize available materials such as research papers, articles, and online resources to enrich your understanding and support your project objectives. Refer to academic papers and research articles related to biomechatronics, musculoskeletal modeling, and assistive devices and technologies. Utilize databases such as PubMed, IEEE Xplore, and Google Scholar, ...etc. to find relevant literature.
3. **GitHub Repositories:**
    - Explore GitHub repositories containing code examples, libraries, and projects related to OpenSim, sensors, and assistive device development.

Teamwork and Evaluation Criteria:

- Collaboration in teams of **five or six maximum** is allowed, with clear documentation of individual contributions and respective contribution percentages.
- Assessment will be based on the significance of the selected idea, scientific approach and methodology, results obtained, teamwork, task distribution, report quality, presentation, and the submitted video documenting the work and activities.

Note: Online models cannot be used without modifications and proper referencing. All sources must be acknowledged appropriately and cited in the references section.

This project provides a comprehensive opportunity for students to apply their knowledge of biomechatronics, simulation, and assistive device control in a practical setting, fostering critical thinking and problem-solving skills.

Each team has to submit 3-pages proposal about their course project by 16/3/2023 through LMS. This proposal should include team names, project idea, aims, detailed descriptions, and the tools needed for the project.

Some useful links

https://osim-rl.kidzinski.com/

https://github.com/stanfordnmbl/osim-rl

https://simtk.org/api_docs/opensim/api_docs/mocomainpage.html

https://opensim-org.github.io/opensim-moco-site/

https://simtk.org/api_docs/opensim/api_docs/index.html

https://simtk-confluence.stanford.edu:8443/display/OpenSim/Simulation-Based+Design+to+Reduce+Metabolic+Cost

https://github.com/ComputationalBiomechanicsLab/opensim-creator

https://www.epic.gatech.edu/oslmodels/