AI-enhanced Smart Physical Rehabilitation

Objectives

The objective of the proposed project is to develop a deep learning system for performance evaluation of physical rehabilitation exercises. The system will use a smartphone for capturing the exercises, and deep learning models for evaluating the level of correctness in performing rehabilitation exercises. The project will include three tasks: (1) Collect videos of rehabilitation exercises with a smartphone, and extract skeletal data for the movement of all joints in the exercises. (2) Develop deep learning models to assign a quality score to the performance of each exercise. (3) Develop models to identify incorrect movement elements.

Background

Although a large portion of physical rehabilitation programs are performed by patients in a home-based environment, numerous studies reported that the absence of continuous monitoring and supervision by a clinician results in inferior outcomes and low adherence to prescribed treatment plans. The lack of tools in support of home-based rehabilitation has been widely recognized and continues to impact patient outcomes and the duration and cost of rehabilitation programs. Developing a system that provides feedback to patient performance can reduce the overall costs and the length of the rehabilitation period. Deep neural networks offer a unique potential for modeling the complex correlations between the joints in rehabilitation movement data.

To achieve the stated objectives, the team will first collect data and extract skeletal joints. Afterward, the focus will be on designing a neural network that employs graph-convolutional layers to establish a representation of the body joints in a nodes-edges graph structure. The graphs will contain spatial edges that connect adjacent skeletal joints at each time frame, and temporal edges that connect the same joint across consecutive time frames. Such models will improve the capacity for encoding the spatial and temporal occurrence of the body joints in rehabilitation data.

The team will also develop a multi-task framework for identifying movement elements that are not correctly performed. The model will consider the postural constraints for each exercise, and it will provide feedback to the subjects for improving the performance.

Hardware and Environment

The team will obtain access to Machine Learning and Data Analytics (MIDA) Lab's two high-performance GPU servers and Falcon supercomputer for training the models.

Customer

University of Idaho's Machine Learning and Data Analytics (MIDA) Lab, Dr. Alex Vakanski, Dr. Min Xian.

Expected team

Two students