Application of Motion Interpolation Algorithms to a Kinect Sensor via Microsoft Visual Studio to Accurately Render At-Home Physical Therapy Exercises: A Low-Cost, Systems-Engineered Approach to Assist Stroke Rehabilitation Patients

Maheshwari, Anjali

Approximately nine out of ten patients will have some level of paralysis due to a stroke and need physical therapy to rehabilitate the paralyzed region of the body. Physical therapy often causes an economic burden on the patient and their family. Therefore, this program was coded on Microsoft Visual Studios in C++ and applied Microsoft Kinect's depth-sensing capabilities to improve physical therapy exercise assessments by recording the continuous motion of a rigid body displacement to generate various motions. However, due to background noise, there were often glitches in the Kinect's recordings, resulting in an incomplete depiction of the patient's physical therapy exercise. Therefore, Kinect's data was transformed into basic mechanical engineering principles called dual quaternions, which have the ability to preserve distances and angles between points and represent spatial rigid body displacements. These dual quaternions were implemented in the Screw, Bezier, B-Spline motion interpolation algorithms to the recorded human motion data to display a smooth and continuous physical therapy exercise. Additionally, the patient has the ability to save the image of their exercise and the dual quaternions to an XML file to allow the physical therapist to analyze the patient's exercises virtually. The framework captures human motion data, tracks joints and filters its trajectories using dual quaternions to assist stroke rehabilitation patients in completing at-home physical therapy exercises and decreasing their recovery time. This Kinect-driven solution has the advantage of hardware portability and a one-time cost of $150, which makes it ideal for stroke victims in remote and medically-underserved regions.

Awards Won:
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Intel ISEF Category