Abstract

Stroke is the third leading cause of acquired adult disability worldwide, and its incidence continues to increase with the aging population.[1] Even after months of rehabilitation, many stroke survivors suffer from a range of motor impairments. While traditional in-person rehabilitation has proven successful in regaining motor function, the approach presents challenges ranging from transportation to long-term insurance coverage. Moreover, in the wake of the COVID-19 pandemic, stroke survivors-- most of whom fall into at-risk age groups-- may feel hesitant to resume in-person treatment due to health concerns. As an alternative, the physical therapist (PT) might prescribe a set of exercises for the patient to do on their own at home; however, most studies report less than 50% adherence to such treatment, largely due to a lack of guidance and patient fidelity to the routine.[2]

Depth-aware Automated Rehabilitation (DARe) addresses these obstacles by providing the patient with a virtual platform for interactive, personalized rehabilitation from the convenience of their own home. This novel approach couples LiDAR technology, used to capture patient movement in 3D, and artificial intelligence, which tracks 18 anatomical landmarks throughout the movement, without the need for physical markers and sensors. The accuracy of this approach was compared against OpenPose, the industry standard for markerless human pose estimation (but which relies on multiple calibrated RGB cameras to track 3D movement, as opposed to the single LiDAR camera needed for DARe), and returned an error of $< 1.0\%$.

The motion capture and analysis software has been prototyped in Python and patient/therapist interfaces have been refined through user experience testing. Within the platform, the PT can communicate with and prescribe custom rehab routines and goals to their patient. The patient can then use the LiDAR camera to record their sessions at home and receive immediate performance-based feedback in their profile. At the same time, a more quantitative report is sent to the PT for record-keeping and analysis. As LiDAR sensors are quickly becoming standard in mobile phones (e.g. Apple's iPhone 12 Pro) and tablets due to the increasing popularity of augmented reality, the DARe platform will eventually take the form of a mobile application that can operate on the built-in camera; however, the video processing/analysis software and the clickable prototype of the interface have not yet been integrated.

As health care models shift from service-based to results-based reimbursement, DARe's quantitative approach to rehabilitation could be covered by insurance for long-term recovery, enabling stroke survivors to continue regaining mobility and independence past the acute recovery period. Moreover, DARe will provide increased availability to structured, easily accessible physical therapy for vulnerable populations while bringing stroke rehabilitation into the telehealth realm. This may help level the playing field so that underserved and under-insured persons of need can receive better, more equitable care.

Bibliography

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