Image Analysis of Rehabilitating Patients' Exercise to Measure and Improve Recovery

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An image analysis measurement system was developed for rehabilitating patients on a prescribed exercise regime after joint injury or joint surgery. The relationship between rehabilitation exercises and common injuries was established and a sample set of typical rehabilitation exercises was selected. The system had to be based on affordable technologies and on ensuring the patient performs the exercises correctly. The system used OpenPose software to measure joint and bone positions on any captured exercise image, with Python code written to extract the co-ordinates for the joints and then to calculate the joint angle and superimpose this on the original image. Close to 3,000 exercise images were captured and analyzed. A comparison with the other “healthy” joint drawn from rehabilitation of elite athletes, called the Limb Symmetry Index (LSI) was demonstrated. When benchmarked against standard large, prefabricated angles, the standard deviation of multiple measurements was less than 1°. The system worked well when tested on a variety of exercises and could be used in remote rehabilitation monitoring and even to replace existing devices to measure rehabilitating patients, as it is easy to transmit images for remote analysis. Limitations of the system in terms of captured images, limitations of OpenPose, positioning of the photographer, orientation of the exercise and of the photograph were considered, with examples to underline the limitations. As the world grapples with the COVID-19 pandemic, remote patient monitoring (RPM) systems such as this could be used to offer a safer rehabilitation to the patient than traditional healthcare models.

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