A virtual post-stroke assistant for rehabilitation

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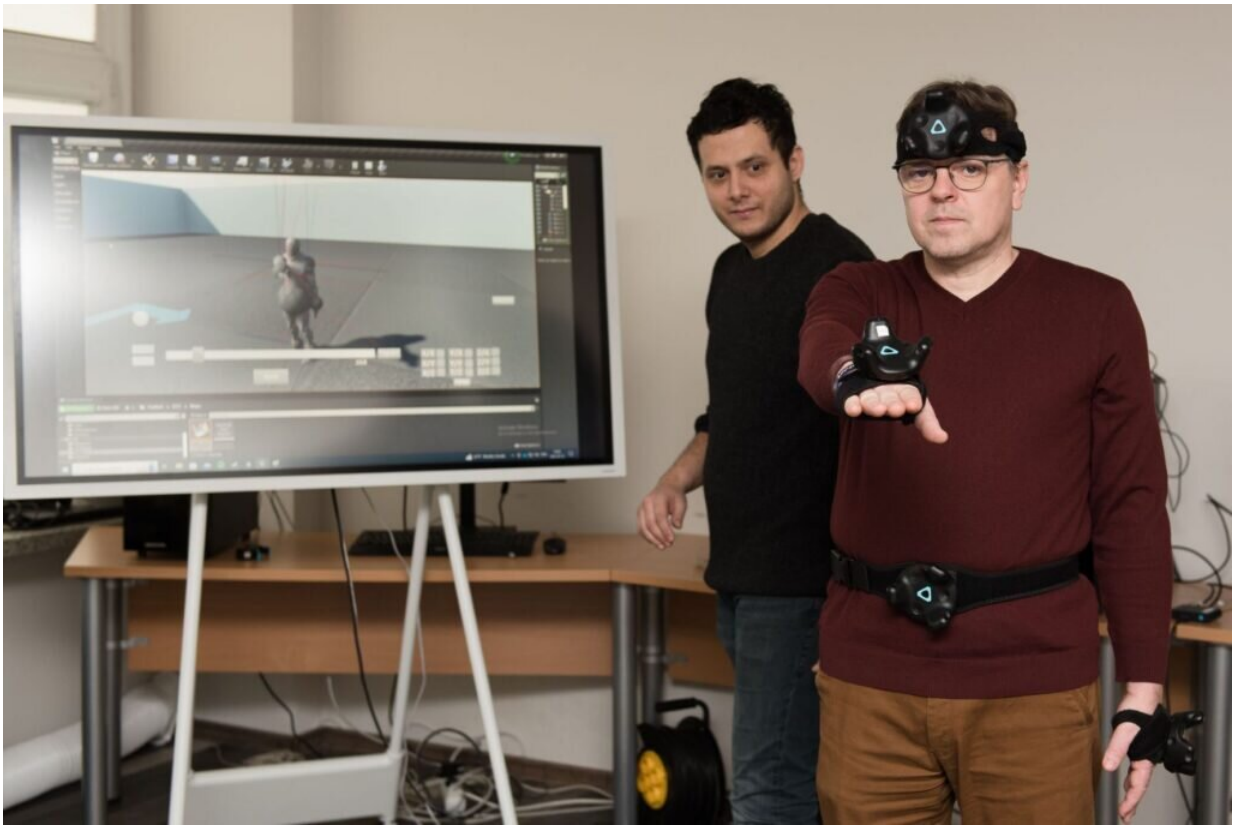

BiomacVR, a VR-based rehabilitation system allows post-stroke patients to exercise at home. Credit: Kaunas University of Technology

Some years ago, virtual reality (VR) systems were associated only with games and leisure in three-dimensional virtual space, but today, VR is

used in a multitude of fields. An innovation created by the team of Lithuanian scientists is a VR-based rehabilitation system, a VR technology without the VR world or glasses, to assist stroke patients.

In the European Union, stroke is the second most common cause of death and a leading cause of adult disability.

Recently, a team of researchers at the Kaunas University of Technology, Faculty of Informatics, led by Rytis Maskeliūnas, presented iTrain, an interactive game designed to care for people after a stroke. While the iTrain game allows the patient to experience patient care in a virtual environment and teaches other essential aspects, BiomacVR, another innovation of the Lithuanian scientists, focuses on patient rehabilitation and the goal of getting the person back on their feet as quickly as possible.

"It is a rehabilitation system with a very simple operation: the person performing the exercises puts the VR sensors on their hands and tries to perform the movements as accurately as possible. With the help of these sensors, the method detects very precisely what the patient is doing in three-dimensional space and reproduces their posture and movements, forming a virtual replica of the person performing the exercises. The doctor can observe and view the exercise from all sides on his monitor and assess it as if the patient was exercising right next to them," says Maskeliūnas about the system.

According to Maskeliūnas, the integration of virtual reality into physical therapy is an innovation that will allow patients to focus on the task at hand and perform it correctly. The software enables the patient to study and adjust the exercises, which ensures an effective healing and rehabilitation process.

Rehabilitation after stroke

According to Aušra Adomavičienė, a researcher at Vilnius University, Faculty of Medicine (VU MF), one of the most common complications in people who have suffered a stroke is an impaired motor function, which is characterized by weakness of the upper and lower limb muscles, spasms, and impaired balance and coordination.

"To match a virtual person with a real patient, we use the person's height and the length of their arms and legs, which we input into the system. Using this information, the system assesses the center of each joint being monitored," says Maskeliūnas about the rehabilitation process.

The system can show deviation and indicate if exercises are not being performed correctly. KTU researcher Maskeliūnas highlights that usually the incorrect execution of the exercises is a result of an injury or stroke.

Adomavičienė agrees, saying that after a stroke when the muscles of both the upper and lower limbs are weakened, the patient's independence in every day and work activities—mobility, self-service, social activity—is impaired. As a result, without sufficient upper limb muscle strength, patients have difficulty eating, dressing or writing, while lower limb motor impairment affects the patient's gait and slows down their walking speed, not only reducing physical activity but also increasing the risk of falls.

The researchers note that the time and potential for recovery varies greatly from patient to patient, and requires a lot of effort, work and expertise. Nevertheless, patients who use the VR system are more engaged in the tasks and strive to complete them as accurately as possible; also, they enjoy seeing the limits of their achievements, feel in control of the situation, and can adjust their movements during the exercise.

So far, the study is limited to stroke patients, but the researchers say that

the system could later be adapted for the rehabilitation of patients with other conditions.

The scientists recently published their invention in the journal *Electronics*, where they present findings from eight commonly used physical education situations from the stroke rehabilitation methodology.

The team emphasizes that the introduction and use of new technologies during rehabilitation enables the patient to be involved in the rehabilitation process, develops their imagination and allows them to actively pursue better outcomes.

"By monitoring the results of the virtual feedback, the rehabilitation specialist can discuss with the patient the difficulties experienced during the session, adjust the program and correct mistakes. The study revealed that by working together and discussing the progress and difficulties of the exercises, the specialist and the patient formulate common goals and discuss the limits of achievement. Also, the patient is more actively involved in the rehabilitation process and becomes a motivated and active participant in the process," says Adomavičienė.

According to the team, this involvement of patients in the rehabilitation process and their ability to take control of the situation and feel able to influence their health outcomes is a very important factor in achieving higher outcomes. Especially, when rehabilitation takes place in the patient's comfort zone—at home.

"The main advantage of this system is that a person can do everything at home, not just in the health care facility, and their progress can be monitored by the doctor remotely, by viewing the recording or by studying the indications of the system," says Maskeliūnas.

The KTU scientist hopes that in the future, the system could be

subsidized as rehabilitation equipment, thus increasing the accessibility and convenience of the medical resource.

More information: Rytis Maskeliūnas et al, BiomacVR: A Virtual Reality-Based System for Precise Human Posture and Motion Analysis in Rehabilitation Exercises Using Depth Sensors, *Electronics* (2023). DOI: 10.3390/electronics12020339