High Fidelity and Objectivity in Balance Assessment

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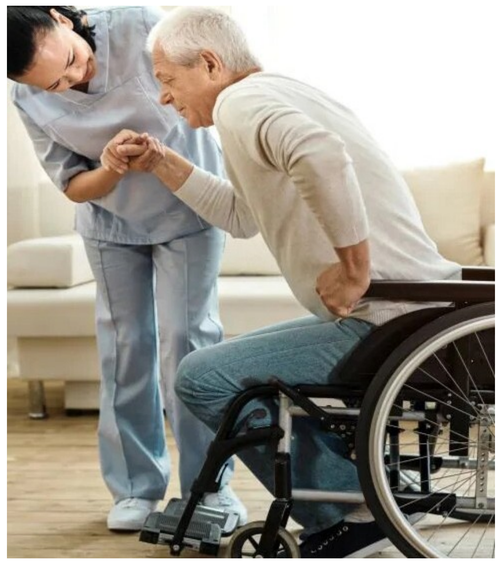
A comparative study of the 6-degree motion tracking for body balance assessment to the conventional paper test by Antoinette Louw , Pei-Fen Chang & Jeff Feng

THE PROBLEM



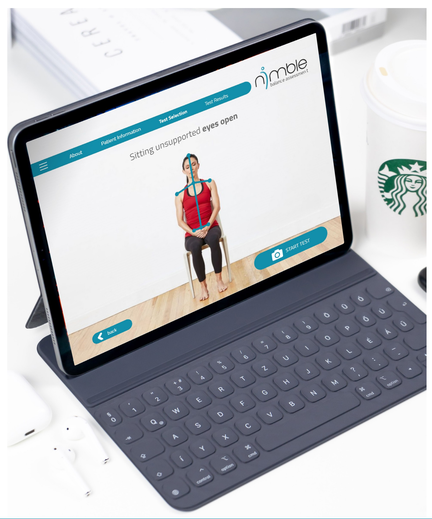
Body balance is an essential capability for an individual to perform activities of daily living (ADLs). There are various performance-based body-balance measures available to occupational therapy clinicians (OT), however, the sitting balance measure is mostly limited to a paper test that is a scoring system for professionals to conduct the test with a subjective assessment. There is a prominent need for a more objective and accurate assessment.

THE SOLUTION

nimble balance assessment

A motion sensing and tracking system developed for objectively assessing patients' body balance in high-resolution motion recording. A collaboration between the School of Occupational Therapy (OT) at Texas Woman's University (TWU) and the College of Architecture and Design at the University of Houston (UH) created the system that uses a six-degree sensing camera system that integrates depth assessment with traditional two-dimensional images. The patients' body motion is identified through a skeleton structure with keyjoint points. The program focuses on the patients' spinal movement highlighted by the spine-shoulder joints and pelvis as a base joint (fig. 1.)

Fig. 1.



THE STUDY

Participants

A pilot study was conducted at a senior activity center in two sessions. A convenience sampling of 20 participants took part in the balance assessment tests. Their age ranged between 60 and 94. Each participant was evaluated by two students simultaneously where one student used the conventional paper-based test and the other student used the NIMBLE system.

Testing Method

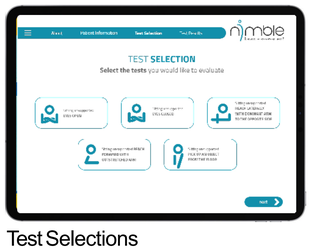
Each participant was tested using 5 different tests to evaluate sitting balance. Each test was performed with the patient sitting unsupported on a stool with both feet on the floor. The NIMBLE system was set up in front of the patient. (See Fig. 2 & 3 for setting).

Fig. 2. The testing setup with the Microsoft Kinect.

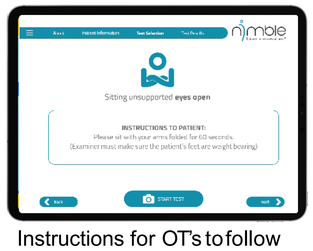
Fig. 3. A patient is being tested.

User Interface

To use this technology, a User Interface for Nimble has been developed and tested to give the Occupational Therapist more control over testing and streamlines the process. The functions include Patient Information, Test Selections, Instructions for OT's to follow, a timer on each test, Test results and Calculated data for an overall result.



Test Selections



Instructions for OT's to follow

THE RESULTS

The NIMBLE system captures body movements and generates a spreadsheet displaying the exact movement increments and illustrating sketches to show movement. All 20 patients obtained a perfect score on the paper tests in all tests which indicated no sitting balance deficits. However, according to the Nimble system, 6 out of the 20 patients showed movement that could not be picked up by eyes and relayed on the paper test. Fig.4 shows a screen-capture example of a perfect sitting test with eyes open unsupported for 30 seconds.

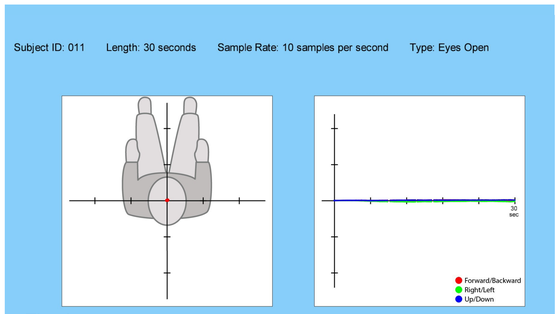


Fig. 4.

As in these displays, the graph on the left shows the testing subject's head movements from a top view. The graph on the right shows the testing subject's body movements in six-degree space representing by moving lines in three colors. The red line shows the forward and backward movement., green shows the right to left movement and blue shows the up and down movement. In Fig. 4, there are very few signs of any movement.

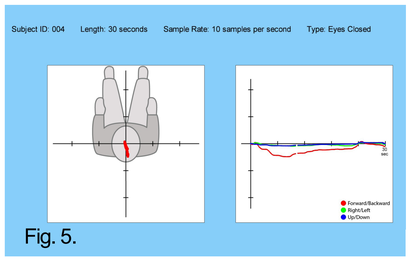


Fig. 5.

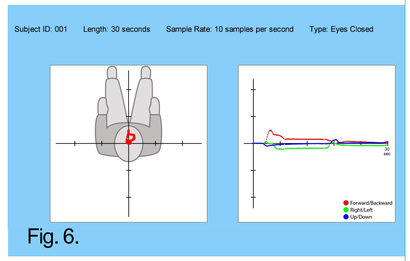


Fig. 6.

Fig.5 and Fig.6 show results from subjects performing the same test but whose body moved backward and forward that was not picked up by the paper test. picked up by the paper test.

THE CONCLUSION

- NIMBLE has shown an excellent capability to capture human body movements when paper-based tests failed to detect balance deficits.
- NIMBLE uses a low cost and user-friendly motion sensing and tracking system to measure balance and has a great potential to be used in various healthcare settings.
- Through the NIMBLE, data is generated and collected on a large scale and the data can be calculated and visualized to show patients' balanced state in a high resolution to measure total travel, velocity, and fluidity of human movement.