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Clinical Science Case Study

The Gait Lab of the Future

Image courtesy of Motek

Over the past 20 years the technologies and techniques available to clinical gait analysis have vastly improved.- Frans Steenbrink - Motekforce Link BV

Pioneering motion capture since 1984.

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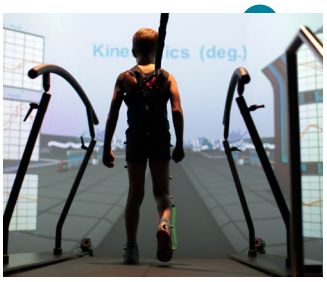

CAREN system

Vero

Motek

There is an ever-growing body of literature showing its usability in various populations, such as cerebral palsy, stroke and orthopedic patients.

Based on clinical gait analysis, a patient's pathological walking condition can be identified, a well-defined treatment protocol can be planned, and the effect of the intervention can be monitored. Unfortunately, the availability of clinical gait analysis for patients remains restricted to highly specialized [academic] medical centers. Gait labs require a significant amount of space (~77m2 on average), which may present challenges in most hospitals and are often left unused for 70% of the time generally only used for assessment and not treatment. The potential for clinical gait analysis is huge, but its field of application is still far too narrow.

Over the past years, rehabilitation technology used for clinical gait analysis has taken a giant leap forward; evolving from primarily scientific setups in research labs to applied research facilities and even certificated medical products. Motekforce Link BV (Amsterdam, NL), in close collaboration with Prof. Jaap Harlaar (VU Medical Center, Amsterdam, NL) and his team, have developed a force instrumented, dual-belt treadmill for clinical gait analysis. In this Gait Real-time Analysis Interactive Lab (GRAIL), patients walk on an enlarged treadmill (walking surface 2mx1m) while Vicon cameras collect motion data. The treadmill can run in a self-paced mode (i.e., it reacts automatically to the changes in pace of the subject), which allows the subject to walk naturally while placed in a speed-matched Virtual Reality (VR) environment with 180° field of view projection. This allows endless natural walking in a realistic environment within the footprint of the treadmill. All gait parameters (i.e., spatio-temporal parameters, joint kinematics, joint kinetics and estimated muscle forces) are calculated using the Human Body Model and are available in real-time.

This treadmill based set-up allows for continuous recordings during walking, which is not typically a priority in conventional gait analysis. For example, in one minute, over 30 full gait cycles can be collected, allowing for analysis of means, variations and changes over time. As all data is available in real-time and can be projected on the screen, predefined parameters of the gait pattern can be assessed directly, which can potentially be used for tuning prosthetic alignment in lower limb amputee patients.

Although for many patients and clinical users this steady state gait analysis will be sufficient, recent studies indicated the benefit of more challenging environments to examine functional gait. The treadmill can be mounted in a robotic frame (CAREN), enabling fast and dynamic pitch and sway of the complete walking surface. This unique concept, together with the interactive VR system, facilitates various types of visual, mechanical and cognitive perturbations during gait. This perturbed functional gait analysis might be a more sensitive and revealing way to assess movement pathologies. Moreover, it enables training for specific real life challenges such as slips and trips, which has tremendous implications for practical implementation.

The option of real-time feedback on any gait parameter provides unique possibilities for gait retraining modalities through a gaming medium. Specific examples of available applications include gait retraining after stroke, gait retraining to treat knee osteoarthritis, dynamic alignment of prosthesis and orthoses, obstacle avoidance for fall prevention, and cueing applications for patients with Parkinson's disease. With more potential applications still to be developed, this kind of clinical gait analysis and training will enhance clinical practice in rehabilitation, neurology and orthopedics.

Close collaborations between medical centers, academia and industry will enhance the use of [functional] gait analysis in routinely clinical practice by allowing co-production of the technology and techniques. As an example, Motekforce Link currently collaborates with the VU Medical Center to develop and evaluate a real-time feedback protocol to enhance information gained from clinical gait analysis of children with Cerebral Palsy which can also be effective in functional gait training.

Prof. Philip Rowe (Strathclyde University, Glasgow, UK) and his team have also been developing uses of the technology in many project areas, including a protocol to assess falls risk in the elderly, based on various types of perturbation, or to developed biomechanical feedback programs for training. Together with Motekforce Link, Prof. Rowe is setting up a consortium to evaluate orthopedic arthroplasty patients, focusing on function restoration post-surgery. Strathclyde, Motekforce Link and Vicon teamed up during the International Society for Biomechanics in July 2015 in Glasgow to run "the ISB Experiment." Over three conference days, 69 subjects walked in six different conditions, equaling 414 full gait analyses performed!

Within a year of ISB we now have six such systems within the NHS in the West of Scotland, showing both the clinical potential of these methods and the ease of implementation they have within clinical services. We boldly feel that we stand on the brink of a transformational change in the role of clinical gait analysis.

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