that of vertical ground reaction forces (GRFs), but greater in transverse rotation (TR) and longitudinal translation (LT) during stance phase with a trans-tibial prosthesis. TR

Directorate of Prosthetics and Orthotics, University of Salford, Salford, UK

Twiste, M., PhD; Rithalia, S.V.S., PhD

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DEVELOPMENT OF AN INSTRUMENTED POLE TEST FOR USE AS A GAIT LABORATORY QUALITY CHECK

Lewis, A., MEng1,2; Stewart, C., PhD3; Postans, N., PhD1; Trevelyan, J., PhD3

1ORLAU, RAH Orthopaedic Hospital, Oswestry, UK; 2School of Engineering, University of Durham, UK

SUMMARY

This paper describes a new pole-based, gait laboratory quality check. It differs from previous designs in that it incorporates a 3D force transducer. Data are presented showing the successful detection of simulated error conditions.

CONCLUSIONS

The pole test provides a useful daily spot check for detecting gait laboratory system failures. Tests such as this are important for any quality system, either general (ISO 9000), or discipline specific.

INTRODUCTION

A 3D gait laboratory contains complex measurement systems. These systems are integrated so there is a risk that sudden equipment failure, or a slow deterioration in performance can go unnoticed. Full calibration tests have been designed (e.g. Hall et al. [1]), but these are generally too time consuming to perform on a daily basis. What is needed is a quick check to verify the position measurements from the cameras, the 3D force output from the force plates and the relative alignment of the different co-ordinate systems.

MATERIALS AND METHODS

A simple test was designed using a long metal pole, with 3 retroreflective markers mounted. The overall design and use is similar to that proposed by Holden et al. [2]. The main difference is that a 3D force transducer is incorporated into the body of the pole. To conduct the test the end of the pole is pressed against the surface of the force plate, while the pole is rotated slowly, transcribing a cone shape. This is repeated at five points across the surface of the plate. Software was produced to automate the data processing. A simple output report gives both detailed information and simple pass/fail indicators based on pre-set thresholds. The functioning of the pole was checked by collecting data sets with the lab operating correctly and under 14 simulated error conditions.

RESULTS

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REFERENCES


P50

CAMERA-MARKER AND INERTIAL SENSOR FUSION FOR IMPROVED MOTION TRACKING

Rutenberg, D.; Veltink, P.H.

Institute for Biomedical Technology, University of Twente, Enschede, The Netherlands

DISCUSSION

The results show that when the lab is functioning correctly the pole test gives a pass. The majority of the failure modes are detected correctly. The failure to detect a transducer Fz or Fy fault is not critical, or surprising, in this configuration. The ability of the system to detect co-ordinate system shifts depends on the pass/fail threshold set. The pole test is simple enough to perform at each patient assessment. This allows the quality of an individual set of patient data to be defended and gives confidence to the clinician when analyzing patient results. The incorporation of the force transducer removes the need to assume an idealized force system and allows the magnitude, as well as the direction, of the force plate output to be verified.

REFERENCES


**SUMMARY**

A method for combining a camera-marker based motion analysis system with miniature inertial sensors is proposed. It is used to fill gaps of optical data and can increase the data rate of the optical system.

**CONCLUSIONS**

Inertial sensors provide accurate position tracking in case of optical data failure. The errors will grow with the gap-time, but off-line analysis significantly reduces the errors. During high dynamic movements, big errors were observed using a standard spline function; however, the inertial sensors measured the trajectory correctly.

**INTRODUCTION**

Optically based systems offer accurate position tracking of body segments. However, the line of sight from marker to camera can be blocked resulting in incomplete data. Miniature inertial sensors like accelerometers and gyroscopes have been proposed as an alternative to camera-based systems. They do not suffer from line-of-sight problems or high costs related to the optical systems, but they are prone to errors due to integration drift. In this study, an optical system was used to update the inertial position estimates and correct drift errors.

**METHODS**

To blend the available data from the inertial sensors and optical system, a complementary Kalman filter was designed in which position, velocity, acceleration and orientation errors were computed based on the measurements of the gyroscopes, accelerometers, optical system and their models. In an offline analysis, a smoothing algorithm was used in which the data was also processed reverse in time. An optical marker was attached to an inertial sensor module (MT9-B, Xsens) and a 6 camera Vicon 470 system was used to capture the trajectory of the marker. The module with marker was moved through the lab by hand in 20 trials (1–2 min).

**RESULTS**

Fig. 1 shows an example of a simulated gap in the optical data from 7 to 9 s in the lab’s x-direction. The 3D measurements from the Vicon system were assigned as unavailable for this period and the Kalman filter estimated the 3D position changes based on the inertial sensor data. The dashed line in the upper graph is the connection between the last and first available optical frames by a standard spline function. The maximum error plotted is 12.1 cm compared to the upper graph is the connection between the last and first available optical frames by a standard spline function. The maximum error plotted is 12.1 cm compared to the upper graph is the connection between the last and first available optical frames by a standard spline function. The maximum error plotted is 12.1 cm compared to the upper graph is the connection between the last and first available optical frames by a standard spline function.

**DISCUSSION**

The combination of an optical system running at a relatively low frame rate with high cost inertial sensors sampled at high frequencies can provide an alternative for expensive high-speed cameras and offer the possibility to measure accelerations of body segments directly instead of differentiating the optical data.

**REFERENCES**


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**PS51**

**TOWARDS PATIENT TRAINING BY AMBULATORY MONITORING AND FEEDBACK OF POSTURAL LOAD EXPOSURE**

**de Vries W.I.K., MSc; Chris B.T.M., Ir**

Roessingh Research and Development, Enschede, The Netherlands

**SUMMARY**

Research goal: To examine the possibilities of training people to minimize their mechanical joint load (e.g. in the low back) by applying automated feedback of orientation based parameters, or by automated assistance of coaching by “clinicians-on-a-distance”. A prototype system has been developed. Inertial sensing is used for the ambulatory measurement of dynamic 3D orientation, and ICT applications are developed for online monitoring, generating feedback, and support for coaching. The measurement method was tested with healthy subjects in an ergonomic assessment. Current work consists of experiments with patients in specific rehabilitation programs, verifying if the system can function as an aid in changing behaviour. This poster tries to discuss what on protocols might be most effective for training. Research questions in this practical part of the study vary from basic learning principles, to acquiring relevant parameters of posture and guidelines for thresholds of feedback, and will build up progressively towards the development of treatment protocols.

**CONCLUSIONS**

It is technically possible to ambulatory assess posture statistics in terms of accurate 3D body segment orientations, while monitoring the stream of data over standard internet facilities. It is still unclear to what extend, or in what way the automated feedback of posture will lead to a change in behaviour.

**INTRODUCTION**

Within the ExO-Zorg framework knowledge is gained considering modelling, design and control of ambulatory healthcare processes, with the help of ICT applications focused on supplying direct automated feedback, and giving the opportunity for professional support on a distance. For the area of postural load a prototype system has been developed.

**MATERIALS AND METHODS**

The proposed method consists of 3D inertial motion sensors, custom calibration protocols for translating sensor to body segment kinematics, applications for the ambulatory measurement of posture and online streaming of data to a server, server-side online analysis, and online monitoring software, which can be assessed by a clinician with a standard web browser from anywhere on the internet.

**RESULTS**

Some first measurements have taken place with healthy subjects in an ergonomic assessment, to test the several functional parts of the system. Calibration of sensors to body segments showed errors less than 2° for thorax and head, to 5–7° for the upper arm. Currently the system supplies feedback based on ergonomic guidelines, but relevant parameters can be adjusted as needed. Current work focuses on applying the method as a coaching assistant for patients suffering from low back pain.

**DISCUSSION**

Discussion is required on: (1) Relevant parameters and amount of information. (2) Acquiring appropriate guidelines and protocols for applying feedback. (3) Basic training principles (feedback, orientation, vibration), automated feedback or coaching by a clinician, obligatory or compulsory feedback.

**REFERENCE**


**Toxin**

**PS52**

**HOW DO REPEATED BTX-A TREATMENTS CHANGE THE WALKING PATTERN IN CHILDREN WITH CP? A LONGITUDINAL EVALUATION**

Molenaers, G., MD, PhD1,2; Desloovere, K., PhD1,2; Van Campenhout, A., MD1; Paewels, P., MD1; Ortibus, E., MD1; Do Cat, J., PT1

1Clinical Motion Analysis Laboratory, CERIM, University Hospital Pellenberg, Belgium.
2Department of Rehabilitation Sciences, Belgium; 3Department of Orthopaedics, K.U. Leuven, Leuven, Belgium.

**SUMMARY**

The effect of repeated botulinum toxin A (BTX-A) treatment session on gait in young children with cerebral palsy (CP) was evaluated, with an averaged follow-up period of 2.3 years.

**CONCLUSIONS**

The present study demonstrates that improved gait can be achieved after repeated multilevel BTX-A treatments. The most significant changes were seen at the ankle joint. The score for Physician Rating Scale (PRS) significantly increased after each treatment session.

**INTRODUCTION**

Positive short-term outcomes with BTX-A have been described in a large number of studies. However, there is a lack of long-term outcome studies of BTX-A treatment in children with CP. Perfectly timed repeated multi-level BTX-A treatments, started at an early age, combined with casting and physiotherapy, may influence the natural history of the child with CP. The purpose of the study was to evaluate the effect of repeated BTX-A treatments in young ambulant children with CP.

**PATTERN/MATERIALS AND METHODS**

Twenty-six children with CP (22 with diplegia and 4 with hemiplegia) were included in this retrospective study according to the following inclusion criteria: predominantly spastic type of CP,