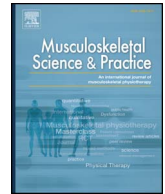




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Technical and measurement report

The development and evaluation of a novel repurposing of a peripheral gaming device for the acquisition of forces applied to a hydraulic treatment plinth

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ABSTRACT

This technical note details the stages taken to create an instrumented hydraulic treatment plinth for the measurement of applied forces in the vertical axis. The modification used a widely available low-cost peripheral gaming device and required only basic construction and computer skills. The instrumented treatment plinth was validated against a laboratory grade force platform across a range of applied masses from 0.5–15 kg, mock Gr I–IV vertebral mobilisations and a dynamic response test. Intraclass correlation coefficients demonstrated poor reliability (0.46) for low masses of 0.5 kg improving to excellent for larger masses up to 15 kg respectively; excellent to good reliability (0.97–0.86) for the mock mobilisations and moderate reliability (0.51) for the dynamic response test. The study demonstrates how a cheap peripheral gaming device can be repurposed so that forces applied to a hydraulic treatment plinth can be collected reliably when applied in a clinically reasoned manner.

1. Introduction

The measurement of force has an almost limitless range of applications within Manual Therapy across mobilisation and soft tissue techniques; however the ability to measure forces in specific and relevant situations poses numerous challenges. The authors were interested in creating an instrumented hydraulic treatment plinth for a variety of purposes within this context.

A multitude of studies have documented how feedback is beneficial in the development of students manual therapy skills and for evaluating practice (Gagnon et al., 2016, 2012; Louw et al., 2004; Snodgrass et al., 2015; Snodgrass et al., 2010a,b; Snodgrass and Odelli, 2012). It is anticipated that the device will be used for research as well as Learning & Teaching purposes, as Snodgrass et al. (2015) details that avenues for distributing their feedback system are being explored, to encourage a wider use of feedback in manual therapy training. There are also, other areas of manual therapy that are yet to be quantified and it is anticipated that, the development of this resource will enable the collection of data for under-researched areas such as soft-tissue massage.

Whilst some instrumented treatment plinths have been cited in literature (Chiradejnant et al., 2001; Snodgrass et al., 2008) they typically involve a complex arrangement of force transducers (at substantial cost) and generally require the ability to write computer code. Although

some alternates including mounting a treatment plinth on force platforms, using force mats or pressure sensors (Gagnon et al., 2016; Shannon et al., 2009; Tuttle, 2011) have been proposed as viable alternatives, the concept of an instrumented treatment plinth removes a number of additional variables (mounting on force platforms or multiple sensors) and is therefore entirely preferable for safety and accuracy reasons. The authors therefore aimed to create a low-cost replicable-instrumented hydraulic treatment plinth with commonly accessible materials and methods of data acquisition.

2. Methods

The lead author had previous experience with the peripheral gaming device (PGD) (Wii Balance Board, Nintendo Inc., Japan) cited to be comparable to a laboratory grade force platform (FP) with the limitation that it is only able to collect force data in a single axis, by design intended to be ground reaction force in the vertical-axis (Clark et al., 2010; Bartlett et al., 2014). The PGD uses four strain-gauge transducers to measure force applied to each corner of a rigid board and transmits data wirelessly to a host console or computer. A major attraction of the PGD is that it is widely available at a fraction of the cost of a laboratory grade FP (Bartlett et al., 2014; Clark et al., 2010). PGDs can be found from as little as £6 UKP compared to several thousand UKP for a

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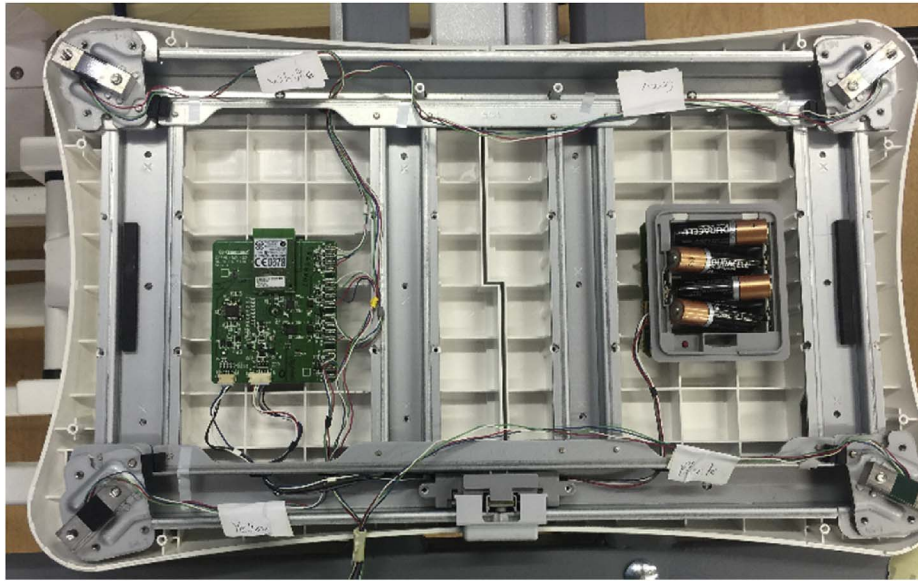


Fig. 1. Internals of a Wii Balance Board.

laboratory FP. The internal construction (Fig. 1) of a PGD provided inspiration for the repurposing of the PGD internals from its manufactured frame onto a bespoke steel frame.

Integration of the PGD transducers into a treatment plinth required separation and isolation of the top cushioned patient sections from the lower base-frame.

A standard two-section treatment plinth (white frame in Fig. 2) was deconstructed to enable the fabrication of two steel frames (grey frame in Fig. 2) from 40 mm box section steel. This provided a complete rigid body for the force transducers that were sandwiched below the padded sections of the treatment plinth for the patient and ensured that a minimal unloaded mass was placed onto the force transducers so that their working range would not be exceeded. The padded cushion

sections were mounted on plywood and therefore not suitable to mount onto the force transducers directly.

The internal force transducers of the PGD together with associated wiring and electronics were noted then carefully removed from the plastic board housing to enable their layout and locations to be up scaled to the much larger dimensions of the hydraulic treatment plinth. Each force transducer was mounted (bolted above and below) with the appropriate plates (Fig. 3) from the PGD enabling specific deformation of the load cell as the manufacturers had intended and then rewired to complete and extend the circuits. Once the padded sections of the treatment plinth had been bolted into place, and the new sub-frames bolted to the original base-frame, the treatment plinth was rigid (in all directions and under normal loading) and able to function safely as before but with the ability to collect force data in the vertical axis, all at a cost of less than £400 to create the PGD_Plinth.

3. Validation

Forceplates (FP) are known as the gold standard of force measurement in a laboratory setting, as a result the PGD_Plinth was positioned across two floor-mounted FP's (AMTI Plates, Watertown, USA) and a range of known masses and mock mobilisation grades applied to establish the accuracy of the PGD_Plinth.

As the PGD_Plinth is intended to record forces applied to a subject, an 80 kg mass was applied to the treatment plinth to simulate the



Fig. 2. Original two-section treatment plinth base-frame (white) and one fabricated steel frame (grey).

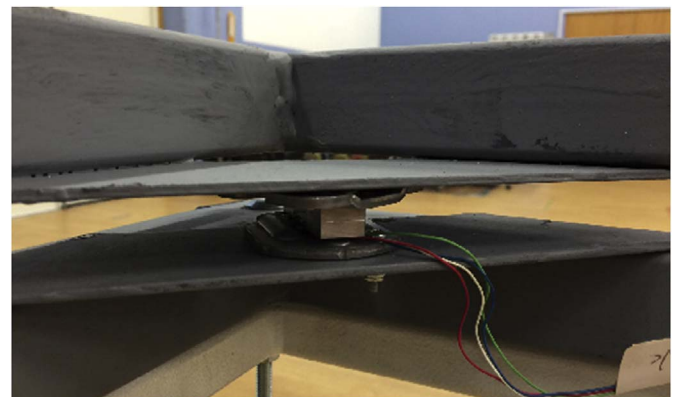


Fig. 3. A PGD force transducer between the two steel frames (prior to being bolted into place).

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