Mechanical Testing Device for Viscoelastic Biomaterials

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The geometric configuration of material specimens can present challenges in fixturing such that the boundary conditions influence test results and skew accurate assessment of material properties. This can further be complicated by specimens of low stiffness such that existing equipment is not optimized for the necessary range of forces and displacements. In this paper, we describe a new device for determining viscoelastic material properties of small biologic specimens and show early results from its use. The mechanical design, control system, and theoretical underpinnings are presented.

3D Foot Plate For Diagnosis of Abnormal Range of Motion in the Hindfoot

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Careful diagnosis of ankle joints with suspected ligamentous trauma is necessary. Accurate 3D stress test techniques can assist in this but the devices used to stress the foot relative to the lower leg are inapt for clinical application. The goal was to evaluate whether a newly designed 3D foot plate fulfills the requirements of the intended users who are the radiology technicians and the patients. Criteria on functionality included position and fixation of the foot in extreme dorsiflexion (45 Å), plantarflexion (85 Å), inversion (55 Å), eversion (55 Å), internal (50 Å) and external rotation (50 Å), compatibility with imaging systems, and sufficient accuracy and reliability. Criteria on usability included the presence of sense of control by manual loading, successful application in 95% of an adult human population, operation within around 100 s. and low mental effort by self-explaining capability of the device. The design was based on a Stewart platform. The dimensions were determined graphically and a fixation mechanism was developed based on friction. A prototype was built from wood and plastics. This was evaluated in a CT-scanner for accuracy and reliability with four subjects. A usability test was performed with 20 radiology technicians who were asked to perform four tasks with the prototype and fill out a questionnaire. The prototype can reach all extreme foot positions for adults with varying anthropometric dimensions. Except two outliers, the accuracy of reaching an extreme foot position is 0.3–6 Å and its reliability is 0.3–3.5 Å. All radiology technicians agreed that the device could be operated by one person with minor physical and mental effort (NASA XLT median 3.5–11%). The tasks were executed with a median time of 91 s. (20–513 s.) and a median error of 0 (0–6). Its appearance was found professional and reliable. Improvement of the rubber hinges, the fixation mechanism and loading protocol could increase accuracy. Concluding, the 3D foot plate fulfills the majority of criteria and is well-received by the intended users. This demonstrates its high potential for clinical use.