Poster Presentation Abstracts:

Paper 1:
Title: 3D Real-Time Multi-Object Interaction and Soft Tissue Deformation Simulation

Abstract:

Soft-tissue deformation is commonly simulated using commercial software applications with nonlinear finite element analysis (FEA) methods. Applications such as LS Dyna and Simulia provide accurate results but they lack in real-time multi-object interaction rendering and have limited simulation settings. Recent development in open-source 3D computer graphics allows more customised applications to be built for various simulation tasks. This paper proposes a workflow of 3D real-time multi-object soft tissue deformation simulation using Blender to voxelise the 3D model, and Unity to simulate multi-object interaction and tissue response. This method was implemented to simultaneously present the soft tissue response of the abdomen and the facial expression of pain of a human avatar undergoing manual palpation. It has the potential to be modified to interface with hardware peripherals, allowing rapid prototyping and testing for application development in computer-based 3D simulations, virtual reality (VR) and augmented reality (AR).

Paper 2:
Title: Spatial Rigid/Flexible Dynamic Model of Biopsy and Brachytherapy Needles Under a General Force Field

Abstract:

Computer-aided simulation of percutaneous needle insertion, as a training tool for junior surgeons, is expected to significantly increase targeting accuracy during minimally invasive operations. An essential requirement for the development of these simulation solutions, is the complete and accurate characterisation of the underlying dynamics of needle insertion. In this regard, this work presents a novel mathematical model, based on the theory of flexible multibody dynamics, that captures the spatial dynamics of needles used for brachytherapy and local anaesthetic transperineal prostate (LATP) biopsy, under a general three-dimensional force field. Due to its accuracy and computational efficiency, the proposed model is expected to constitute a valuable tool for both real-time visual/haptic simulation and control of percutaneous needle insertion.

Paper 3:
Title: Acoustic Response Analysis of Medical Percussion using Wavelet Transform and Neural Networks

Abstract:

Medical percussion is a diagnostic procedure used to detect tissue anomalies by its acoustic response. Although it is common in medical practice, there is a limited understanding of its dynamics. This paper examines the acoustic response of percussion and explores how computational techniques may be used to predict the presence and location of tissue anomalies and develop remote assessment devices. In the experiment, audio signals were obtained using a mechanically actuated device percussing a silicone phantom with an embedded nodule at varying depths. The waveforms were analysed using 1-D wavelet transform and classified through a convolutional neural network (CNN).

Research results showed that a nodule presence closer to the surface of the phantom increases the damping factor and attenuates frequencies between 50 Hz - 400 Hz. This research, for the first time, provides insights and methodologies on how to automate and further understand medical percussion.

Paper 4:
Title: Feasibility of using Cartoon Faces for Expressing Pain to be used in a Robotic Patient: A Preliminary Study

Abstract:

This short paper presents an attempt to study the potential of using cartoon faces for expressing pain. Based on the results of an online survey conducted among 105 participants emphasised that user perception of pain expression increases with the cartoon characteristics of an image. These results suggest the possibility of utilizing cartoon facial expressions for future robotic patients.

Paper 5:
Title: Design and Implementation of a Robotic Device for Medical Percussion

Abstract:

Medical percussion is a diagnostic procedure whereby the chest, back and abdomen are tapped to determine the condition of underlying tissue through the characteristics of the acoustic response. Although percussion is common in medical practice, there is a limited understanding of its dynamics. Experienced doctors may adjust the percussion force and impulse by varying the stiffness of the elbow and wrist joints, but the relationship between adjustments and acoustic response is unexplored. This work presents a novel robotic percussion device that aims to replicate the human percussion action using a two degrees of freedom linkage mechanism with adjustable joint stiffness. The force profile of a medical student performing percussion was recorded and a mathematical model of the mechanism was simulated in MATLAB to find suitable parameters to fabricate a hardware prototype. The device was tested on a silicone phantom tissue model. The measured force profile was similar to a human with less variation between consecutive percussion actions.

Paper 6:
Title: Towards a Soft Hand Tremor Suppression Device for Primary Care

Abstract:

Here we present the conceptual design, initial test findings and a discussion of a soft orthosis for the suppression of hand tremors. The video presents the problem definition, concept of a soft wearable device, initial findings and the conclusions made. Patients with hand tremors face huge difficulties in conducting their daily activities due to tremors. The proposed device uses layer jamming elements with sandpaper (320 grade) and tracing paper, in actuation and has shown promising results at the initial stages under laboratory conditions.