Abstract

During the daily activities, such as chewing, eating, speaking, etc., the human jaw moves and the earcanal is deformed by its anatomic neighbor called the Temporomandibular Joint (TMJ). While these cyclic deformations can influence the positioning, comfort and functioning of ear-fitted devices (like hearing aids, earphones, hearing protectors and earplugs, etc.) they can also provide a significant amount of energy to harvest. The TMJ movements and earcanal deformations have been individually studied so far, however their mutual actions are not fully understood yet. This presentation details the recent development of a six-bar linkage mechanism capable of simulating the complicated interactions between human earcanal and jaw. The development relies on a two-phase mechanism design algorithm to numerically optimize and analytically synthesize mechanisms for which the classical optimization approaches cannot return a converged solution. The proposed optimization approach enables the design of a biomechanical simulator to reproduce the TMJ movement and replicate the jaw rotation during the mouth opening motion by respecting all the hinge-axis parameters of the jaw including the condylar slope of -38.73°, the horizontal translation of 16.30 mm and the correlation of 2.05°/mm between rotaion and translation of the jaw. This algorithm can be subsequently used to further investigate the TMJ-earcanal interactions and ultimately adopted to synthesize other nonlinear complex linkage mechanisms for biomechanical implants, humanoid robots and medical prosthesis.