

Optimizing 3D Shape Parameters of Sports Bra Pads in Motion by Finite Element Dynamic Modelling with Inverse Problem Solution

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Abstract : The design of sports bras poses a considerable challenge due to the difficulty in accurately predicting the wearing result after computer-aided design (CAD). It needs repeated physical try-on or virtual try-on to obtain a comfortable pressure range during motion. Specifically, in the context of running, the exact support area and force exerted on the breasts remain unclear. Consequently, obtaining an effective method to design the sports bra pads shape becomes particularly challenging. This predicament hinders the successful creation and production of sports bras that cater to women's health needs. The purpose of this study is to propose an effective method to obtain the 3D shape of sports bra pads and to understand the relationship between the supporting force and the 3D shape parameters of the pads. Firstly, the static 3D shape of the sports bra pad and human motion data (Running) are obtained by using the 3D scanner and advanced 4D scanning technology. The 3D shape of the sports bra pad is parameterised and simplified by Free-form Deformation (FFD). Then the sub-models of sports bra and human body are constructed by segmenting and meshing them with MSC Apex software. The material coefficient of sports bras is obtained by material testing. The Marc software is then utilised to establish a dynamic contact model between the human breast and the sports bra pad. To realise the reverse design of the sports bra pad, this contact model serves as a forward model for calculating the inverse problem. Based on the forward contact model, the inverse problem of the 3D shape parameters of the sports bra pad with the target bra-wearing pressure range as the boundary condition is solved. Finally, the credibility and accuracy of the simulation are validated by comparing the experimental results with the simulations by the FE model on the pressure distribution. On the one hand, this research allows for a more accurate understanding of the support area and force distribution on the breasts during running. On the other hand, this study can contribute to the customization of sports bra pads for different individuals. It can help to obtain sports bra pads with comfortable dynamic pressure.

Keywords : sports bra design, breast motion, running, inverse problem, finite element dynamic model

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