

コンピュータグラフィクスにより構築した骨格と 骨格筋の三次元画像を用いたスポーツ活動時における 障害発生メカニズムの四次元的解析

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4D Analysis of Skeletal and Muscular Model Using Computer Graphics in Sports Exercise

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ABSTRACT

The mutual interactions of muscles during exercise is one of the most difficult images to visualize. These interactions are usually only estimated by observations made from the skin surface. We aimed to develop a technique to visualize muscle dynamics with quantitative 3D imaging. In this system the skeletal system and muscle system were reconstructed from 3D data sets obtained by CT and MRI.

The skeletal system was reconstructed from CT 3D data sets and each joint could be moved

using the location data obtained by motion capture system in 3D. In the muscle system, the shape and size of each muscle was obtained from MRI 3D data sets measured from the same subject that the skeletal structure was obtained from. We added a few features for this 3D muscle model. These muscle models are composed of elements of muscle fibers and each element is able to contract or relax like real muscle. In Addition, these muscle fibers are able to contract and relax by avoiding the bone or adjacent muscle fibers as real muscle acts in the body by accounting for physical interference. These components of virtual muscle fibers are used to form a 3D structure by fitting the shape and volume according to the reconstructed 3D muscle image of the subject. Finally, each muscle is attached to the skeletal system one by one in its anatomical position. According to the movements of the skeletal system measured by motion capture system, muscle model could be manipulated. In this system, it is possible to record and visualize the dynamics of each muscle and their relative interactions in space and in time sequential domains quantitatively. This system should provide a useful tool to analyze muscle dynamics anatomically and physiologically in 4D space.

要 旨

運動に伴う人体各部のメカニズムの相互作用は、いままで体表からの観察と解剖学的知識情報を基に推測してきた。このような従来の計測手法では視覚化しにくい、運動に伴う骨格各部の空間的な移動とこれを駆動する骨格筋の四次元的（時間的、空間的）な相互作用をコンピュータグラフィックスを用いて定量的に再現し解析できる手法を開発することを目的とした。

本システムにより計測データを基に被験者ごとの骨格、筋肉群の特長を反映した三次元モデルを構築しこれを駆動することにより、一連の動作に伴った各筋肉の活動状況を時系列変化として得ることができることがわかった。今後、本システムを用いることにより正常な運動に伴う筋肉の連係動作を時空間的に観察、解析できるだけでなく、ある筋肉における局所的な損傷が総合的な動作にどのような影響を与えるかといったシミュレーションを行うことができると考える。