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STRENGTH CAPABILITY OF ASTRONAUTS IN SPACESUIT FROM BOTH BIOMECHANICAL MODELING AND EXPERIMENTAL ASPECTS

Abstract

Strength capability of astronaut declines significantly in extravehicular activities due to several reasons including spacesuit stiffness, feet-constraint working mode, and long-term bone loss and muscle atrophy. Our research handles the influence of spacesuit stiffness on astronaut strength capability from both experimental and biomechanical modeling methods. We measured the single-joint isometric contraction and isokinetic contraction of elbow and shoulder muscles. And we measured static functional strength capability of these subjects in several positions and directions such as pull, push, press and lift. Surface electromyography of several muscles was collected during the experiment. All these data was collected in both unsuited and suited condition for comparison. In addition to that, we implemented an integrated biomechanical model for analyzing human-spacesuit arm interaction. The model is able to calculate the joint torques and muscle forces in the arm while wearing spacesuit so that we can predict maximum muscle capability of a joint and activations of a muscle in different function operations. In single joint strength test, we found dramatic strength declines. In functional tasks, we found relative low strength declines. By analyzing the surface electromyography for single joint test, we conclude that the contact pressure between spacesuit and human skin has great influence on strength capability especially when the pressure approaches or exceeds human tolerance. By comparison of the surface electromyography and model-predicted muscle activation, we validated the consistency between model and experimental results. By comparison of predicted maximum muscle forces and measured forces in functional tasks, we concluded that the model could be applied to functional strength capability prediction.