Design and Development of a Model to Simulate 0-G Treadmill Running Using the European Space Agency's Subject Loading System

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PURPOSE

Develop a model that simulates a human running in 0 G using the European Space Agency's (ESA) Subject Loading System (SLS). The model provides ground reaction forces (GRF) based on speed and pull-down forces (PDF).

DESIGN

The theoretical basis for the Running Model was based on a simple spring-mass model. The dynamic properties of the spring-mass model express theoretical vertical GRF (GRFv) and shear GRF in the posterior-anterior direction (GRFsh) during running gait.[1,2] ADAMs VIEW software was used to build the model, which has a pelvis, thigh segment, shank segment, and a spring foot (see Figure 1).the model's movement simulates the joint kinematics of a human running at Earth gravity with the aim of generating GRF data.

DEVELOPMENT & VERIFICATION

ESA provided parabolic flight data of subjects running while using the SLS, for further characterization of the model's GRF. Peak GRF data were fit to a linear regression line dependent on PDF and speed. Interpolation and extrapolation of the regression equation provided a theoretical data matrix, which is used to drive the model's motion equations. Verification of the model was conducted by running the model at 4 different speeds, with each speed accounting for 3 different PDF. The model's GRF data fell within a 1-standard-deviation boundary derived from the empirical ESA data.

CONCLUSION

The Running Model aids in conducting various simulations (potential scenarios include a fatigued runner or a powerful runner generating high loads at a fast cadence) to determine limitations for the T2 vibration isolation system (VIS) aboard the International Space Station. This model can predict how running with the ESA SLS affects the T2 VIS and may be used for other exercise analyses in the future.

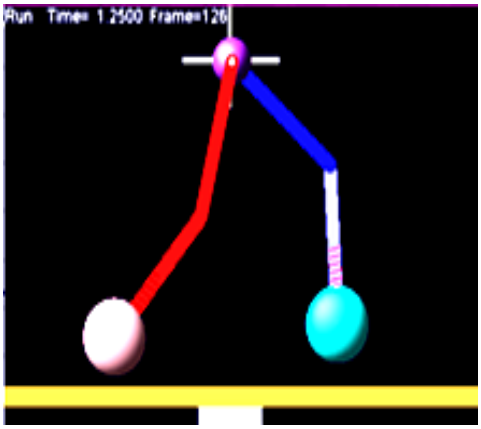

Figure 1. Running Model.

REFERENCES

[1] Bullimore S. et al (2007) J Theor Biol 248, 686-695. [2] Geyer H. (2006) Proc Royal Soc Biol Sci, 273, 2861-2867.