Modeling of soft tissue deformation using mass spring method with nonlinear volume force

Mohd Nadzeri Omar[1], Nasrul Hadi Johari[1], Mohd Hasnun Arif Hassan[1] and Mohd Amzar Azizan[2]

[1] Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia

[2] UniKL MIAT, 43900 Sepang, Selangor, Malaysia

nadzeri@ump.edu.my

nhadi@ump.edu.my

mhasnun@ump.edu.my

mohdamzar@unikl.edu.my

ABSTRACT

Soft tissues displayed two phases of deformation, linear behavior during small deformation and nonlinear behavior during large deformation. Mass Spring Method (MSM) is one of the preferred methods for simulating soft tissue deformations. MSM-based models provide simpler calculations that allow real-time interaction. However, only a small number of MSM models are capable of simulating two phases of soft tissue deformation. This study introduces a new approach to modeling the deformation. The conventional MSM model, which is governed by Hooke's law, is coupled with the nonlinear volume force defined using the conical spring methodology. The nonlinear volume force is triggered by a change in volume in the structure of the MSM model. With the implementation, at small deformation where volume change is also small, only the Hooke's law equation is activated resulting in linear deformation. Whereas, during large deformation, nonlinear deformation occurs as a result of a large change in the MSM volume. Analyzes conducted show that the proposed model can simulate the two phases of deformation. The proposed model can also control each phase independently, which shows that it has a high degree of flexibility on modeling various of soft tissue deformation.

KEYWORDS

Nonlinear volume force; Mass spring method (MSM); Nonlinear deformation; Soft tissue deformation

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