## Proceedings of International Conference on Technology and Social Science 2018 (ICTSS 2018) Keynote Lecture

## Numerical Simulation to Obtain Dynamic Responses for Complicated Systems Involving Hard/Soft Structures and Living Bodies with Reaction

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Abstract. A numerical method is proposed using a fast finite element method to compute dynamic responses for complicated systems including elastic (hard) /viscoelastic (soft) /porous (soft) structures and living bodies with reaction. An explicit expressions of modal loss factor are derived by applying asymptotic expansion to complex eigenvalue problem of the dynamics systems with dissipations Due to this method, we can know modal couplings in damping of the dynamics systems. This method was named as MSKE (Modal Strain and Kinetic Energy) Method. MSKE method is extended for the systems having nonlinear restoring force with linear/nonlinear hysteresis. The proposed method can be applied to compute impact responses of soft structures. We extended this method as complex nonlinear restoring force element to calculate impact responses of interaction systems between alive human bodies and machines (e. g. robots and vehicles). Dynamic responses can be computed for alive human bodies in consideration of difference between contraction and relaxing condition of muscle using complex coefficients for the nonlinear restoring force. Effects of precaution, foresight and panic on the responses can be treated in the computation when negative values are given for the imaginary parts of the nonlinear restoring force element.