SUCCESSIVE ITERATION PROCESS TO INTEGRATE NONLINEAR DIFFERENTIAL EQUATIONS SYSTEMS

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Motion equations for a meshed structure, as in a finite element approach for dynamical analysis of structures, form a differential equations system

$$[M]\{\ddot{U}\}+[C]\{\dot{U}\}+[K]\{U\}=\{F(t)\}, \quad (1)$$

with initial conditions $t=0$, $\{U\}=\{U_0\}$, $\{\dot{U}\}=\{v_0\}$, where

- $[M]$, $[C]$, $[K]$ are coefficients matrix of system,
- $\{\ddot{U}\}$, $\{\dot{U}\}$, $\{U\}$, $\{F\}$, are unknowns, their derivatives and external forces vectors, written in the global coordinates system. The unknown values $\{U\}$ are time varying functions, $\{U\}=\{U(t)\}$.

For some mechanical structures, which include compliant elements like springs, dumping elements, nonrigid joints etc., the motion equations (1) are a strong nonlinear differential second order equations, with matrix coefficients depending of unknowns, their derivatives and eventually of the time:

$$[M]=[\Phi(u,\dot{u},\ddot{u},t)],[C]=[\Phi(u,\dot{u},\ddot{u},t)],[K]=[\Phi(u,\dot{u},\ddot{u},t)]. \quad (2)$$

To integrate this systems there are not a direct method like for linear systems. The solution results after a successive iteration process. Integration will be made at discrete time moments t, *t+Δt*, *t+2Δt,...,t+nΔt*, in considered interval of solutions.

At each time step *i* would evaluate characteristic matrix of structure [*M*], [*K*] and [*C*], but these depend of unknowns and their derivatives would be known at this time. The exit of this situation is a *successive iterations process*, which involves followings steps at each discrete time moments:

- on initialize unknowns with an arbitrary set of values;
- on calculate the first and second order derivatives of unknowns using the initial values with a regressive differential method;
- on determine characteristic matrix of system [M], [K] and [C];
- on integrate resulting linear system using a numerical method;
- on compare the resulted solution with iteration starting values; if the errors are grater than admitted tolerance on proceed an another iteration using start values the solution determinated at anterior iteration;

In this paper are detailed this procedure for integration of the motion equations resulting from a finite element approach in dynamical analysis of a compliant structure.

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