c:\tex\berichte\bremer@RICAM_english.pdf]

Recursive Methods in Nonlinear Multi Body Dynamics

H. Bremer

Methodology. Considering nontrivial Multi Body Systems (MBS), the analytical procedures (Lagrange, Hamilton) cannot be recommended because of the required effort. The effort even grows when nonholonomic variables are used (Hamel, Boltzmann, Maggi) which in principle allows for nonholonomic constraints. However, these may only be inserted afterwards because these methods demand directional derivatives w.r.t. the kinetic energy. This directional derivative also plays a special role in systems where large and small amplitudes arise synchroneously as is typical for elastic bodies with superimposed gross motion. Here, the partially linearized equations of elastic deformations may feign wrong results. All mentioned disadvantages are avoided with the use of the Projection Equation.

Recursion - ODE. Sum splitting in the Projection Equation leads to a subsystem representation. Its kinematics is suitably calculated with a forward recursion. By this, the functional matrix which assembles the subsystems becomes upper block-triangular. Resolving equations in the sense of an Gaussian algorithm needs a backward recursion till the basic system which does not contain unknown predecessor accelerations any more. A subsequent forward recursion then yields the minimal acceleration vector avoiding inversion of the total mass matrix. The resulting tools prove to be extremely simple due to the use of nonholonomic variables. This fact also holds for elastic MBS in combination with a direct Ritz procedure. Because of the presumed small deformation amplitudes, special attention has to be drawn to the corresponding partial linearization ("Dynamical Stiffening").

Recursion - PDE? Although solution convergence of Ritz's procedure is basicly assured, the number of needed shape functions may grow significantly. The minimal form of motion equations in an elastic MBS is the hereto assigned coupled ordinary and partial differential system. It is obtained from the Projection Equation without problems with the use of a (spatial) differential operator. Also, the upper triangular structure is retained in principle. Due to the transmission of deformations and velocities at the coupling points from one system to the next, however, one is left with disastrous boundary conditions ...