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A penalty approach to the numerical simulation of a constrained wave motion

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Abstract

The main goal of this article is to investigate the numerical solution of a vector-valued nonlinear wave equation, the nonlinearity being of the Ginzburg-Landau type, namely (|u|2-1)u. This equation is obtained when treating by penalty a constrained wave-motion, where the displacement vector is of constant length (1 here, after rescaling). An important step of the approximation process is the construction of a time discretization scheme preserving-in some sense-the energy conservation property of the continuous model. The stability properties of the above scheme are discussed. The authors discuss also the finite element approximation and the quasi-Newton solution of the nonlinear elliptic system obtained at each time step from the time discretization. The results of numerical experiments are presented; they show that for the constraint of the original wave problem to be accurately verified we need to use a small value of the penalty parameter.

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Keywords

Constrained wave motion, Numerical simulation, Penalty approach