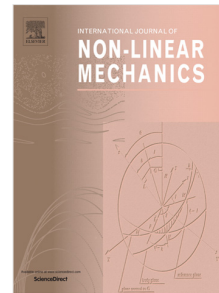


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Non-linear problems with non-monotonic blow-up solutions: Non-local transformations, test problems, exact solutions, and numerical integration

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Abstract

The method of non-local transformations is proposed for numerical integration of non-linear Cauchy problems having non-monotonic blow-up solutions. In such problems there exists a singular point whose position is unknown in advance (for this reason, the standard numerical methods for solving blow-up problems can lead to significant errors). In addition, the non-monotonic behavior of the solution excludes a possibility of applying the hodograph transformation and some other methods that are used for numerical investigation of simpler problems having monotone blow-up solutions. In this paper, the method is described for numerical integration of similar problems for non-linear n th-order ordinary differential equations $x_t^{(n)} = g(t, x, x_t', \dots, x_t^{(n-1)})$, based on the introduction of a new non-local independent variable ξ , which is related to the original variables t and x by the equation $\xi_t' = g(t, x, x_t', \dots, x_t^{(n-1)}, \xi)$, and the subsequent transformation of the original problem to the Cauchy problem for the corresponding system of first-order differential equations. With a suitable choice of the regularizing function g , the proposed method leads to problems whose solutions are presented in parametric form and do not have blowing-up singular points; therefore the transformed

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