Journal of Convex Analysis 25 (2018) 861–898

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# Elliptic-Regularization of Nonpotential Perturbations of Doubly-Nonlinear Flows of Nonconvex Energies: A Variational Approach

This paper presents a variational approach to doubly-nonlinear (gradient) flows (P) of nonconvex energies along with nonpotential perturbations (i.e., perturbation terms without any potential structures). An elliptic-in-time regularization of the original equation $(\mathrm{P})_\varepsilon$ is introduced, and then, a variational approach and a fixed-point argument are employed to prove existence of strong solutions to $(\mathrm{P})_\varepsilon$. More precisely, we introduce a family of functionals (defined over entire trajectories) parametrized by a small parameter $\varepsilon$, whose Euler-Lagrange equation corresponds to the elliptic-in-time regularization of an unperturbed (i.e. without nonpotential perturbations) doubly-nonlinear flow. Secondly, due to the presence of nonpotential perturbation, a fixed-point argument is performed to construct strong solutions $u_\varepsilon$ to the elliptic-in-time regularized equations $(\mathrm{P})_\varepsilon$. Finally, a strong solution to the original equation (P) is obtained by passing to the limit of $u_\varepsilon$ as $\varepsilon \to 0$. Applications of the abstract theory developed in the present paper to concrete PDEs are also exhibited.