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Normalized P-Laplacian: From Stochastic Game to Image Processing

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Abstract : More and more contemporary applications involve data in the form of functions defined on irregular and topologically complicated domains (images, meshs, points clouds, networks, etc). Such data are not organized as familiar digital signals and images sampled on regular lattices. However, they can be conveniently represented as graphs where each vertex represents measured data and each edge represents a relationship (connectivity or certain affinities or interaction) between two vertices. Processing and analyzing these types of data is a major challenge for both image and machine learning communities. Hence, it is very important to transfer to graphs and networks many of the mathematical tools which were initially developed on usual Euclidean spaces and proven to be efficient for many inverse problems and applications dealing with usual image and signal domains. Historically, the main tools for the study of graphs or networks come from combinatorial and graph theory. In recent years there has been an increasing interest in the investigation of one of the major mathematical tools for signal and image analysis, which are Partial Differential Equations (PDEs) variational methods on graphs. The normalized p-laplacian operator has been recently introduced to model a stochastic game called tug-of-war-game with noise. Part interest of this class of operators arises from the fact that it includes, as particular case, the infinity Laplacian, the mean curvature operator and the traditionnal Laplacian operators which was extensiveley used to models and to solve problems in image processing. The purpose of this paper is to introduce and to study a new class of normalized p-Laplacian on graphs. The introduction is based on the extension of p-harmonious function introduced in as discrete approximation for both infinity Laplacian and p-Laplacian equations. Finally, we propose to use these operators as a framework for solving many inverse problems in image processing.

Keywords : normalized p-laplacian, image processing, stochastic game, inverse problems
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