Jo, Gwanghyun; Lee, Young Ju; Ojeda-Ruiz, Iván
2D and 3D image reconstruction from slice data based on a constrained bilateral smoothing and dynamic mode decomposition. (English) Zbl 07483719

Summary: In this paper, we present an algebraic, graph theoretic and data-based image inpainting algorithm. The algorithm is applied to reconstruct area or volume from one-dimensional and two-dimensional slice data. Given one-dimensional or two-dimensional slice data, our algorithm first performs a simple algebraic presmoothing of the data, e.g., Gaussian filters. The second step is to obtain, from these smoothed data, an operator that reconstructs them via Dynamic Mode Decomposition. Dynamic Mode Decomposition is an equation-free modeler, which is designed to construct the discrete dynamical operator considering slice data as a time series data. We interpret the DMD as a solution to the inverse problem and apply an appropriate continuous extension of DMD to fill the missing time series data. The last step is to smooth the outcome from the second step using a Constraint Bilateral Smoother. The Constraint Bilateral Smoother is designed to smooth the boundary of area or volume, respecting the given slice data. We demonstrate the performance of the proposed algorithm, in several test cases, which include an Magnetic Resonance Imaging of a two-year-old and a Computed Tomography scan of a Covid-19 patient. We also show that a couple of test results are better than those from some competitive alternative techniques up to 50%. Our tests also show that the inpainting computation time increases linearly as a function of the number of pixels or voxels with slope just around 0.5.

MSC:
15Axx Basic linear algebra
94Axx Communication, information
65Nxx Numerical methods for partial differential equations, boundary value problems

Keywords:
dynamic mode decomposition; constrained bilateral smoothing; image segmentation; image inpainting

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References:
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