

A Total Variation Minimization Template Library

Master Thesis

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1 Introduction

- TV Minimization of Grayscale images (Osher paper)
- RGB, flat and non-flat color models
- generalization: manifold valued data
- Optimization on manifolds, intrinsic geometry, gradient descent versus Newton
- IRLS paper

2 Library

2.1 Capabilities

- Manifolds: Euc, S^n , $SO(n)$, $SPD(N)$, $GR(N,P)$
- Functionals: Aniso/Iso, first order
- Minimizer: IRLS, PRPT
- Data: 2D, 3D, Various input formats, OpenCV Integration

2.2 Design Concepts

- Goals: Extendable, modularized, templated, fast, easy to use
- C++ techniques: Variadic templates, lambda function, compile time optimization
- Levels of Parallelism: Thread, shared memory, Vectorization, instruction level parallelism
- Diagram of Components, short description of each component

2.3 Usage

- Prerequisites and Installation
- Usage of the library and example cases

3 Theory and Implementation details

3.1 Algorithms overview

- IRLS, PRPT

3.2 Manifolds

- Short summary of Euclidian, S^n
- Summary of Semi-analytic expressions for derivatives of SPD , $SO(n)$
- Implementation of Frechet Derivatives for DLog
- Grassmann manifold

3.3 3D generalization

- Data container, functional

4 Numerical experiments

4.1 Applications

- Image denoise: gray, RGB flat and non-flat colormodels
- SON: fingerprint orientation and flowfield calculation
- SOD: DTI images
- Grassmann: Chromatic denoising and maybe something else more interesting

4.2 Performance analysis (optional)

- pixel versus time needed, analysis of various metrics cache misses: cpu cycles in which part of the program...

5 Outlook

- further improvements and possible extension,..

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