IPOL: A Reproducible Research Journal and Platform for Image Processing

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Sous la co-tutelle de :
CNRS
ÉCOLE DES PONTS PARISTECH
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Some definitions

Repeatability and replicability

Capacity to perform the same experiment as many times as needed.
→ **Repeatability**: Same team, same experimental setup
→ **Replicability**: Different team, same experimental setup

Example: is distilled water electrically conductive? Is salt water conductive?
We can perform the experiment many times and get results
(https://www.dailymotion.com/video/x2lcg6a).

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Reproducibility

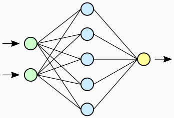
Capacity to obtain the same results when repeating an experiment by following a detailed procedure
→ Different team, different experimental setup

In computational sciences (deterministic code, digital data): results obtained by following a detailed and correct pseudo-code description must coincide if the same input data is provided.

Repeatability Examples

Repeatable

Obtaining the classification results with a neural network.
We can repeat the experiment as many times as we want.
We just need the weights of the network and the input data.



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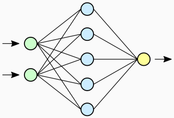

Not repeatable:

Detection of the merger of two black holes from gravitational waves. We can't repeat the experiment as needed.

Reproducibility Examples

Reproducible:

Given:

- a detailed pseudo-code (or the source code itself),
- any associated learning or initialization data,
- the input data,

we should obtain exactly the same results each time we run the algorithm.

$\Rightarrow$ Exactly the same denoised image, classification results, etc.

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⇒ Exactly the same denoised image, classification results, etc.

Not reproducible

In a paper that shows

- a pseudo-code without all the details, or its initialization,
- the source code is not available,
- neither the learning data,

other researchers can't compare with the proposed method.

⇒ We can't be sure about anything on the method, nor test it with our own data.

Implementation of Reproducible Research

- Non-exact sciences (biology, medicine,): dicult (but *desirable*). Hard to have exactly the same conditions along experiments.
- Computational sciences: no excuse!

Why are we not all doing reproducible research?

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Several reasons in general:

- Some researchers don't want to make public working code
  - doesn't correspond to any version of the pseudo-codes,
  - low software quality,
  - quality software takes more time to produce: testing, documentation, objective quality metrics.
- Results of the method do not generalize
- . . . (For the discussion later!)

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Not really considered for career advance

- Classic metrics: "number of high impact-factor classic publications"
- Software is considered as a 2nd class citizen

Reproducible Research Platforms

Different types of platforms

- Online execution platforms.
- Dissemination platforms.
- Peer-reviewed journals.

- **Galaxy** - `https://galaxyproject.org`
- **IPython** - `https://ipython.org`
- **Jupyter** - `http://jupyter.org`
- **RunMyCode** - `http://www.runmycode.org`
- **Code Ocean** - `https://codeocean.com`
- **DAE** - `http://dae.cse.lehigh.edu/DAE`
- **IPOL** - `https://www.ipol.im`
- **Research Compendia** - `ResearchCompendia.org`
- **MLOSS** - `https://mloss.org/software`
- **DataHub** - `https://datahub.io/`
- **PaperWithCode** - `https://paperswithcode.com`

- **ReScience Journal** - `http://rescience.github.io`
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- **DAE** - http://dae.cse.lehigh.edu/DAE
- **IPOL** - https://www.ipol.im
- **Research Compendia** - ResearchCompendia.org
- **MLOSS** - https://mloss.org/software
- **DataHub** - https://datahub.io/
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The IPOL Journal

- Started in 2009 under the initiative of Nicolas Limare and Jean-Michel Morel (ENS Paris Saclay).
- A journal initially targeting image processing (Image Processing On Line)
- Some other data types were added: video, audio, 3D data...
- Even some articles on SARS-CoV-2 evolution!
  "A Daily Measure of the SARS-CoV-2 Effective Reproduction Number for all Countries" `http://www.ipol.im/pub/art/2020/304/`
- Today it it a general journal on reproducible algorithms
  → Information Processing On Line

IPOL Publications

Peer-reviewed

- Both the article (PDF) and the source code.
- Reproducibility: the reviewers check carefully that the source code matches the pseudo-code.

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- The source code, under an open-source software license.
- An online demo which allows users to test the method with their own data.
- An archive of experiments.

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- ISSN, DOI, indexed by SCOPUS. Not yet an "Impact Factor".

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Let's have a look! ⇒ `http://www.ipol.im/pub/art/2017/201/`

IPOL
article


ipol.im/pub/art/2017/201/

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Multi-Scale DCT Denoising

Nicola Pierazzo, Jean-Michel Morel, Gabriele Facciolo

article demo archive

published • 2017-10-29
reference • Nicola Pierazzo, Jean-Michel Morel, and Gabriele Facciolo, *Multi-Scale DCT Denoising*, Image Processing On Line, 7 (2017), pp. 288–308. https://doi.org/10.5201/ipol.2017.201

BibTeX info

Communicated by Julie Delon
Demo edited by Gabriele Facciolo

This IPOL article is related to a companion publication in the SIAM Journal on Imaging Sciences:
G. Facciolo, N. Pierazzo, J-M. Morel, "Conservative Scale Recomposition for Multiscale Denoising (The Devil is in the High Frequency Detail)" *SIAM Journal on Imaging Sciences* 10(3):1603-1626, 2017. http://dx.doi.org/10.1137/17M1111826

Abstract

DCT denoising is a classic low complexity method built in the JPEG compression norm. Once made translation invariant, this algorithm was still proven to be competitive at the beginning of this century. Since then, it has been outperformed by patch based methods, which are far more complex. This paper proposes a two-step multi-scale version of the algorithm that boosts its performance and reduces its artifacts. The multi-scale strategy decomposes the image in a dyadic DCT pyramid, which keeps noise white at all scales. The single scale denoising is then applied to all scales, thus giving multiple denoised versions of the low frequency coefficients of the denoised image. A 'multi-scale fusion' of these multiple estimates avoids the ringing artifacts resulting from the pyramid recomposition. The final algorithm attains a good PNSR and much improved visual image quality. It is shown to have a deficit of only 1dB with respect to state of the art algorithms, but its complexity is two orders of magnitude lower.

Download

- full text manuscript: PDF low-res. (1.7M) PDF (15.2M)
- source code: ZIP SWHID info

Preview

Loading takes a few seconds. Images and graphics are degraded here for faster rendering. See the downloadable PDF documents for original high-quality versions.

For the hard thresholding pass of the algorithm the aggregation weights are set, as in [3], by counting the number N_P of nonzero DCT coefficients (excluding the zero frequency) in the patch after thresholding. These aggregation weights are then given by

$$(1+N_P)^{-1}, \quad (1)$$

where the one is added to prevent the dividing by zero (but it is an arbitrary choice). Indeed, the number of non-zero coefficients will be small for the flat patches, compared to patches containing

290

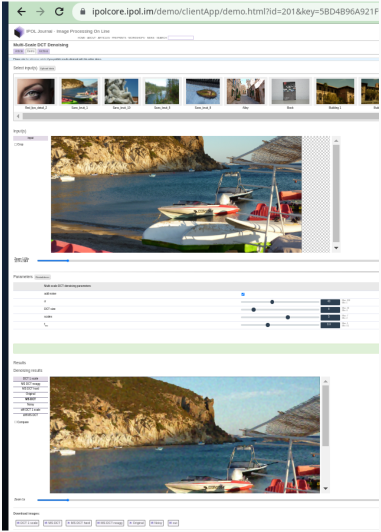
LOW RESOLUTION PDF: Images may show compression artifacts. A full resolution PDF is available at www.ipol.im.

Multi-Scale DCT Denoising

Algorithm 2: DCT Denoising - Hard thresholding

1 **Function** DCTdenoisingHard(Y, σ, s)
input : noisy image Y, noise level σ, and patch size s

IPOL demo


ipolcore.ipol.im/demo/clientApp/demo.html?id=201&key=5BD4B96A921F
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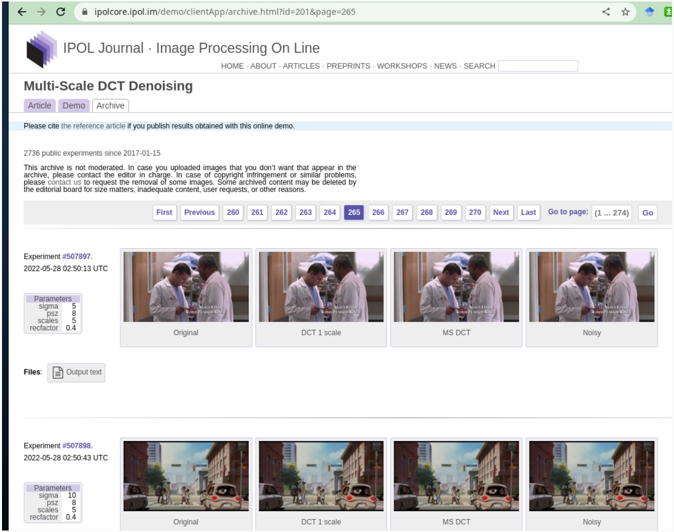
Multi-Scale DCT Denoising
Select input(s)
Input(s)
Parameters
Results
Denoising results
Download images:

IPOL archive



Benefits of RR

If a method is worth it, the impact is large

- Users worldwide can test the algorithm with their own data.
- Increase in the number of citations: other researchers can now compare to you.

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Useful to show a landscape of our scientific activity

Reviewing RR

Main attention points:

- Consider **source code** as part of the publication, not supplementary material
- Different **levels of evaluation**:
  - Lowest: **black box** (same inputs same outputs)
  - . . .
  - Highest: deep understanding of the method and checking that the source code matches the implementation faithfully.

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- Many researchers are not software engineers!

$\Rightarrow$ A possible solution (IPOL): use **at least two reviewers**, one of them being an expert reading source code.

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Special case of neural networks

Focus on the **architecture**, **training**, **understanding**, and **generalization**.

IPOL Submission Processing

- Four editors in chief: Luis Alvarez (Univ. Gran Canaria), PM, Jean-Michel Morel (ENS Paris Saclay), Gregory Randall (Univ. Montevideo)
- EiCs decide if the submission looks interesting.
- EiCs name an associate editor for the submission.
- The editor chooses reviewers and a demo editor.
- Reviewers may be asked to check different aspects: article, code, demo.
- After acceptation, an EiC checks the article and plays with the demo, testing with different input data and parameters

Published articles

Currently about 15–20 accepted submissions per year.

Google Scholar	CONNEXION

IPOL CITATIONS

SUIVRE

IPOL Journal Image Processing Online
Adresse e-mail validée de ctim.es - Page d'accueil
Image Processing   Applied Mathematics

TITRE	CITÉE PAR	ANNÉE
LSD: a line segment detector RG Von Gioi, J Jakubowicz, JM Morel, G Randall IPOL Journal Image Processing On Line 2, 35-55	720	2012
Non-Local Means Denoising A Buades, B Coll, JM Morel IPOL Journal : Image Processing On Line 1	691	2011
TV-L1 Optical Flow Estimation J Sánchez, E Meinhardt-Llopis, G Facciolo IPOL Journal : Image Processing On Line. 3, 137-150	394 *	2013
An Analysis of the Viola-Jones Face Detection Algorithm YQ Wang IPOL Journal : Image Processing On Line 4, 128-148	390	2014
Asift: An algorithm for fully affine invariant comparison G Yu, JM Morel IPOL Journal : Image Processing On Line 1	385	2011
An Analysis and Implementation of the BM3D Image Denoising Method M Lebrun IPOL Journal Image Processing On Line 2, 175-213	350	2012
Multiscale Retinex AB Petro, C Sbert, JM Morel IPOL Journal : Image Processing On Line 4, 71-88	266	2014
Rudin-Osher-Fatemi total variation denoising using split Bregman P Getreuer IPOL Journal : Image Processing On Line 2, 79-95	263	2012
Chan-vese segmentation P Getreuer IPOL Journal : Image Processing On Line 2, 214-224	189	2012
Horn-schunck optical flow with a multi-scale strategy E Meinhardt-Llopis, JS Pérez, D Kondermann	157	2013

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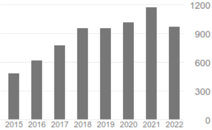
Citée par	TOUT AFFICHER

	Toutes	Depuis 2017
Citations	7724	5853
indice h	39	36
indice i10	106	92



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- A. Buades
- Pascal Getreuer — Google Research
- rafael grompone von gioi — Centre Borelli, ENS Paris-Saclay…
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Thank you for your attention