NTIRE 2023 Image Denoising ($\sigma = 50$) Challenge Factsheet - Denoising network with 4 Concatenation (D4C) -

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1. Introduction

This factsheet template is meant to structure the description of the contributions made by each participating team in the NTIRE 2023 challenge on image denoising with noise level $\sigma = 50$.

Ideally, all the aspects enumerated below should be addressed. The provided information, the codes/executables and the achieved performance on the testing data are used to decide the awardees of the NTIRE 2023 challenge.

Reproducibility is a must and needs to be checked for the final test results in order to qualify for the NTIRE awards.

The main winners will be decided based on overall performance and a number of awards will go to novel, interesting solutions and to solutions that stand up as the best in a particular subcategory the judging committee will decided. Please check the competition webpage and forums for more details.

The winners, the awardees and the top ranking teams will be invited to co-author the NTIRE 2023 challenge report and to submit papers with their solutions to the NTIRE 2023 workshop. Detailed descriptions are much appreciated.

The factsheet, source codes/executables, trained models should be sent to **all of the NTIRE 2023 challenge organizers (Yawei Li, Yulun Zhang, and Radu Timofte)** by email.

2. Email final submission guide

To: yawei.li@vision.ee.ethz.ch
yulun100@gmail.com
timofte.radu@gmail.com
cc: your_team_members
Title: NTIRE 2023 Image Denoising Challenge - TEAM_NAME - TEAM_ID

To get your TEAM_ID, please register at Google Sheet. Please fill in your Team Name, Contact Person, and Contact Email in the first empty row from the top of sheet. Body contents should include:

a) team name

b) team leader's name and email address

c) rest of the team members

d) user names on NTIRE 2023 CodaLab competitions

e) Code, pretrained model, and factsheet download command, e.g. `git clone ...`, `wget ...`

f) Result download command, e.g. `wget ...`

- Please provide different urls in e) and f)

Factsheet must be a compiled pdf file together with a zip with .tex factsheet source files. Please provide a detailed explanation.

3. Code Submission

The code and trained models should be organized according to the GitHub repository. This code repository provides the basis to compare the various methods in the challenge. **Code scripts based on other repositories will not be accepted.** Specifically, you should follow the steps below.

1. Git clone the repository.
2. Put your model script under the `models` folder. Name your model script as `[Your_Team_ID]_[Your_Model_Name].py`.
3. Put your pretrained model under the `model_zoo` folder. Name your model checkpoint as `[Your_Team_ID]_[Your_Model_Name].[pth or pt or ckpt]`
4. Modify `model_path` in `test_demo.py`. Modify the imported models.
5. `python test_demo.py`

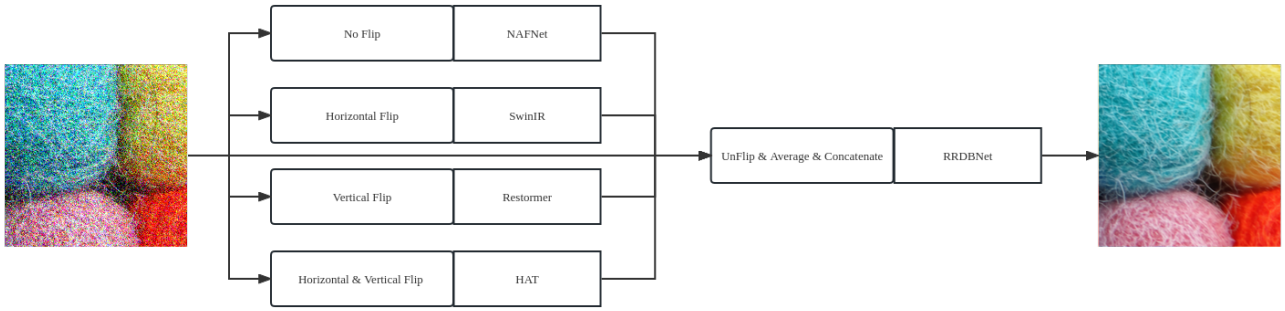

Figure 1. The architecture of our pipeline.

Please send us the command to download your code, e.g. `git clone [Your repository link]` When submitting the code, please remove the noisy and denoise images in `data` folder to save the bandwidth.

4. Factsheet Information

The factsheet should contain the following information. Most importantly, you should describe your method in detail. The training strategy (optimization method, learning rate schedule, and other parameters such as batch size, and patch size) and training data (information about the additional trainning data) should also be explained in detail.

4.1. Team details

- Team name

  MiAlgo

- Team leader name

  Shuai Liu

- Team leader address, phone number, and email

  Address: Xiaomi Technology Park, Anningzhuang Road, Haidian District, Beijing, China

  Phone number: +86-18601200232

  Email: liushuai21@xiaomi.com

- Rest of the team members

  Furui Bai, Chaoyu Feng, Hao Wang, Yuqian Zhang, Xiaotao Wang, Lei Lei

- Team website URL (if any)

- Affiliation

  Xiaomi Inc., China

- Affiliation of the team and/or team members with NTIRE 2023 sponsors (check the workshop website)

- User names and entries on the NTIRE 2023 Codalab competitions (development/validation and testing phases)

  mialgo_ls

- Best scoring entries of the team during development/validation phase

- Link to the codes/executables of the solution(s) `https://github.com/q935970314/NTIRE23_denoising_MiAlgo_D4C`

4.2. Method details

You should describe your proposed solution in detail. This part is equivalent to the methodology part of a conference paper submission. The description should cover the following details.

- General method description (How is the network designed.)

  Recently, the development of deep learning-based image enhancement techniques has been advancing rapidly. Many state-of-the-art methods based on CNN and Transformer have achieved great success in tasks such as super-resolution reconstruction, image denoising, and image deblurring. In order to further explore the potential of deep learning-based methods in image denoising tasks, we propose a **D**enoising network with **4** **C**oncatenation (D4C).

  As shown in the Figure 1,our pipeline can be divided into two stage. We employed the idea of ensemble learning to design our pipeline. In the first stage, we have selected four network architectures [1][2][3][4] that have achieved outstanding results in the field of image enhancement as the backbone to process the noisy images separately, and then fusion the results. In the second stage, we used another highly effective structure as the refine module to optimize the previous

Figure 2. From left to right, the order is noisy input, stage1 output, stage2 output.

results and further improve the image quality, including removing residual noise and enhancing image clarity. The design of the entire pipeline aims to maximize image quality although it increases a lot of computational complexity.

- Representative image / diagram / pipeline of the method(s)

  The pipeline of our approach is shown in Figure 1.

- Training strategy

  During the training phase, we first train the four basic networks of the first stage, each of which will be trained with sufficient data and fully trained to a converged state. After that, we fix the parameters of these networks and then begin training the refine network of the second stage. The training data used in these two stages are completely consistent.

- Experimental results

  shown in Figure 2.

- References

  [1] Liang J, Cao J, Sun G, et al. Swinir: Image restoration using swin transformer[C]//Proceedings of the IEEE/CVF international conference on computer vision. 2021: 1833-1844.

  [2] Zamir S W, Arora A, Khan S, et al. Restormer: Efficient transformer for high-resolution image restoration[C]//Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2022: 5728-5739.

  [3] Chen X, Wang X, Zhou J, et al. Activating More Pixels in Image Super-Resolution Transformer. arXiv 2022[J]. arXiv preprint arXiv:2205.04437.

  [4] Chen L, Chu X, Zhang X, et al. Simple baselines for image restoration[C]//Computer Vision–ECCV 2022: 17th European Conference, Tel Aviv, Israel, October 23–27, 2022, Proceedings, Part VII. Cham: Springer Nature Switzerland, 2022: 17-33.

Additionally, you can refer to the following items to detail your description.

- Total method complexity (number of parameters, FLOPs, GPU memory consumption, number of activations, runtime)

  Max Memery : 3596.877 [M]

  Average runtime of (valid) is : 93651.621533 seconds

  Activations : 4111.0736 [M]

  Conv2d : 1055

  FLOPs : 3347.4298 [G]

  Params : 205.6092 [M]

- Which pre-trained or external methods / models have been used (for any stage, if any)

- Which additional data has been used in addition to the provided NTIRE training and validation data (at any stage, if any)

- Training description

  A two-stage training strategy.

- Testing description

  tile 384, overlap 64

- Quantitative and qualitative advantages of the proposed solution

  Our method can obtain more outstanding performance quantitatively and qualitatively.

- Results of the comparison to other approaches (if any)
- Results on other benchmarks (if any)
- Novelty degree of the solution and if it has been previously published
- It is OK if the proposed solution is based on other works (papers, reports, Internet sources (links), etc). It is ethically wrong and a misconduct if you are not properly giving credits and hide this information.

  We have used several SOTA architectures as our backbone.

5. Other details

- Planned submission of a solution(s) description paper at NTIRE 2023 workshop.
- General comments and impressions of the NTIRE 2023 challenge.
- What do you expect from a new challenge in image restoration, enhancement and manipulation?
- Other comments: encountered difficulties, fairness of the challenge, proposed subcategories, proposed evaluation method(s), etc.

References