NTIRE 2023 Efficient SR Challenge Factsheet
-Efficient Deep Residual Network-

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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 efficient image super-resolution.

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 Efficient SR 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`

Please send us the command to download your code, e.g. `git clone [Your repository link]` When submitting the code, please remove the LR and SR 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

  LVGroup_HFUT

- Team leader name

  Zhao Zhang

- Team leader address, phone number, and email

  9th Floor, Block A, Science And Education Building, Hefei University of Technology (Emerald Lake Campus), 485 Danxia Road, Hefei 230601, China,

  (+86)18356138079,

  cszzhang@gmail.com

- Rest of the team members

  Baiang Li, Hefei University of Technology (HFUT)

  Huan Zheng, Hefei University of Technology (HFUT)

  Suiyi Zhao, Hefei University of Technology (HFUT)

  Yangcheng Gao, Hefei University of Technology (HFUT)

  Jiahuan Ren, Hefei University of Technology (HFUT)

- Team website URL (if any)

- Affiliation

  Hefei University of Technology

- 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) MotaLee, 2(validation)

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

  best scoring entry:2, score:28.977731

- Link to the codes/executables of the solution(s): This link

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.) Considering the requirements of the Efficient Super-Resolution task [3], we need to improve the performance of the model as much as possible under the limited computational cost. Although FMEN [1] can efficiently extract features while saving time and space memory, it still cannot meet the corresponding accuracy requirements. We infer that this is because it still cannot effectively extract the correlation features between pixels of low-resolution images and Deep connections between different pixels of an image. At the same time, it uses relatively few residual connections [2] in order to reduce computational cost consumption, which will cause it to lose the original features in the process of feature extraction, resulting in reduced accuracy and unable to meet the final competition requirements. Therefore, we design an Efficient Deep Residual Network (EDRN). Specifically, our backbone network is the same as FMEN. Besides, in order to better extract the deep features of the feature maps, we modified the Repblock, designed a D-Resblock, and used a residual connection to preserve the original features of the image.

- Training strategy

  We trained a total of 300 epochs to bring the model to convergence. The number of feature maps of DRB and DAB is set to 64 and 16, respectively. The initial learning rate is set to $2 * 10^{-4}$, and the learning rate decays to $4 * 10^{-5}$ after 200 epochs. Meanwhile, in the first 250 epochs, we use L1 loss, and in the last 50 epochs we use L2 loss. Our other settings are exactly the same as FMEN [1].

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

  see Fig 1 and Fig 2.

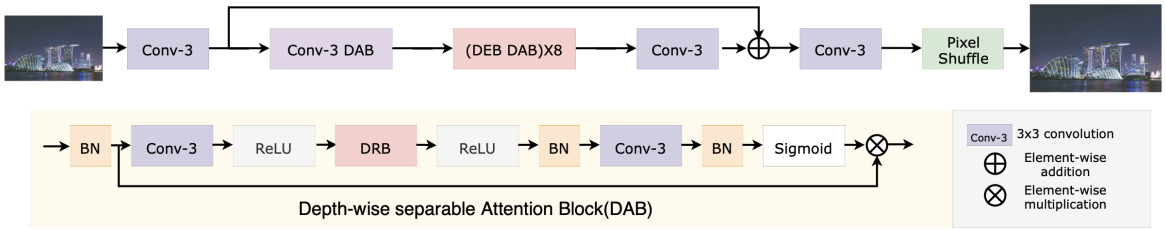

Figure 1. The structure of the proposed EDRN.

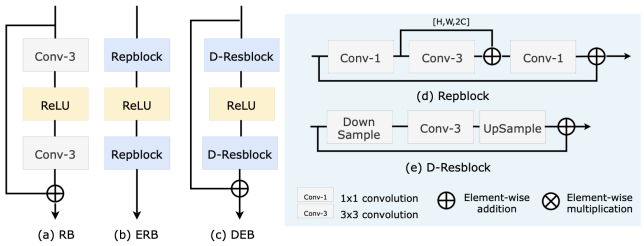

Figure 2. The structure of our proposed DEB(c) and DRB(e). To show the difference, we show some modules of FMEN(a,b,d) [1].

- Experimental results
  Val PSNR: 28.98
  Val Time(ms) per image: 59.31
  Params(M): 3.426
  FLOPs(G): 224.19
  Acts(M): 335.28
  GPU Memory(M): 612.78
  Convolution nums: 94
- References

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)
- 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
- Testing description
- Quantitative and qualitative advantages of the proposed solution
- 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.

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

[1] Zongcai Du, Ding Liu, Jie Liu, Jie Tang, Gangshan Wu, and Lean Fu. Fast and memory-efficient network towards efficient image super-resolution. In *IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops, CVPR Workshops 2022, New Orleans, LA, USA, June 19-20, 2022*, pages 852–861. IEEE, 2022. 2, 3

[2] Kaiming He, Xiangyu Zhang, Shaoqing Ren, and Jian Sun. Identity mappings in deep residual networks. In Bastian Leibe, Jiri Matas, Nicu Sebe, and Max Welling, editors, *Computer Vision - ECCV 2016 - 14th European Conference, Amsterdam, The Netherlands, October 11-14, 2016, Proceedings, Part IV*, volume 9908 of *Lecture Notes in Computer Science*, pages 630–645. Springer, 2016. 2

[3] Yawei Li, Kai Zhang, Radu Timofte, Luc Van Gool, Fangyuan Kong, Mingxi Li, Songwei Liu, Zongcai Du, Ding Liu, Chenhui Zhou, Jingyi Chen, Qingrui Han, Zheyuan Li, Yingqi Liu, Xiangyu Chen, Haoming Cai, Yu Qiao, Chao Dong, Long Sun, Jinshan Pan, Yi Zhu, Zhikai Zong, Xiaoxiao Liu, Zheng Hui, Tao Yang, Peiran Ren, Xuansong Xie, Xian-Sheng Hua,

Yanbo Wang, Xiaozhong Ji, Chuming Lin, Donghao Luo, Ying Tai, Chengjie Wang, Zhizhong Zhang, Yuan Xie, Shen Cheng, Ziwei Luo, Lei Yu, Zhihong Wen, Qi Wu, Youwei Li, Haoqiang Fan, Jian Sun, Shuaicheng Liu, Yuanfei Huang, Meiguang Jin, Hua Huang, Jing Liu, Xinjian Zhang, Yan Wang, Lingshun Long, Gen Li, Yuanfan Zhang, Zuowei Cao, Lei Sun, Panaetov Alexander, Yucong Wang, Minjie Cai, Li Wang, Lu Tian, Zheyuan Wang, Hongbing Ma, Jie Liu, Chao Chen, Yidong Cai, Jie Tang, Gangshan Wu, Weiran Wang, Shirui Huang, Honglei Lu, Huan Liu, Keyan Wang, Jun Chen, Shi Chen, Yuchun Miao, Zimo Huang, Lefei Zhang, Mustafa Ayazoglu, Wei Xiong, Chengyi Xiong, Fei Wang, Hao Li, Ruimian Wen, Zhijing Yang, Wenbin Zou, Weixin Zheng, Tian Ye, Yuncheng Zhang, Xiangzhen Kong, Aditya Arora, Syed Waqas Zamir, Salman H. Khan, Munawar Hayat, Fahad Shahbaz Khan, Dandan Gao, Dengwen Zhou, Qian Ning, Jingzhu Tang, Han Huang, Yufei Wang, Zhangheng Peng, Haobo Li, Wenxue Guan, Shenghua Gong, Xin Li, Jun Liu, Wanjun Wang, Kun Zeng, Hanjiang Lin, Xinyu Chen, and Jinsheng Fang. NTIRE 2022 challenge on efficient super-resolution: Methods and results. In *IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops, CVPR Workshops 2022, New Orleans, LA, USA, June 19-20, 2022*, pages 1061–1101. IEEE, 2022. 2