MuLUT: Cooperating Multiple Look-Up Tables for Efficient Image Super-Resolution

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https://mulut.pages.dev

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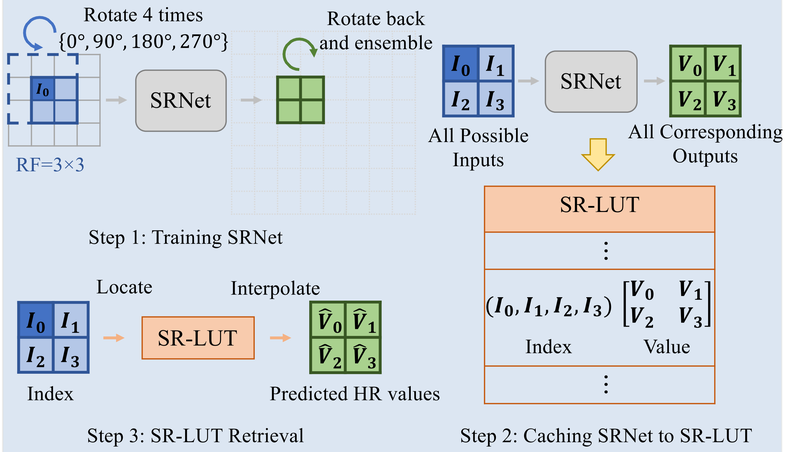
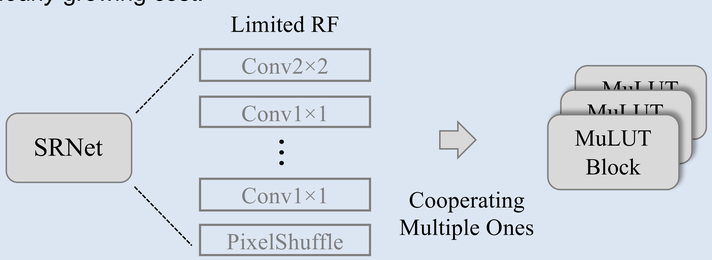
Background: SRNet to SR-LUT

An SR network can be cached into a Look-Up Table (LUT), SR-LUT, by traversing all possible LR pixels and save the exhaustive HR results, avoiding heavy computational burden when deployed to edge devices.



Single LUT to MuLUT: Exponential to Linear

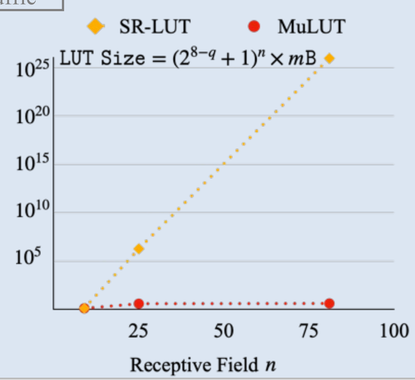
However, for a single LUT, its size grows *exponentially* as its receptive field (RF) increases, leading to limited RF and thus inferior performance. In this work, we cooperate Multiple LUTs (MuLUT) to expand RF at a *linearly* growing cost.



To increase RF:

✗ Single LUT → *Exponential* Growth

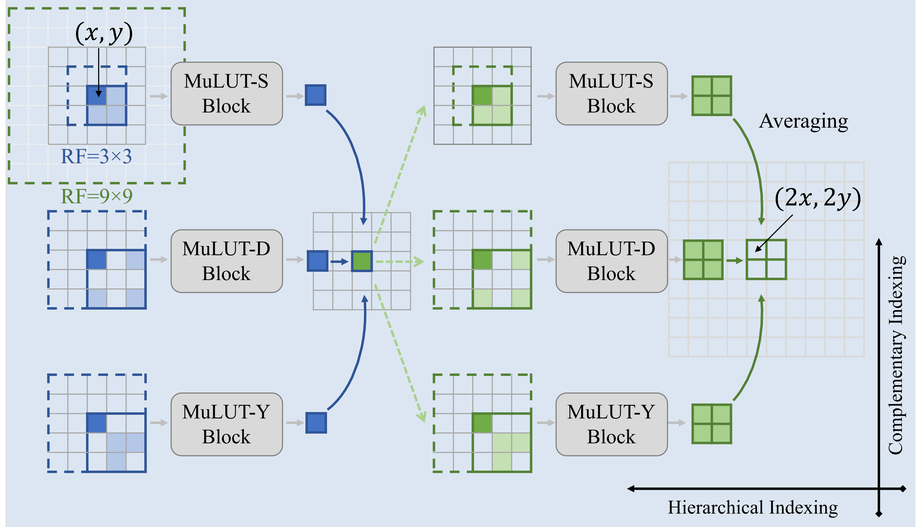
✓ Multiple LUTs → *Linear* Growth



Github Repo.

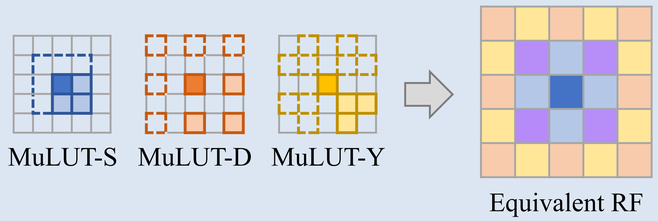
Framework Overview

We cooperate multiple LUTs via complementary indexing (width) and hierarchical indexing (depth).



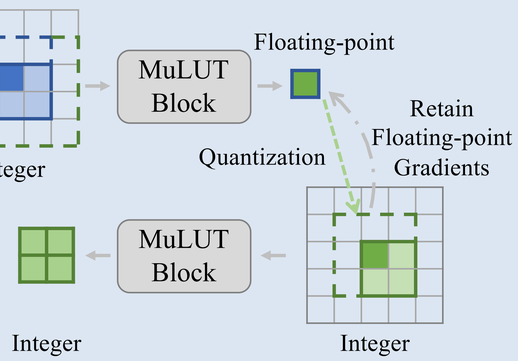
Complementary Indexing

In complementary indexing, the sampling patterns complement each other.



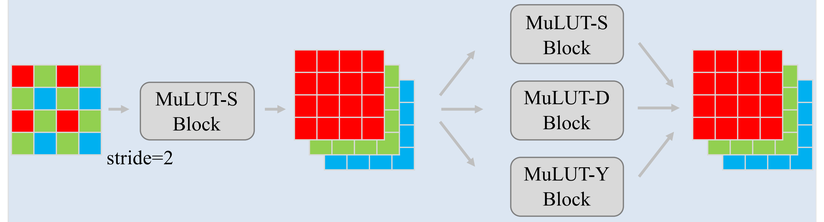
Hierarchical Indexing

In hierarchical indexing, cascaded LUTs are learned with the LUT re-indexing mechanism.



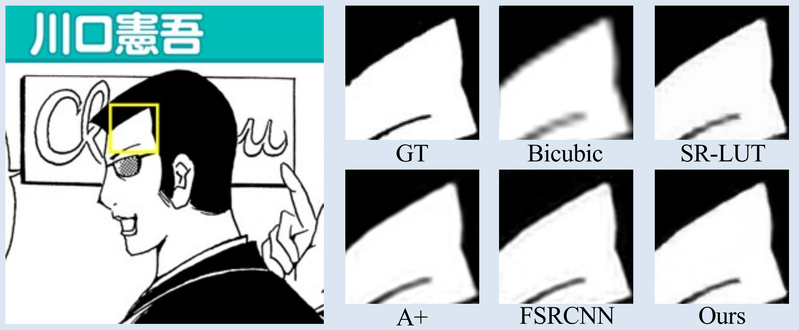
Flexibility and Versatility

We further adapt MuLUT to image demosaicing, showing its versatility to serve as a universal caching framework and an efficient solution to avoid deploying heavy DNNs on edge devices.

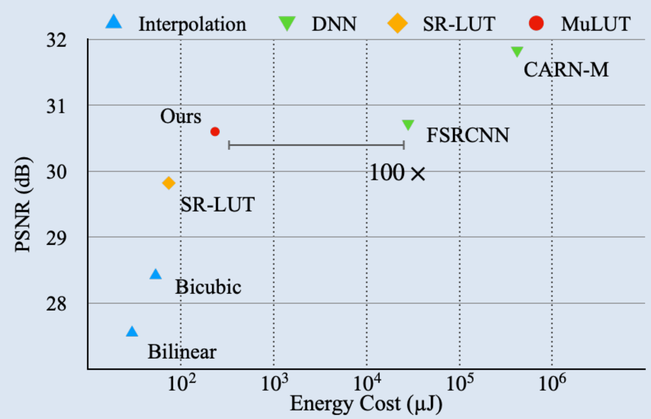


Evaluation

Visual Quality



The Performance-Efficiency Trade-off



MuLUT boosts the performance of SR-LUT significantly while preserving its efficiency, achieving a better performance-efficiency trade-off.

- *For performance, MuLUT significantly outperforms SR-LUT (up to 1.1dB PSNR) and obtains comparable or better visual quality as DNN methods like FSRCNN and sparse coding methods like A+.*
- *For efficiency, MuLUT preserves the clear advantage of LUT-based solutions, taking less than 100x energy cost compared to light-weight DNN methods like FSRCNN.*