BOSTON UNIVERSITY

EC601
Product Design in Electrical and Computer Engineering

A1 Team 12
High Resolution Images

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Product Mission

A free and effective Image Super Resolution helper.

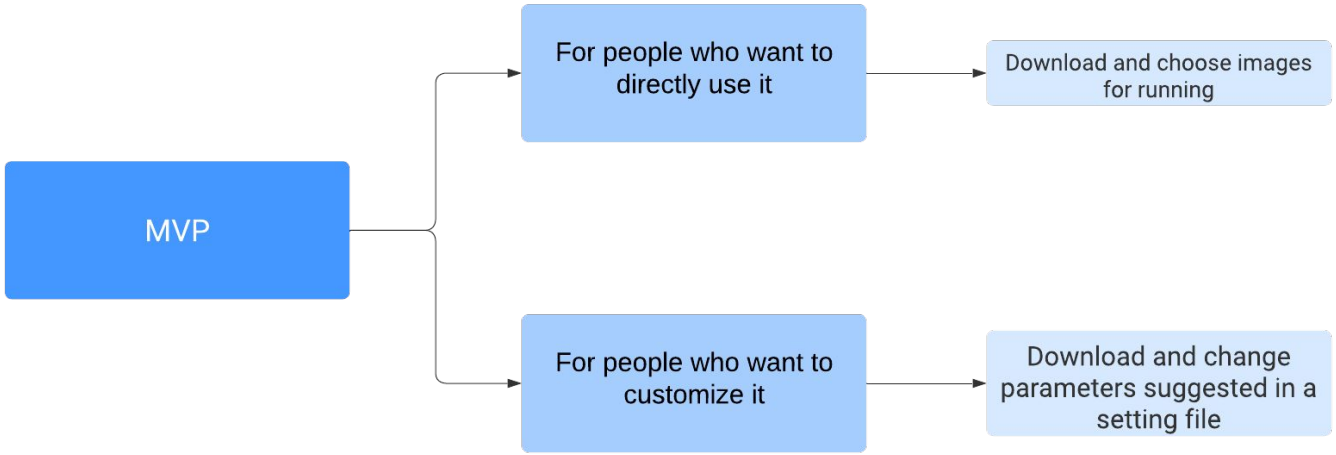
When people want to improve their images' quality, they can use our product.

The expected effect is like upgrading your monitor from 1080P to 4K.

Everything in the image will be less ambiguous, including noise, stains, …

Therefore, it is lossless amplifying instead of image identification

Product Mission



Open Source

HAN: "Single Image Super-Resolution via a Holistic Attention Network"

A model which is built on RCAN (PyTorch)

Github: https://github.com/wwlCape/HAN

Adjust some parameters to better perform in our program.

Method

Convolution Layer：
A very basic process in the network is convolution, the purpose of it is extracting feature maps from input.

Residual Learning:
Deeper neural networks can extract more complex features, but traditional CNNs may face training difficulties with excessive depth, resulting in performance issues compared to shallower networks.

Attention Mechanism:
Models often require processing a large amount of data, of which only a small portion is truly crucial. With help of attention mechanism, we can more easily capture more important part of feature mappings.

The overall process of how it works:
Dataset preparing→Training model→Testing model using pretrained model→Calculating the value of PSNR and SSIM of test results to validate the model→Use the pretrained model for further applications.

Result of high-resolution images:
Showing a series of different pictures that processed by the model.

Image Degradation

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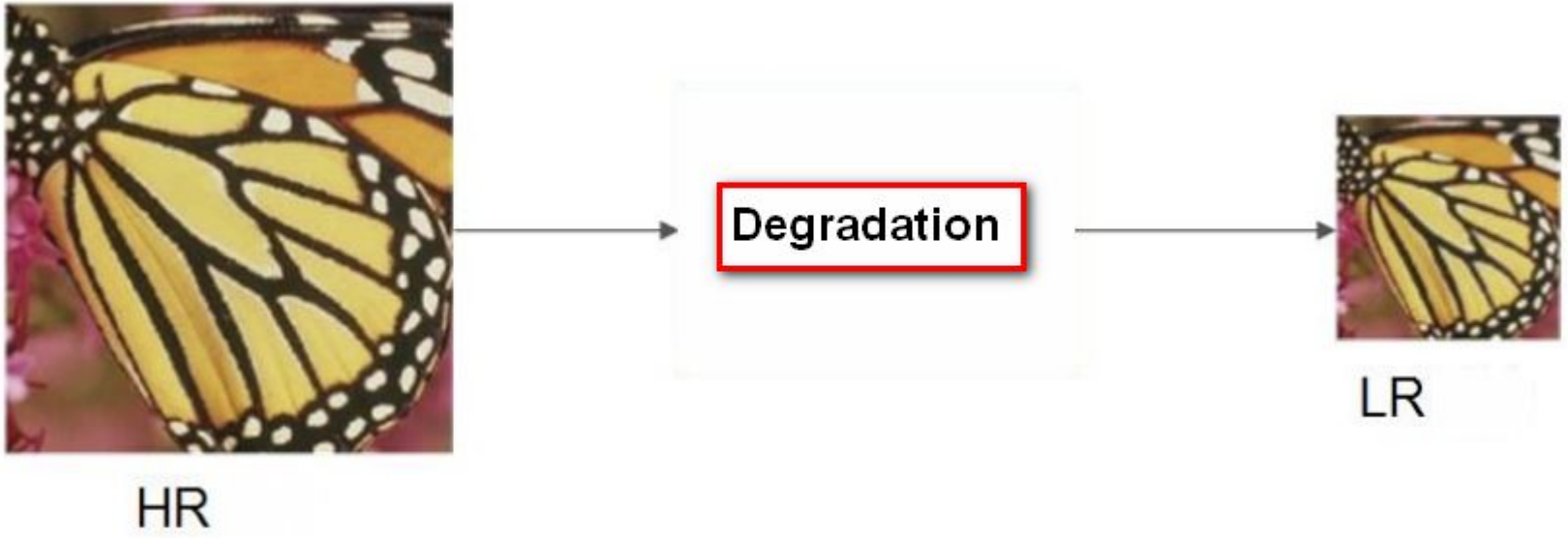
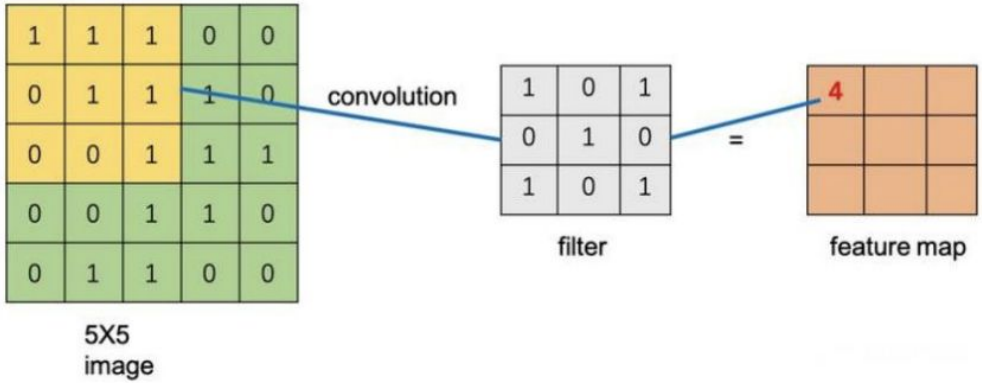


Here degradation model is bicubic interpolation which is a commonly used test ground in this field. Which can be written like:

$$p(x,y) = \sum_{i=0}^{3}\sum_{j=0}^{3} a_{ij}x^i y^j.$$

What Technique Are Included

A very basic process in the network is convolution, the purpose of it is extracting feature maps from input.



A simple showcase can be like:

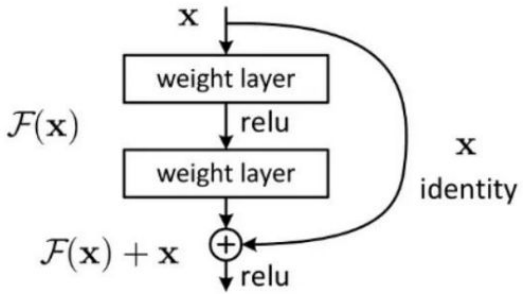
During the training, the paraments of the filter will constantly be adjusted.

Residual Learning

From experience, the depth of the network plays a crucial role in the performance of the model. Every time the number of network layers is increased, the network has the ability to perform more complex feature extraction. However, in fact, for traditional CNN networks, due to the difficulty of training, excessively deep networks can cause degradation problems, and the effectiveness is not as good as relatively shallow networks.
If our input is x, certain layer of the network is to learn a mapping H(x). If we have enough layers with their mapping to be identity mapping like H(x)=x, then our network will become a relatively shallow network. So a better strategy is designing the layer like:

$$H(x) = F(x) + x$$

Which is:

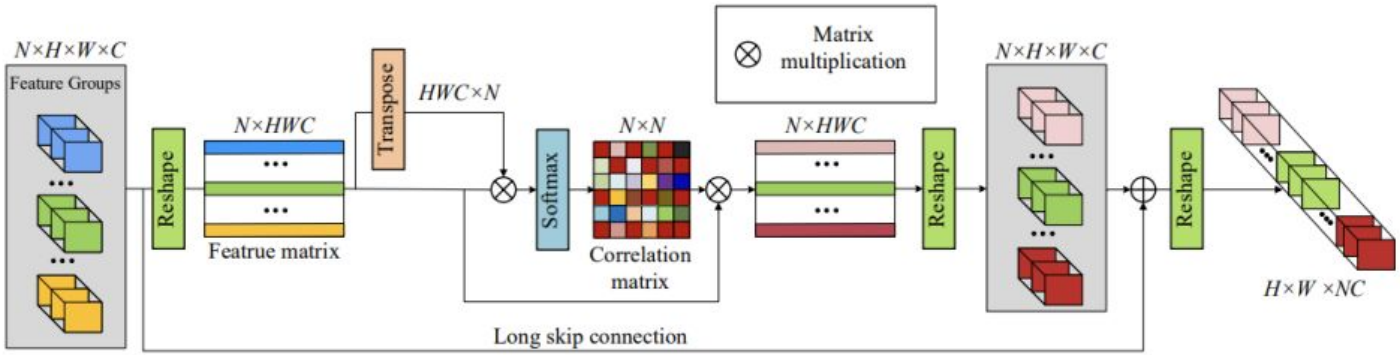


Attention Mechanism

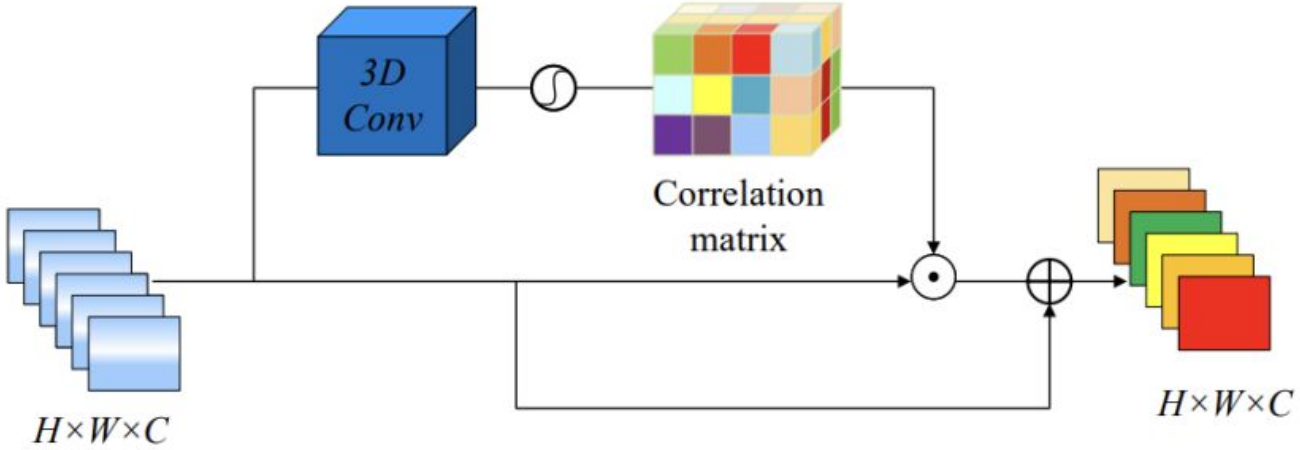
Models often require processing a large amount of data, of which only a small portion is truly crucial. With help of attention mechanism, we can more easily capture more important part of feature mappings.

We used Layer Attention Module(LAM) and Channel-Spatial Attention Module(CSAM) to better our current network.

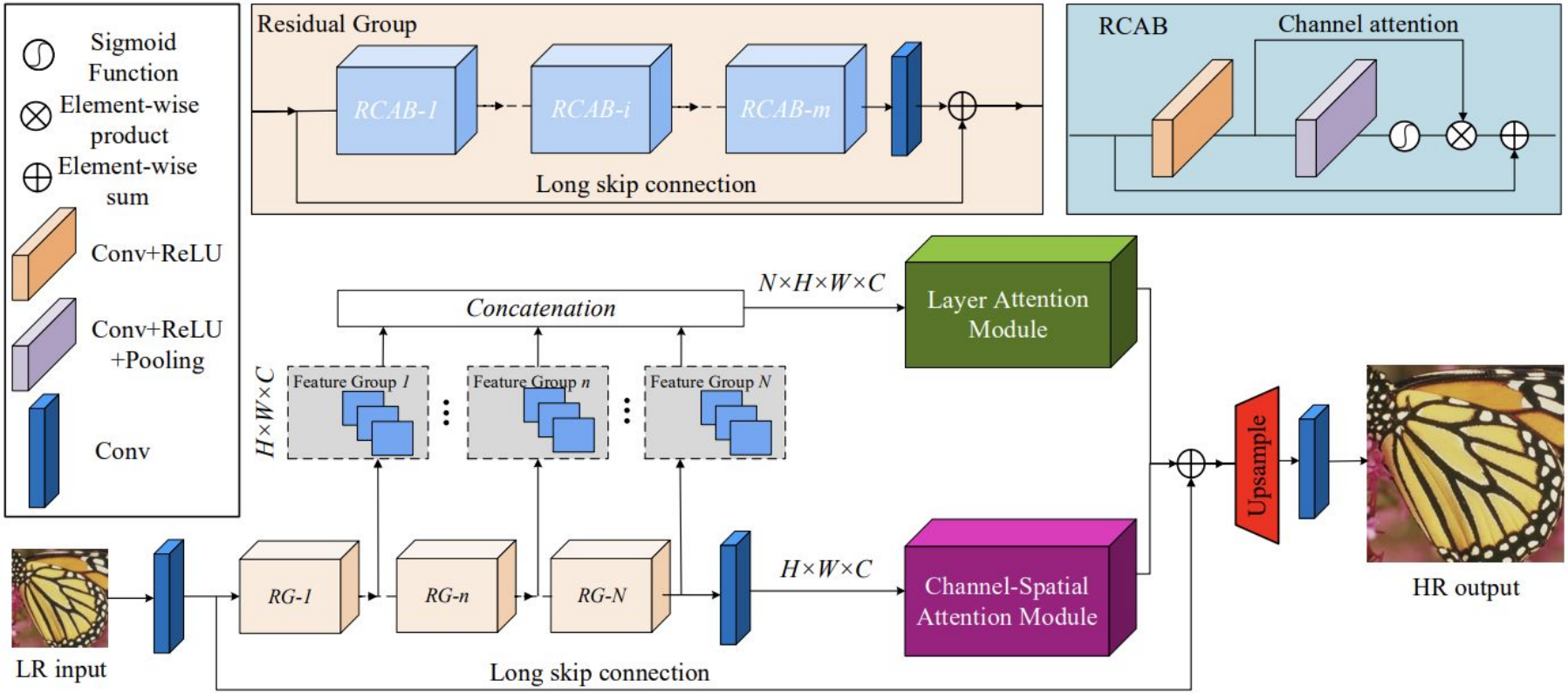
LAM


N×H×W×C
Feature Groups
Reshape
N×HWC
Featrue matrix
Transpose
HWC×N
Softmax
N×N
Correlation matrix
Matrix multiplication
N×HWC
Reshape
N×H×W×C
Reshape
H×W ×NC
Long skip connection

CSAM



Structure of The Module



The Overall Process

Transfer original high-resolution (HR) imagines into low-resolution (LR) ones (½, ⅓, ¼ size of original imagines) with Matlab.

Train and test prepared datasets with Pytorch.
(Dataset for training: DIV2K, dataset for testing: Set5, Set14, Urban100, Manga109)

Calculate the PSNR and SSIM of output with Matlab.

Try adjust the model based on the results.

Visible Results

Let’s take x4 test (Set5) as an example.（PSNR：32.634）

LR

SR

HR

Demo

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Super Resolution

Demo

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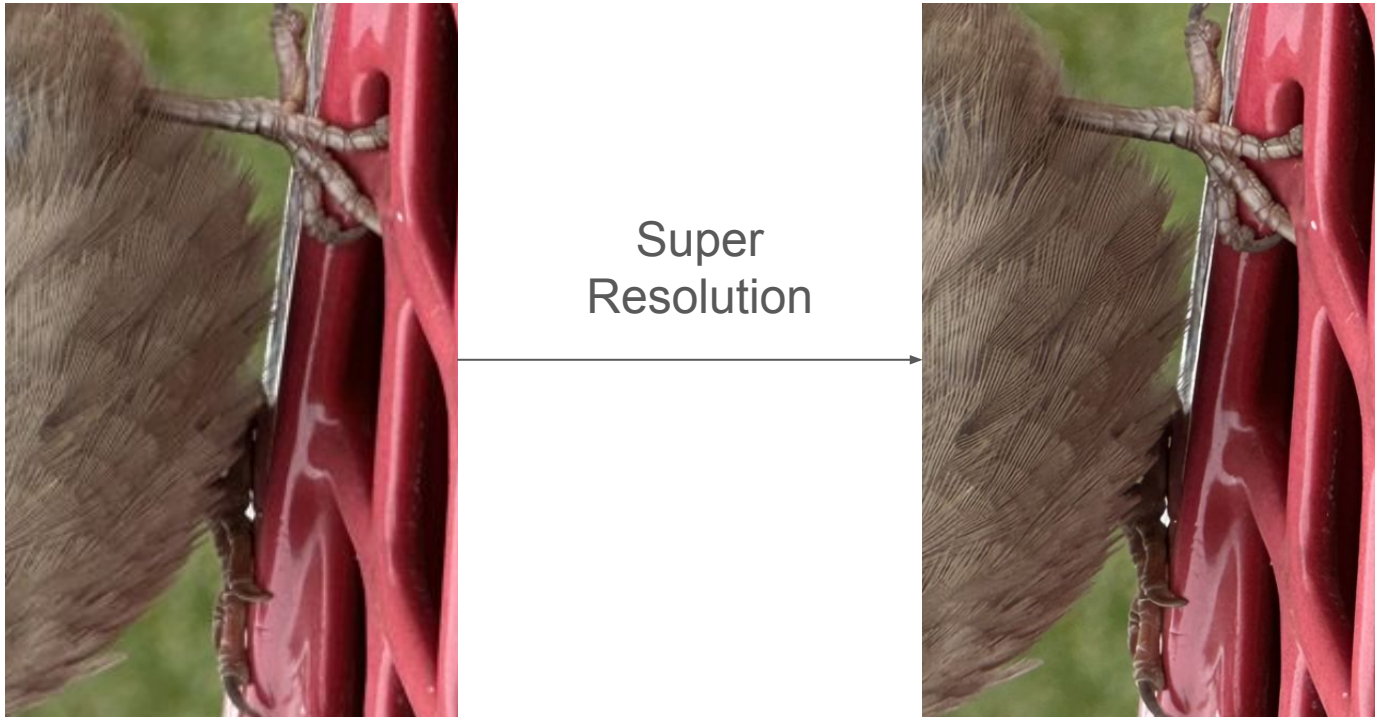

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Thank You!