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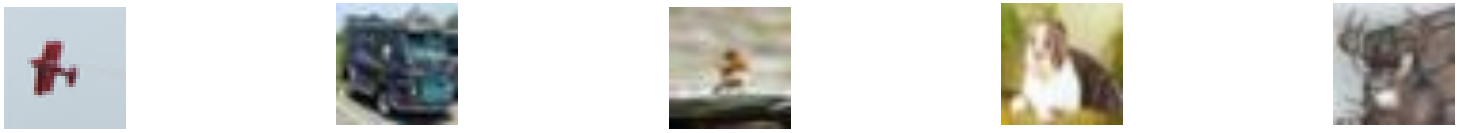

Improving Low-Resolution Image Classification by Super-Resolution with Enhancing High Frequency Content

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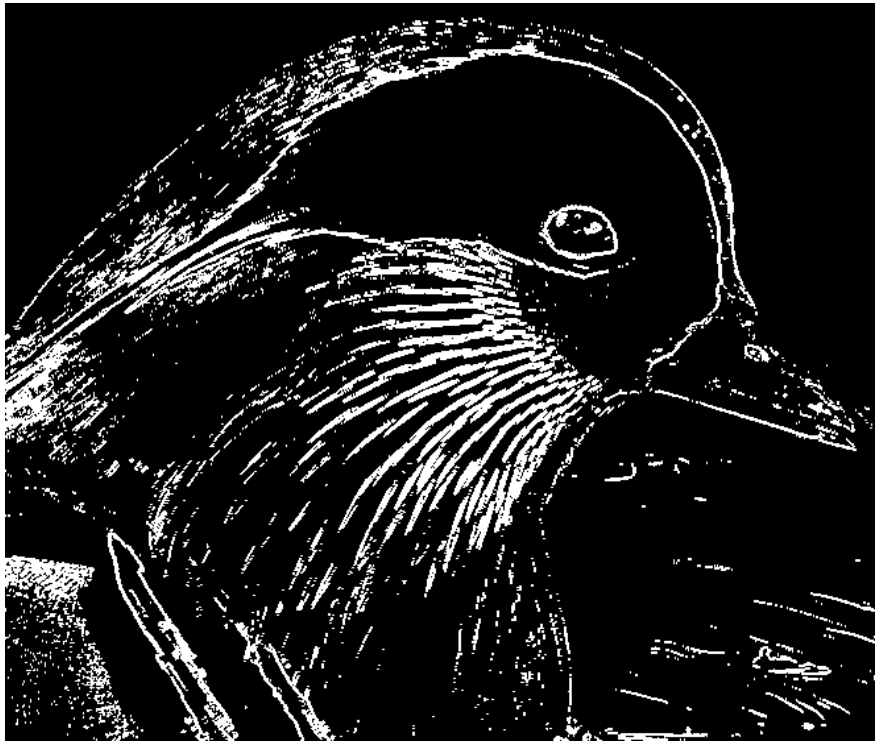
Improving Low-Resolution Image Classification by Super-Resolution with Enhancing High Frequency Content

INTRODUCTION

How the brain recognizes objects?



Contours → Bird

Texture in non-flat areas → Mandarin Duck

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INTRODUCTION

- **Result**: High frequency contents are essential for humans to recognize objects.

  (High frequency contents are areas where pixel values change dramatically.)

- **Assumption**:

  Pixels located at areas where color and intensity change dramatically are more important for CNN-based object recognition algorithms.

- **Proposal**:

  1. Find out the important pixels in ground-truth HR image.
  2. Give them more weight in training SR networks to gain more high frequency content.

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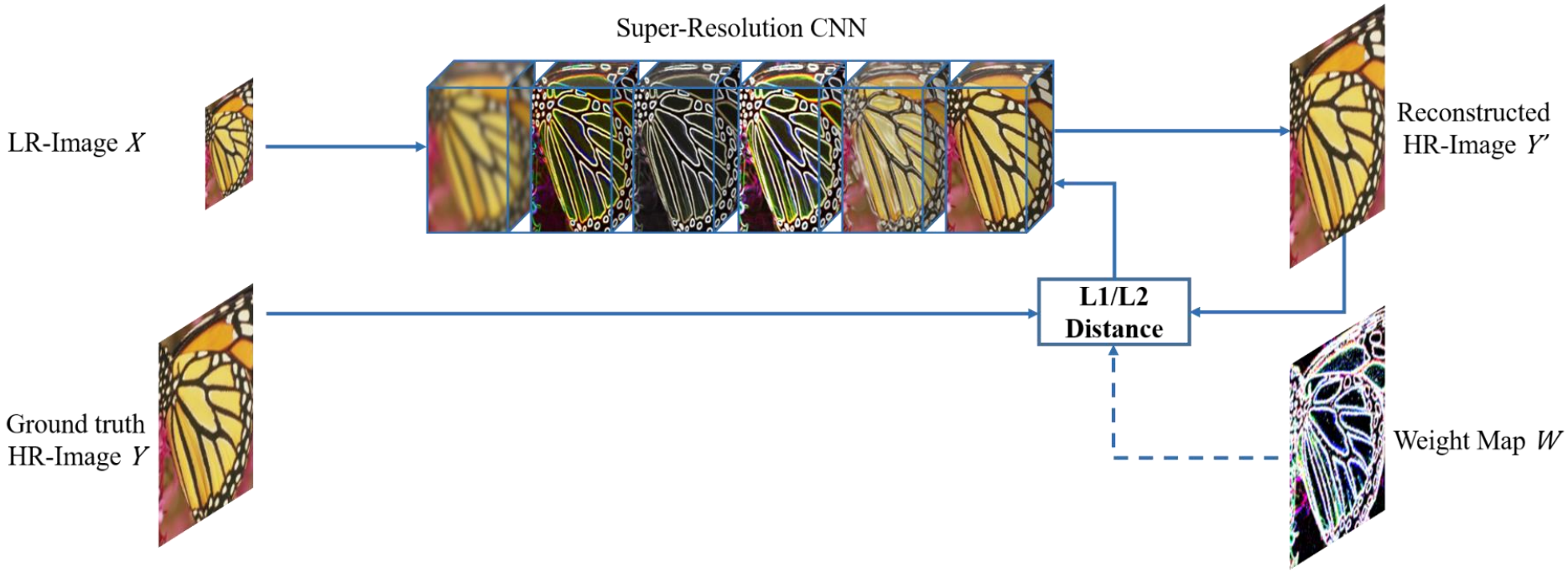
INTRODUCTION - Pipeline

1. Train a SR network which can produce more high frequency content.



2. Upscale LR-images to HR-images by the network model above.

3. Train an object recognition network with the new HR-images.

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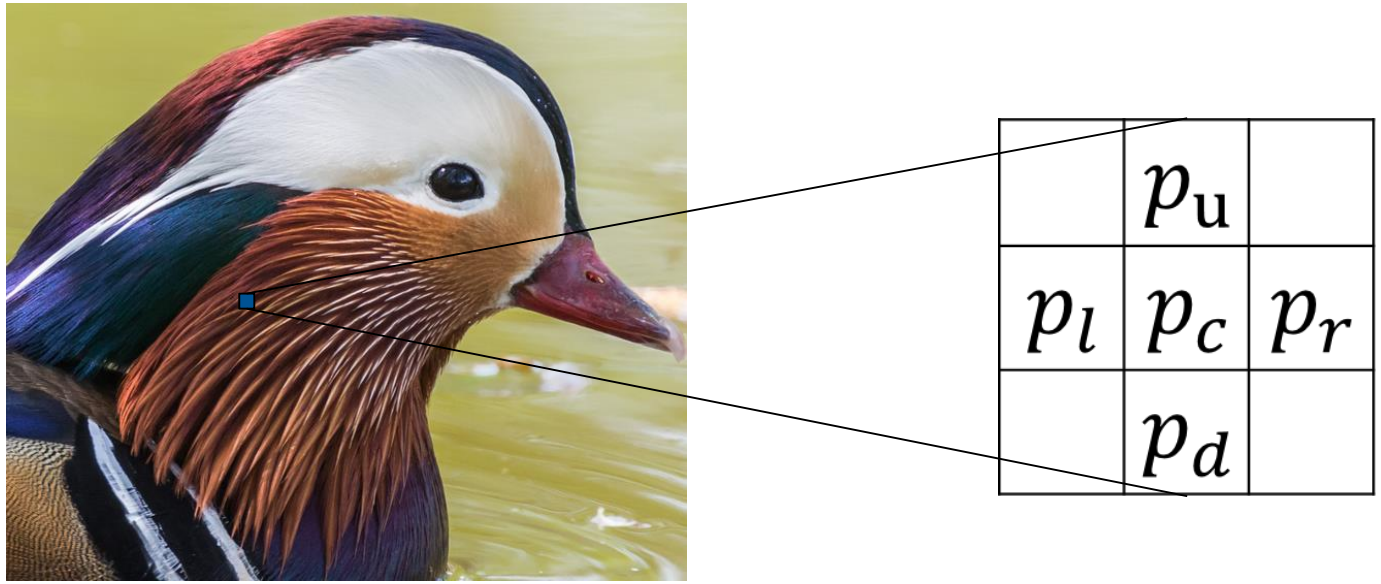
METHOD - Pixel's Important Degree



$$D = \begin{bmatrix} \boldsymbol{p}_c - \boldsymbol{p}_u \\ \boldsymbol{p}_c - \boldsymbol{p}_d \\ \boldsymbol{p}_c - \boldsymbol{p}_l \\ \boldsymbol{p}_c - \boldsymbol{p}_r \end{bmatrix}$$

$$D_a = \begin{bmatrix} |\boldsymbol{p}_c - \boldsymbol{p}_u| \\ |\boldsymbol{p}_c - \boldsymbol{p}_d| \\ |\boldsymbol{p}_c - \boldsymbol{p}_l| \\ |\boldsymbol{p}_c - \boldsymbol{p}_r| \end{bmatrix}$$

$$\boldsymbol{i}_c = D[argmax(D_a)]$$

1. Get 4 absolute diff-values between $\boldsymbol{p}_c$ and its 4 nearest neighbors.
2. Select the max-value, and treat it as the important degree $\boldsymbol{i}_c$ of $\boldsymbol{p}_c$.

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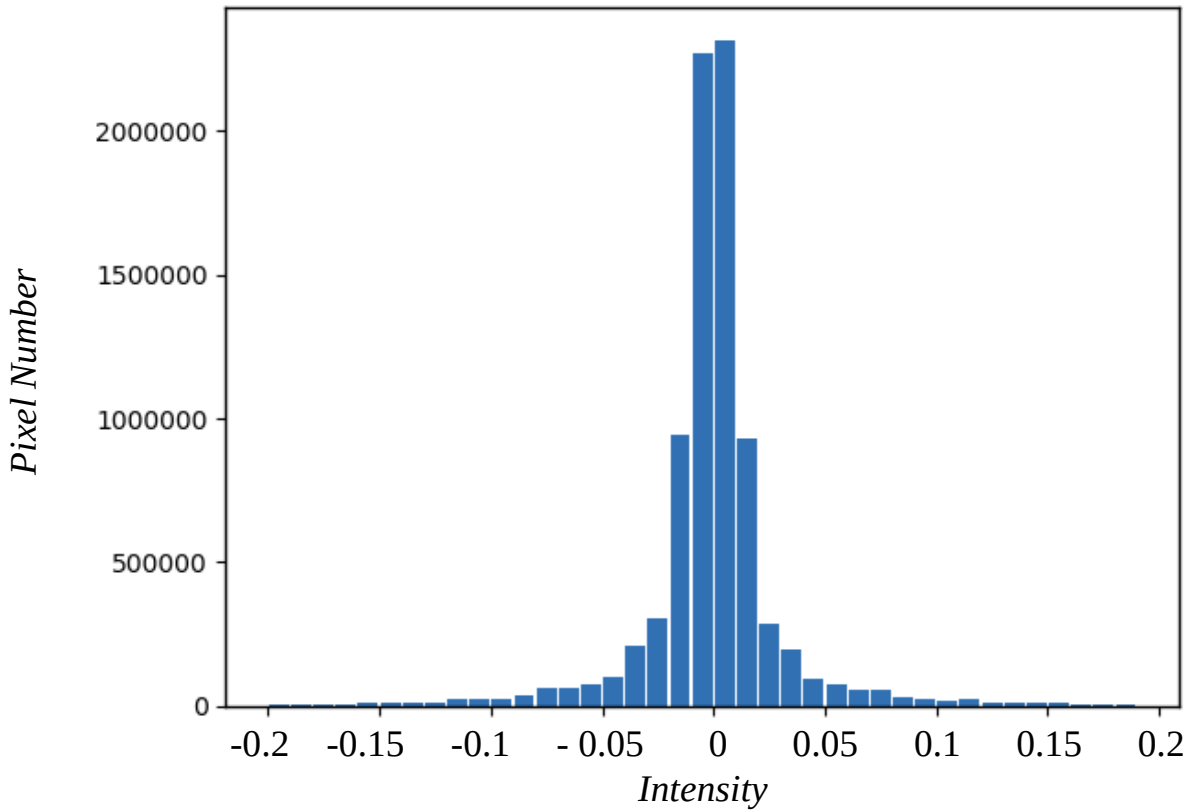
METHOD - Distribution of Pixel's Important Degree

Map of Pixel's Important Degree (I)



Distribution of Pixel's Important Degree
(Gaussian Distribution)

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METHOD - Give more Weight to Important Pixels

$$w = \begin{cases} 0, & \boldsymbol{i} \in [\boldsymbol{\mu} - \boldsymbol{\alpha\sigma}, \boldsymbol{\mu} + \boldsymbol{\alpha\sigma}] \quad \text{（Low Frequency）} \\ 1, & otherwise \quad \text{（High Frequency）} \end{cases}$$

i is the value in map I
μ is the mean of I
σ is the standard deviation of I
α is used for controlling the number of each part

Weight Map (W)

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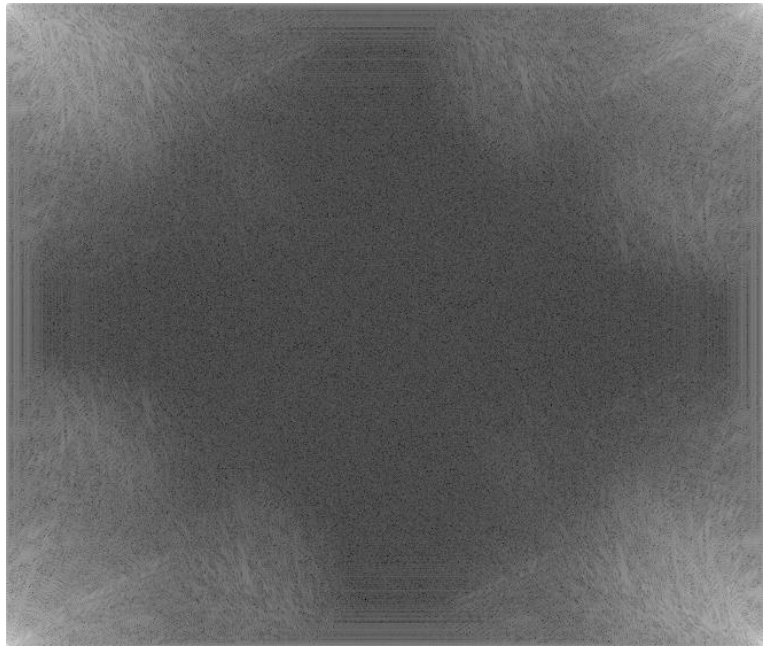
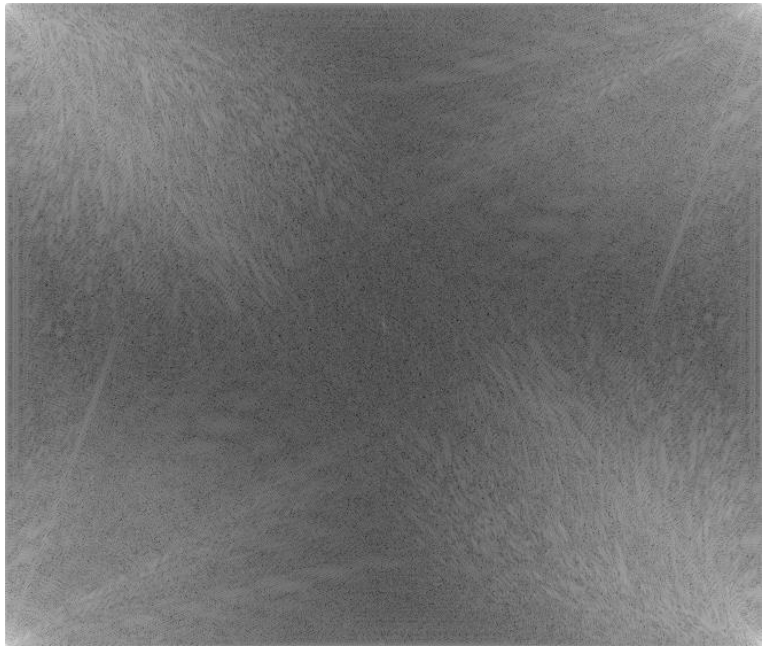
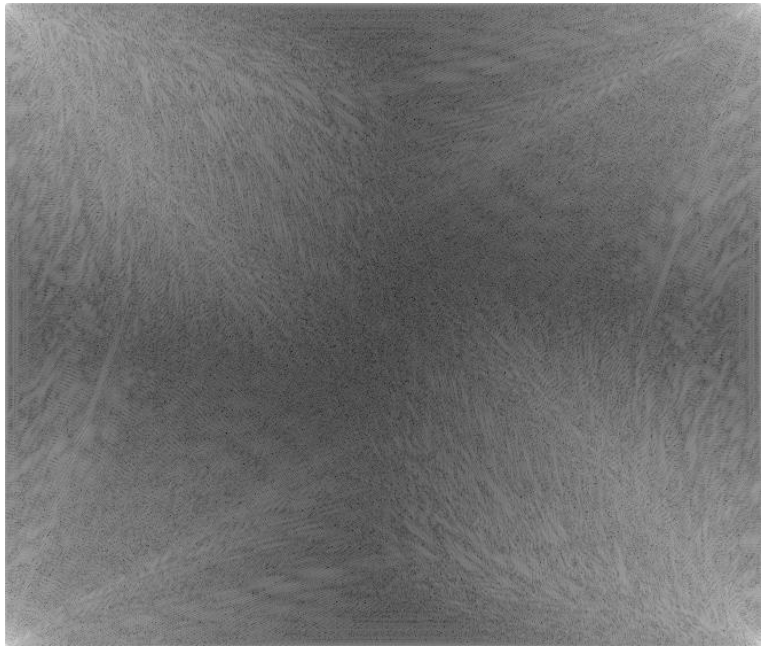
RESULT – Frequency Domain Images



BICUBIC



SRCNN



OURS

Conclusion: The center part denotes the high frequency. Our method can obtain more high frequency content.

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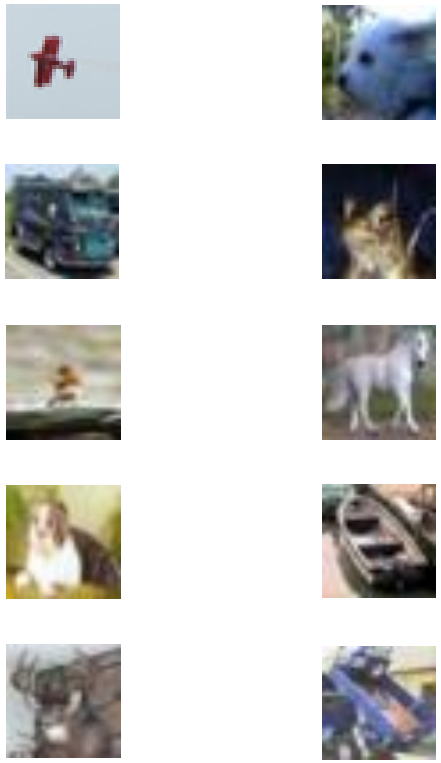
RESULT – LR Object Recognition Dataset CIFAR



Low Resolution Samples

	Accuracy	
	CIFAR-10	CIFAR-100
Original Images	94.69%	77.21%
BICUBIC	94.43%	77.59%
SRCNN	94.78%	77.03%
WDSR	94.80%	78.12%
Ours (α = 1/3)	95.05%	78.13%
Ours (α = 1/4)	95.04%	78.06%
Ours (α = 1/5)	95.23%	78.17%
Ours (α = 1/6)	95.18%	78.24%
Ours (α = 1/7)	95.15%	78.05%

Result

Thank You!