NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE
School of Computer Science and Engineering
College of Engineering

Multi-Degradation Image Super-Resolution Using Texture-Transfer

Student: Stephanie Audrey Susanto
Supervisor: Assoc Prof Loy Chen Change

Background

Image Super-Resolution (SR) is a classical open task under Computational Photography that aims to recover a high-resolution (HR) image from its low-resolution (LR) counterpart. SR research is broadly applicable in the medical, forensics, and satellite imagery fields. Without SR, high-quality imaging is usually either too expensive to set up or cannot be integrated due to technological limitations.

Motivation & Objective

Most leading Image SR methods assume that input LR images are bicubically downsampled from their HR counterparts. This causes state-of-the-art models to not perform as well when evaluated with non-bicubic LR images.

This research presents a **non-blind reference-based SR (RefSR) using multi-degradation method that aims to be more well-rounded compared to leading SR methods** thus far. It uses Texture Transformer Network for Image Super-Resolution (TTSR) combined with Super-Resolution Network for Multiple Degradations (SRMD) as the base model. The approach feeds degradation map into the network that is obtained from the blur kernel information applied on the LR. There are sixteen representative Gaussian kernels used as blur kernels.

Not only does the model perform better in non-bicubic LRs, but it also caters to LRs where the blur kernel information is not known, commonly known as real LRs. KernelGAN is used to estimate the otherwise unknown blur kernel. Performance improvements were achieved by training the model with augmented LRs and feeding the degradation map information in multiple scales in the network.

Approach

The original TTSR architecture consists of Texture Transformers stacked across multiple scales so that better visual representations can be learnt. Figure 1 shows the full architecture where degradation maps are embedded in multiple scales in the network.

Embedding degradation map in one-scale of the network is sufficient for evaluation on Gaussian LRs, while embedding in multiple scales marginally improves the model performance on real images.

The embedding is done by concatenating the degradation map with LR features from the Shallow Feature Extraction module in the DNN Backbone.

Degradation map is obtained by transforming blur kernel and its PCA matrix into degradation map. The transformation process stems from SRMD.

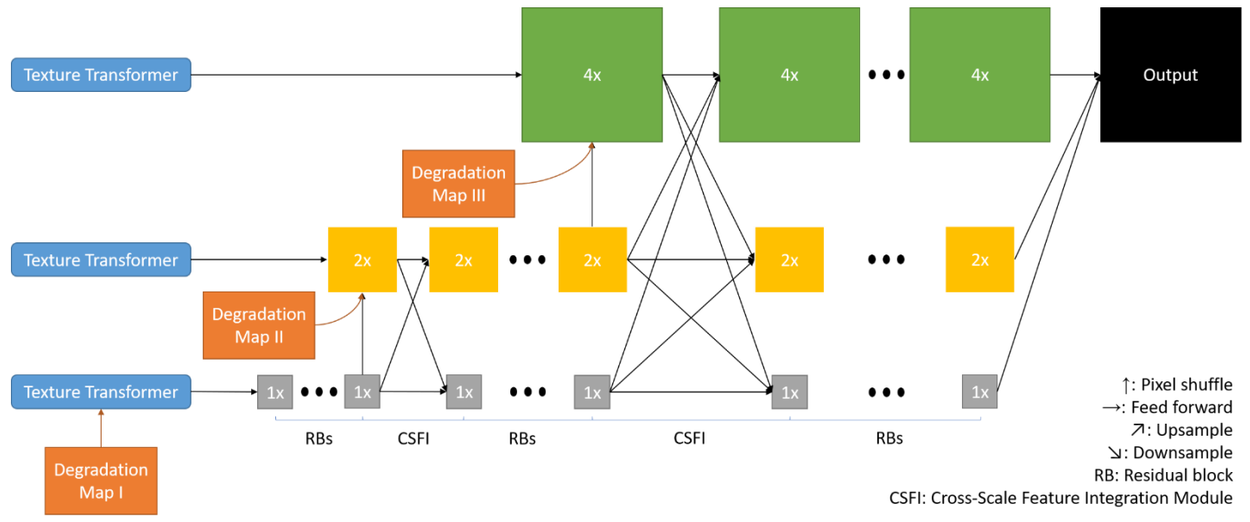

Figure 1: Architecture of TTSR with multi-scale degradation map embeddings

Results

The proposed approach quantitatively and qualitatively outperform existing methods on Gaussian LRs and real LRs evaluations.

Table 1: Evaluation results on Gaussian and real LRs

	Model	Map	LR type	PSNR / SSIM
A	TTSR pretrained model	-	Gaussian	20.033 / 0.5494
B	Proposed approach	None	Gaussian	23.253 / 0.6797
C	Proposed approach	1-scale	Gaussian	24.498 / 0.7235
D	Zero-Shot SR (ZSSR)	-	Real	N/A
E	TTSR pretrained model	-	Real	N/A
F	Proposed approach	1-scale	Real	N/A
G	Proposed approach	2-scale	Real	N/A
H	Proposed approach	3-scale	Real	N/A

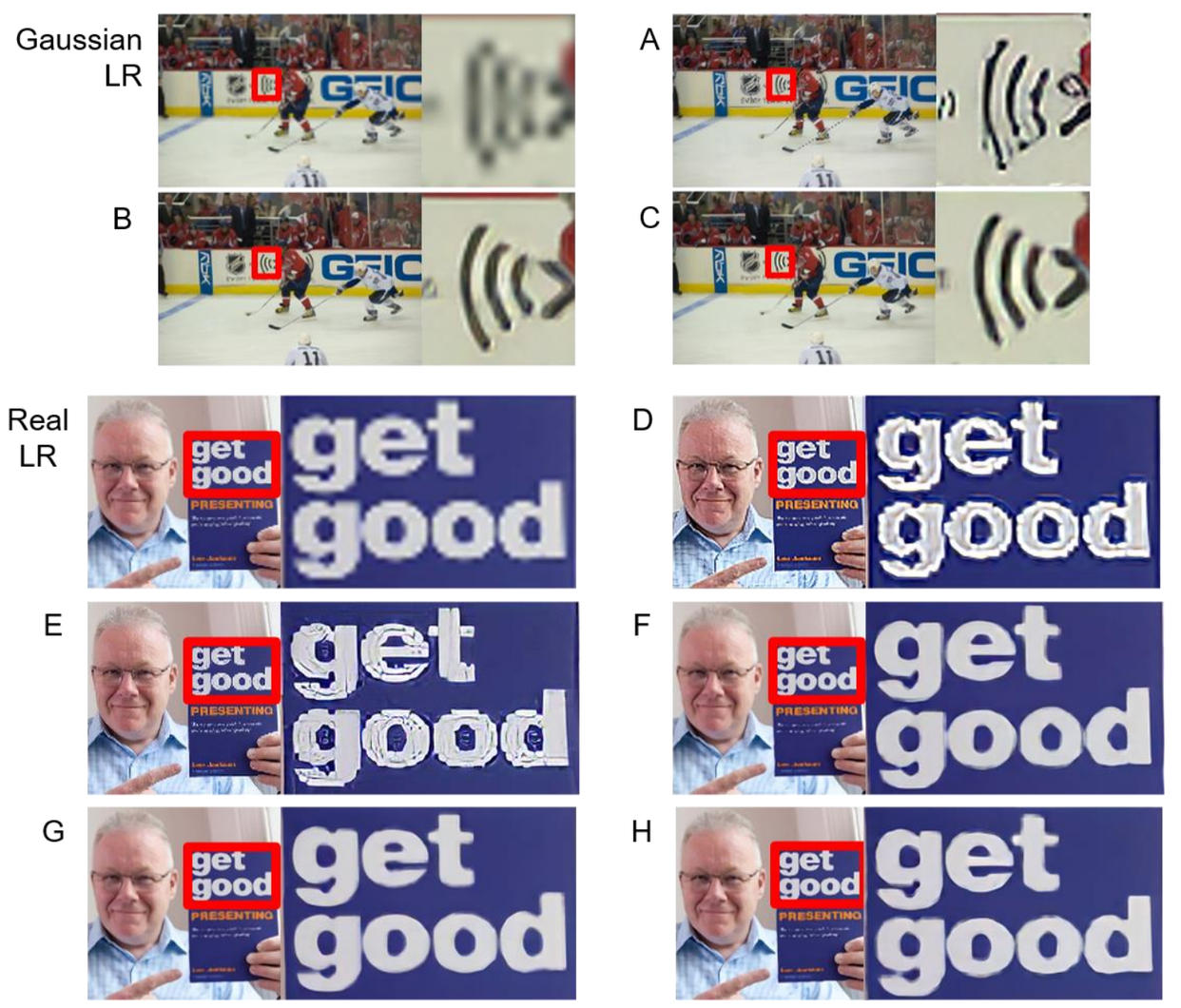

Figure 2: Visual comparisons between existing and proposed models