No-reference Image Quality Assessment via Non-local Dependency Modeling

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Background

Image Quality Assessment (IQA): play an indispensable role in improving users' visual experience and optimizing the production line.

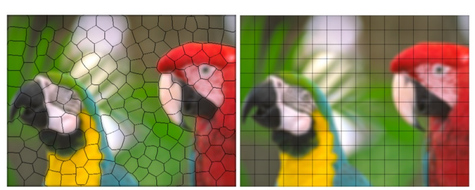
No-reference Image Quality Assessment (NR-IQA): objectively measure the input image quality in the absence of reference images.

Limitations of Local Modeling Method

1. Small-sized receptive field → Extracted features are **too local**.
2. Parameters fixed across the whole image → Contents are **equally treated**.
3. Lack of geometric and relational modeling → Missing **complex relations and layouts**.

Superpixel *versus* Square Patch

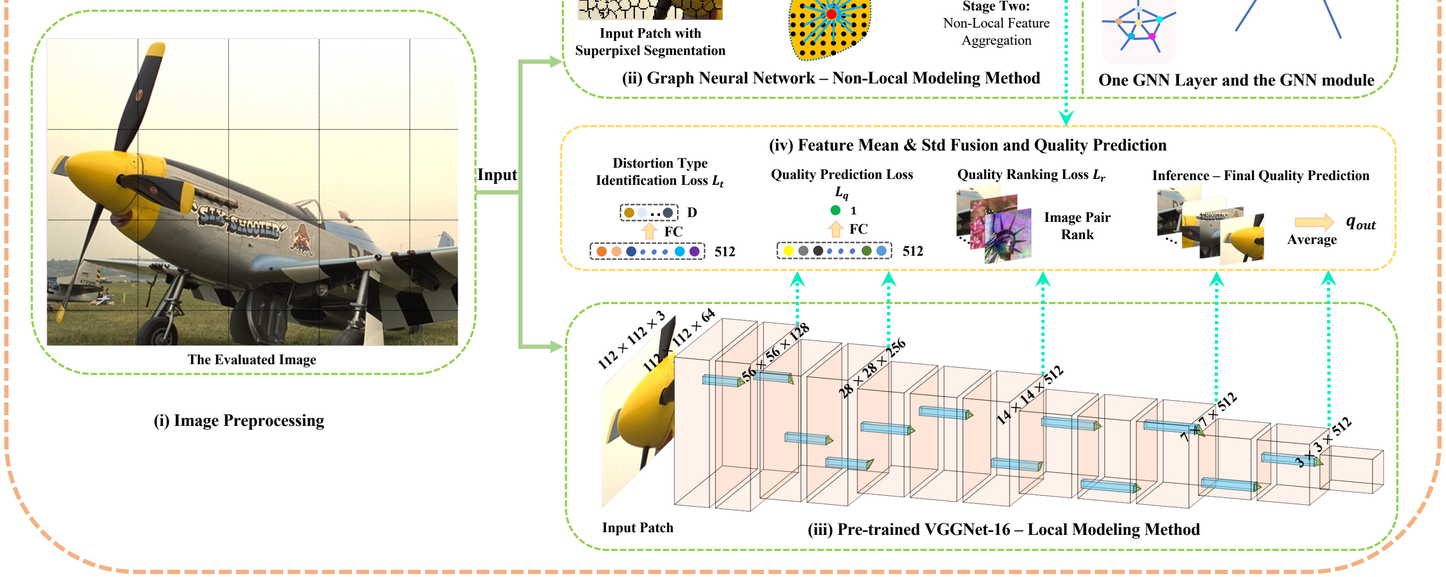
1. Adherence to boundaries and visually meaningful.
2. Accurate feature extraction.



(a) Superpixel segmentation (b) Square patch representation

Figure 1: The superpixel and square patch segmentation of the parrot image distorted by the Gaussian blur.

The proposed NLNet



Experimental Results

TABLE I
PERFORMANCE COMPARISONS ON THE LIVE, CSIQ, AND TID2013 DATABASES

Method	LIVE		CSIQ		TID2013	
	SRCC	PLCC	SRCC	PLCC	SRCC	PLCC
BRISQUE (2012) [3]	0.939	0.935	0.746	0.829	0.604	0.694
CORNIA (2012) [6]	0.947	0.950	0.678	0.776	0.678	0.768
M3 (2015) [40]	0.951	0.950	0.795	0.839	0.689	0.771
HOSA (2016) [7]	0.946	0.947	0.741	0.823	0.735	0.815
FRIQUEE (2017) [41]	0.940	0.944	0.835	0.874	0.68	0.753
DIQaM-NR (2018) [42]	0.960	**0.972**	-	-	0.835	0.855
DB-CNN (2020) [11]	0.968	**0.971**	**0.946**	**0.959**	0.816	0.865
HyperIQA (2020) [12]	0.962	0.966	0.923	0.942	0.729	0.775
GraphIQA (2022) [14]	**0.968**	0.970	0.920	0.938	-	-
TReS (2022) [15]	**0.969**	0.968	0.922	0.942	**0.863**	**0.883**
NLNet (Proposed)	0.962	0.963	**0.941**	**0.958**	**0.856**	**0.880**

TABLE II
CROSS-DATABASE PERFORMANCE COMPARISONS

Training / Testing	LIVE		CSIQ		TID2013	
	CSIQ	TID2013	LIVE	TID2013	LIVE	CSIQ
BRISQUE (2012) [3]	0.562	0.358	0.847	0.454	0.790	0.590
CORNIA (2012) [6]	0.649	0.360	0.853	0.312	0.846	0.672
M3 (2015) [40]	0.621	0.344	0.797	0.328	0.873	0.605
HOSA (2016) [7]	0.594	0.361	0.773	0.329	0.846	0.612
FRIQUEE (2017) [41]	0.722	0.461	0.879	0.463	0.755	0.635
DIQaM-NR (2018) [42]	0.681	0.392	-	-	-	0.717
DB-CNN (2020) [11]	**0.758**	**0.524**	0.877	**0.540**	**0.891**	**0.807**
HyperIQA (2020) [12]	0.697	**0.538**	**0.905**	**0.554**	0.839	0.543
NLNet (Proposed)	**0.771**	0.497	**0.923**	0.516	**0.895**	**0.730**

Motivation

1. Human Visual System (HVS) is **adaptive to the local content** → Local appearance artifacts affect the overall quality.
2. HVS perceives image quality with **long-dependency** constructed among different regions → Non-local feature extraction for long-range dependency modeling.

(a) Local feature extraction is critical (b) Non-local dependency learned by the NLNet

Figure 2: Local region feature extraction and non-local dependency feature extraction

Conclusion

1. We propose a novel NR-IQA framework based on the GNN. The non-local behavior of natural images is emphasized and learned in our proposed **N**on-**L**ocal Dependency **Net**work (termed as NLNet).
2. Extensive experimental results reveal that the proposed NLNet manages to extract the non-local information for quality prediction, and the superior performance in cross-dataset settings verifies the high generalization capability of our proposed method.