IMAGE QUALITY ASSESSMENT USING MULTI-METRIC FUSION (MMF)

Tsung-Jung Liu[1], Weisi Lin[2], and C.-C. Jay Kuo[1]

[1]Ming Hsieh Department of Electrical Engineering, University of Southern California, Los Angeles, USA

[2]School of Computer Engineering, Nanyan Technological University, Singapore

USC Viterbi School of Engineering

Ming Hsieh Department of Electrical Engineering

Motivation

❑Many objective quality metrics have been developed during the last decade.

Table 1. Ten quality metrics used in MMF

Metric Index	m1	m2	m3	m4	m5	m6	m7	m8	m9	m10
Metric Name	MS-SSIM	SSIM	VIF	VSNR	NQM	PSNR-HVS	IFC	PSNR	FSIM	MAD

❑In Table 3, we observe that different quality metrics work well with respect to different image distortion types.

Table 2
Distortion Types In TID2008 Image Database

Type	Type of distortion
1	Additive Gaussian Noise
2	Different additive noise in color components
3	Spatially correlated noise
4	Masked noise
5	High frequency noise
6	Impulse noise
7	Quantization noise
8	Gaussian blur
9	Image denoising
10	JPEG compression
11	JPEG2000 compression
12	JPEG transmission errors
13	JPEG2000 transmission errors
14	Non eccentricity pattern noise
15	Local block-wise distortions of different intensity
16	Mean shift (intensity shift)
17	Contrast change

Table 3

Type / Metric (PLCC)	Best metric	2nd best metric	3rd best metric
1	m6 (0.9366)	m8 (0.9333)	m3 (0.8717)
2	m8 (0.9285)	m6 (0.9137)	m3 (0.9004)
3	m8 (0.9524)	m6 (0.9510)	m10 (0.8745)
4	m3 (0.8928)	m8 (0.8737)	m6 (0.8240)
5	m6 (0.9730)	m8 (0.9708)	m3 (0.9464)
6	m8 (0.9084)	m6 (0.8651)	m3 (0.8263)
7	m6 (0.8965)	m8 (0.8911)	m2 (0.8745)
8	m1 (0.9506)	m2 (0.9452)	m9 (0.9414)
9	m9 (0.9680)	m2 (0.9664)	m1 (0.9638)
10	m6 (0.9720)	m9 (0.9710)	m2 (0.9608)
11	m9 (0.9801)	m10 (0.9789)	m1 (0.9751)
12	m1 (0.8844)	m9 (0.8823)	m10 (0.8784)
13	m6 (0.9256)	m2 (0.8574)	m9 (0.8491)
14	m7 (0.8394)	m10 (0.8315)	m3 (0.7460)
15	m2 (0.8768)	m9 (0.8531)	m3 (0.8434)
16	m2 (0.7547)	m6 (0.7099)	m8 (0.7076)
17	m3 (0.9047)	m9 (0.7706)	m1 (0.7689)

MMF Scores

❑Consider the fusion of n quality metrics with m training images.

❑Define the quality score vector $\boldsymbol{x}_i=(x_{i,1}, \ldots, x_{i,n})^T$ for the i-th image.

❑The new MMF quality score is defined as

$$mmf(\boldsymbol{x}_i) = \boldsymbol{w}^T \varphi(\boldsymbol{x}_i) + b \quad (1)$$

where $\boldsymbol{w} = (w_1, \ldots, w_n)^T$ is the weight vector, and b is the bias.

Training Stage

❑Determine the weight vector $\boldsymbol{w}$ and the bias b from the training data that minimizes

$$||mmf(\boldsymbol{x}_i) - y_i||, \quad i=1,2,\ldots,m \quad (2)$$

where y_i is the mean opinion score (MOS) obtained by human observers.

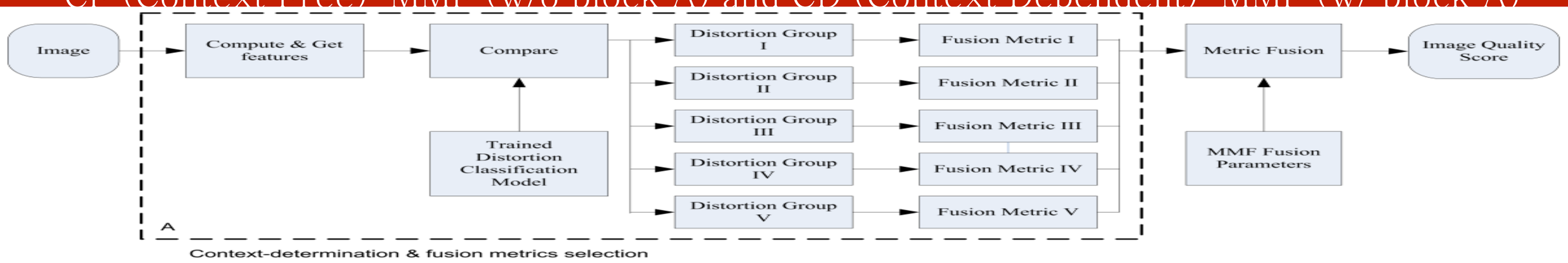
❑The maximum absolute difference in (2) is bounded by a certain level ε and adopt the ***support vector regression (SVR)*** for its solution.

Test Stage

❑Use the quality score vector $\boldsymbol{x}_j$ of the jth test image, where j = 1, 2,…, l, where l is the number of test images, and formula (1) to determine the quality score of the MMF method, $mmf(\boldsymbol{x}_j)$.

❑In all our experiments, the training and the test image sets are disjoint sets to avoid any bias in the final result.

Proposed Quality Assessment System
CF (Context Free)–MMF (w/o block A) and CD (Context Dependent)–MMF (w/ block A)



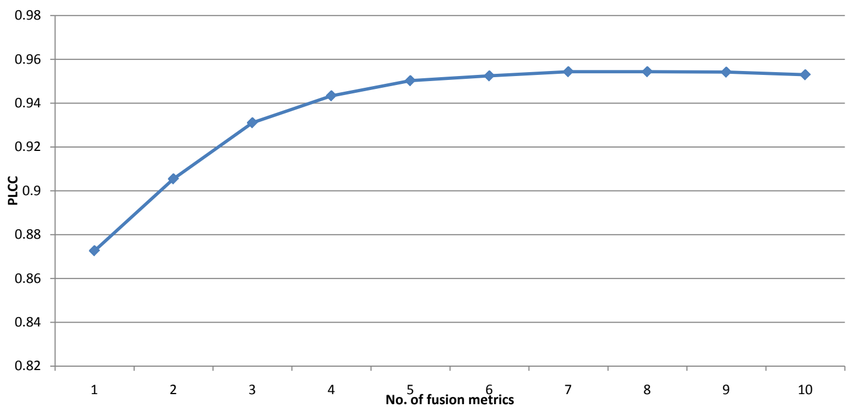


Fig.1. PLCC performance of CF-MMF in TID2008 database

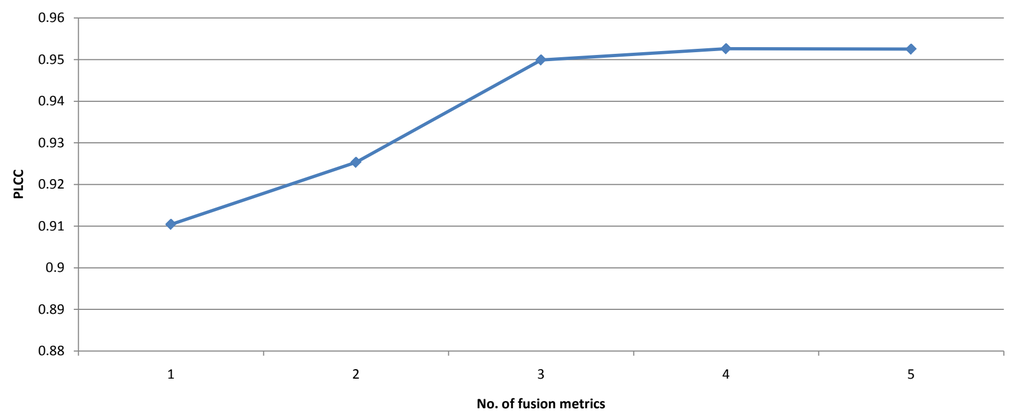


Fig. 2. PLCC comparison of CD-MMF in TID2008 database

Performance Comparison and Conclusions

IQA Model \ Measure	PLCC	SROCC	RMSE
MS-SSIM	0.8389	0.8528	0.7303
SSIM	0.8069	0.8081	0.7926
VIF	0.8055	0.7496	0.7953
VSNR	0.6820	0.7046	0.9815
NQM	0.6103	0.6243	1.0631
PSNR-HVS	0.5977	0.5943	1.0759
IFC	0.7186	0.5707	0.9332
PSNR	0.5355	0.5245	1.1333
FSIM	0.8710	0.8805	0.6592
MAD	0.8306	0.8340	0.7474
CF-MMF (6 metrics)	0.9524	0.9485	0.4090
CD-MMF (4 metrics)	0.9526	0.9480	0.4083

❑The performance of the proposed MMF metric and comparison with other existing metrics are provided in terms of
- Pearson linear correlation coefficient (PLCC)
- Spearman rank order correlation coefficient (SROCC)
- Root-mean-squared error (RMSE).

❑Experiments show that proposed multi-metric fusion (MMF) approach for image quality assessment outperforms state-of-the-art quality metrics by a significant margin.

Email: [1]liut@usc.edu, [2]wslin@ntu.edu.sg, [1]cckuo@sipi.usc.edu

Ming Hsieh Institute
Ming Hsieh Department of Electrical Engineering