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Full Reference Objective Video Quality Assessment with Temporal Consideration

Loh Woei Tan

Master of Engineering
2018

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Full Reference Objective Video Quality Assessment with Temporal Consideration

Loh Woei Tan

A thesis submitted

In fulfilment of the requirements for the degree of Master of Engineering

(Electronic and Computer Engineering)

Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK
2018

DECLARATION

The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Name:

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DEDICATION

Dedicated to my beloved parents, family members and friends.

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ABSTRACT

Video quality assessment (VQA) is an extension of image quality assessment (IQA). A video is a series of images arranged in time sequence. Therefore, IQA methods can be used to assess videos quality. A video has three dimensional data; two for the spatial dimensions and one for the temporal dimension. IQA methods assess video quality by assessing spatial effects without the need to consider the temporal effects and distortions. This makes IQA methods inappropriate and maybe inaccurate for assessing video quality. In order to apply in real time scenarios, VQA methods have to be reliable and correlated well to the judgement of human visual system (HVS). Furthermore, they have to be computationally efficient to give fast results. Current VQA methods have good correlations with subjective scores but are high in terms of computational complexity. In this thesis, two VQA methods, Index1 and Index2, with lower computational complexity are proposed. Index1 deals with Just Noticeable Difference (JND) in both spatial and temporal parts of the video. For the temporal part, JND is combined with temporal information to account for temporal distortions. For Index2, it is based on the previous work of mean difference structural similarity index (MD-SSIM). The temporal part of Index2 deals with the variation of temporal information. Both of the proposed methods are then compared with state-of-the-art VQA methods in terms of performance and computational complexity. The proposed methods were found to have acceptable performance with lower computational complexity.

Keywords: quality assessment, temporal, just noticeable difference, video, computational complexity.

Penilaian Kualiti Video Objektif Rujukan Penuh dengan Pertimbangan Dimensi Masa

ABSTRAK

Penilaian kualiti video (VQA) ialah lanjutan daripada penilaian kualiti imej (IQA). Video ialah satu siri imej disusun dalam urutan masa. Oleh itu, kaedah IQA boleh menilai kualiti video. Video ada tiga dimensi, dua untuk dimensi ruang dan satu untuk dimensi masa. Kaedah IQA mengabaikan kesan dan gangguan masa. Pengabaian ini menjadikan kaedah IQA tidak tepat dan sesuai untuk menilai kualiti video. Untuk penggunaan situasi sebenar, kaedah VQA perlu mempunyai kaitan dengan sistem visual manusia (HVS), Selain itu, kaedah VQA perlu mempunyai kerumitan pengiraan yang rendah. Walaupun kaedah-kaedah VQA yang dicadangkan baru-baru ini mempunyai korelasi yang baik dengan skor subjektif, tetapi mereka mempunyai kerumitan pengiraan yang tinggi. Dalam tesis ini, dua kaedah VQA dengan kerumitan pengiraan yang lebih rendah telah dicadangkan. Salah satu kaedah yang dicadangkan menggunakan konsep perbezaan hanya diketahui (JND) dalam dimensi ruang dan masa. Bagi bahagian masa, JND digabungkan dengan informasi masa untuk mengambil kira gangguan masa. Bagi kaedah VQA kedua, ia berdasarkan kerja perbezaan purata struktur indeks persamaan (MD-SSIM). Bahagian masa kaedah VQA ini berkaitan dengan perubahan informasi masa. Dua kaedah yang dicadangkan telah dibandingkan dengan kaedah VQA yang dicadangkan oleh penyelidik lain dari segi prestasi dan kerumitan pengiraan. Dua kaedah yang dicadangkan telah terbukti mempunyai prestasi yang lebih baik dan kerumitan pengiraan yang lebih rendah.

Kata kunci: *penilaian kualiti, dimensi masa, perbezaan hanya diketahui, video, kerumitan pengiraan.*

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LIST OF ABBREVIATIONS

2D	Two Dimensional
3D	Three Dimensional
ACR	Absolute Category Rating
ATI	Absolute Temporal Information
BIBS	Blind Image Blur Score
CC	Pearson Linear Correlation Coefficient
CSF	Contrast Sensitivity Function
DCR	Degradation Category Rating
DCT	Discrete Cosine Transform
DMOS	Difference Mean Opinion Score
DSCQS	Double Stimulus Continuous Quality Scale
DSIS	Double Stimulus Impairment Scale
DVD	Digital Versatile Disc
DVQ	Digital Video Quality
FMSE	Foveated Mean Squared Error
FR	Full Reference
GUI	Graphic User Interface
HDTV	High-Definition Television
HVS	Human Visual System
IIR	Infinite Impulse response
IP	Internet Protocol
IQA	Image Quality Assessment

JND	Just Noticeable Difference
MAD	Most Apparent Differences
MD-SSIM	Mean Squared Error Difference Structure Similarity
Mod-MSE	Modified Mean Squared Error
MOS	Mean Opinion Score
MOVIE	Motion-Based Video Integrity Evaluation
MPEG-2	Moving Picture Experts Group type
MSE	Mean Squared Error
MSSIM	Multiscale Structure Similarity Index
NR	No Reference
PCom	Pair Comparison
PC	Phase Congruency
PS	Program Segment
PSNR	Peak Signal to Noise Ratio
QoE	Quality of Experience
QoS	Quality of Service
QP	Quality Parameters
RR	Reduced Reference
SAMVIQ	Subjective Assessment Methodology for Video Quality
SNR	Signal-To-Noise Ratio
SROCC	Spearman Rank-Order Correlation Coefficient
SSCQE	Single Stimulus Continuous Quality Evaluation
SSIM	Structure Similarity Index
STS	Spatiotemporal Slices

TP	Test Presentation
TS	Test Session
VQA	Video Quality Assessment
VQEG	Video Quality Expert Group
VQM	Video Quality Metrics
VIF	Visual Information Fidelity
VSSIM	Video Structural Similarity index

LIST OF SYMBOLS

C	Constant
CC	Pearson Linear Correlation Coefficient Value of a Method
$c(x, y)$	Contrast Value of a Pixel
$C(p)$	Contrast Map at Block
D	Distorted Frame
$D(b)$	Perceived Distortions
$D(x, y)$	Pixel in Distorted Frame
F	Number of Frames
f_{min}	Minimum Number of Frames
$FSIM$	Feature Similarity Index for an Image
$FSIM_c$	Feature Similarity Index for a Color Image
G	Frequency Response
$GM(x)$	Gradient magnitude value of a Pixel
K	Constant
L	Dynamic Range
$l(x, y)$	Luminance Value of a Pixel
LA	Local Amplitude
lG	Logarithm Gabor Filter Response
$Lmap$	Local Statistical Difference Map
MAD	Most Apparent Differences Index of an Image
MAX	Maximum Value of a Pixel

$MDSSIM$	Mean Squared Error Difference Structure Similarity Index of a Video
$ModMSE$	Mod-Mean Squared Error Index of a Video
MSE	Mean Squared Error Value of a Video
$MSE(f)$	Mean Squared Error Value of a Frame
$MSE(x_f, y_f)$	Mean Squared Error Value of a Pixel
$MSSIM(x, y)$	Multiscale Structural Similarity Index of a Pixel
N	Total Number of Pixels
$PC(x)$	Phase Congruency value of a Pixel
$pv(f)$	Processed Video Frame
$PSNR$	Peak Signal to Noise Value of an Image
q	Result of Mapping Objective Score
R	Reference Frame
$R(x, y)$	Pixel in Reference Frame
rd	Respective Difference
$r(f)$	Result of Averaging f frames
$s(x, y)$	Structure Value of a Pixel
$SSIM(x, y)$	Structural Similarity Index of a Pixel
$SROCC$	Spearman Rank-Order Correlation Coefficient Value of a Method
$thres$	Threshold Value
$v(f)$	Frame of a Video
θ	Orientation Angle

κ	Kurtosis
μ	Mean Intensity
ξ	Local Distortion Visibility Map
σ	Standard Deviation
$\tilde{\sigma}$	Minimum Standard Deviation
ς	Skewness
τ	Parameters to be fitted