Faculty of Engineering

BLUR ASSESSMENT USING EDGE INFORMATION

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Blur Assessment Using Edge Information

ADELINE NG SIN LIN

This Thesis Is Submitted To
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Dedicated to my beloved family and friends

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ABSTRAK

Kualiti imej digital sering dijejaskan oleh artifak kekaburan dalam keadaan seperti mampatan, ralat fokus, pergerakan relatif dan transmisi multimedia. Kehilangan komponen frekuensi tinggi menyebabkan kesan pengaburan dalam imej tersebut. Dalam kertas kerja ini, penilaian kekaburan yang berunsur rujukan penuh dan tidak penuh secara objektif dibentangkan untuk mengukur darjah *Gaussian blur* dalam imej berdasarkan maklumat yang diperolehi daripada pengesanan sisi imej. Darjah *Gaussian blur* suatu imej ialah jumlah purata lebar sisi daripada keseluruhan sisi yang dikesan. Prestasi penilaian kekaburan juga disahkan melalui keputusan subjektif. Keputusan menandakan hubungan rapat di antara penilaian kekaburan dengan persepsi manusia. Ukuran kekaburan sesuai digunakan dalam pelbagai aplikasi seperti anggaran kekaburan dalam fotografi digital, pemprosesan imej, percetakan atau sebagai perbandingan metrik antara dua imej. Kod bahasa pengaturcaraan untuk mengimplementasikan penilaian kekaburan ditulis dalam program MATLAB.

ABSTRACT

Quality of digital images is often impaired by blur artifacts in situation such as compression, focus error, relative motion and multimedia transmission. The loss of high frequency content leads to blurring effect in the image. In this paper, objective full-reference and no-reference blur assessments are presented to measure the degree of Gaussian blur in the image by using edge information. The degree of Gaussian blur of an image is the average of total edge widths over all detected edges. The performance of the blur assessment is also validated with subjective results. The results show that the blur assessment correlates relatively well with human perception. The blur measurement is applicable to numerous applications such as blur estimation in digital photography, image processing, printing or as a simple metric in comparing two images. The source code of this low computational complexity blur assessment is written in MATLAB program.

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LIST OF ABBREVATIONS

BM	–	Blur metric
Bmp	–	Bitmap
DCT	–	Discrete Cosine Transform
DMOS	–	Differential Mean Opinion Score
FR	–	Full-reference
HVS	–	Human Visual System
JPEG	–	Joint Photographic Experts Group
MOS	–	Mean Opinion Score
MSE	–	Mean Square Error
NBM	–	Normalized blur measurement
NR	–	No-reference
PSNR	–	Peak Signal-to-Noise Ratio
RGB	–	Red Green Blue
RF	–	Reduced-reference
SDBM	–	Square root of difference in blur measurement
VQEG	–	Video Quality Experts Group
YCbCr	–	Luminance and Chrominance information
YIQ	–	Luminance In-phase Quadrature
YUV	–	Luminance and Chrominance information
α	–	Gain between two gradients
σ	–	Gaussian blur standard deviation

BM_{FR}	–	Blur measurement from FR implementation
BM_{G}	–	Blur measurement on gray-level component
BM_{GI}	–	Blur measurement using grayscale image
BM_{H}	–	Blur measurement using horizontal edge detection
BM_{NR}	–	Blur measurement from NR implementation
BM_{RI}	–	Blur measurement on RGB image represented by grayscale component
BM_{V}	–	Blur measurement using vertical edge detection
BM_{Y}	–	Blur measurement on luminance component

CHAPTER 1

INTRODUCTION

1.1 Project Background

Along with the rapid advances in digital and multimedia imaging industry, digital images have been playing an increasingly important role in the communication of visual information. Digital images can be classified as binary images, color images, grayscale images and so forth. Unfortunately, these images can be degraded during acquisition, compression, transmission or even processing. Thus, a measure to the image quality is necessary to assess the degree of degradation. There are indeed many great efforts made towards the development of image quality assessment to produce suitable methods of assessing the quality of the image to measure visual artifacts like brightness, blurriness and jerkiness.

Methods of measuring the artifacts are categorized into objective and subjective evaluation. Objective method is based on mathematical measure while subjective method relies on the perception of a selected group of human observers such as professionals or lay viewers. Human visual perception on the quality of the image is very important as human observers are the final arbiters who determine the acceptability of the image contents.

Researchers have developed various perceptual image quality metrics where these metrics are used to measure the global distortion but a perceptual objective image quality analysis to measure a specific artifact is rarely found. There are a few objective measurements proposed for blockiness but less attention is devoted for other artifacts like blur and noise. Therefore, the aim of this project is to propose an objective blur assessment using edge information which correlates well with human visual perception.

1.2 Problem Statement

Most digital imaging capture devices and electronically displaying visual information devices aim to produce the best image quality. When an artifact like blur is introduced in an image due to acquisition or compression, the blur image has to be enhanced in order to look visually appealing. However, there is a possibility that this corrected image might not satisfy human perception. Various people evaluate the quality differently due to the sensitivity of human eye. Therefore, a blur metric which correlates with human visual is necessary to measure the blur image to determine the level of degradation so that it can be corrected to a certain extent to produce a better quality image and maintain the pleasure of human observers in viewing the image. For instance, in digital photography application, the metric is used to notify user the level of blurring in the image that has been captured.

The blur assessment proposed in this thesis is an objective method. Objective image assessment is least preferable as the most reliable means to access the image quality is through subjective evaluation where the quality of the image is evaluated by human. However, it is not an easy task to conduct a subjective evaluation image assessment because it is expensive and time-consuming [1]. Due to the limitations in subjective evaluation, researchers believed that it is useful to design objective method as long as it produces results that correlate closely with human visual system (HVS) [2]. There are 3 approaches to objective image quality assessment that can be considered such as no-reference (NR) measurement, reduced-reference (RR) measurement and full-reference (FR) measurement.

1.3 Project Objectives

The objectives of the project are:

a) To implement objective NR and FR blur assessments using edge information with MATLAB as the assessment tool.
b) To compare and analyze the blur metric that is measured on luminance component for color images and grayscale intensity component for gray-level images.
c) To compare and investigate the difference between blur assessment using grayscale images and RGB images measuring on grayscale component.
d) To test the difference of blur assessment using vertical edge detection and horizontal edge detection.
e) To validate the performance of the objective blur assessment with subjective testing results.