# BLUR DETECTION TECHNIQUE FOR THUMBNAIL IMAGE GENERATION

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# BLUR DETECTION TECHNIQUE FOR THUMBNAIL IMAGE GENERATION

**by**

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| **2D** | Two-Dimensional |
| **3D** | Three-Dimensional |
| **DIB** | Down-sampling with Integrated Blur |
| **DoF** | Depth of Field |
| **DPD** | Direct Pixel-based Down-sampling |
| **DSD** | Direct Sub-pixel-based Down-sampling |
| **NR** | Non-reference |
| **OOI** | Object of Interest |
| **PDAF** | Pixel-based Down-sampling with Anti-aliasing Filter |
| **RGB** | Red, Green and Blue |
| **SVM** | Support Vector Machine |
| **TBI** | Thumbnail with Blur Information |
| **TBNI** | Thumbnail with Blur and Noise Information |

## LIST OF SYMBOLS

| | |
|---|---|
| $a$ | the Lanczos filter size parameter |
| $b$ | the blue layer of color image |
| $B_r$ | the radius of the blur kernel |
| $\mathbf{B}$ | the space-varying blur |
| $\mathbf{C}$ | the ideal clean and sharp image |
| $E_w$ | the edge width |
| $F$ | the original high resolution input image |
| $f$ | the output thumbnail image |
| $g$ | the green layer of color image |
| $G_x$ | the first order derivative in $x$-direction |
| $G_y$ | the first order derivative in $y$-direction |
| $G_\theta$ | the gradient orientation |
| $G_m$ | the gradient magnitude |
| $G_{min}$ | the local minimum point |
| $G_{max}$ | the local maximum point |
| $L$ | the down-sampling factor |
| $L_z$ | the Lanczos window or sinc window |
| $r$ | the red layer of color image |

| | |
|---|---|
| $p$ | the resulting image of bicubic filter |
| $S$ | the structuring element |
| $w$ | the space varying weight values |
| $z$ | the set of points |
| $\lfloor x \rfloor$ | the floor function of $x$ |
| $\alpha$ | the sensitivity parameter towards noise and blur |
| $\sigma$ | standard deviation |
| $\circledast$ | the convolution process |
| $(y, x)$ | the spatial coordinates of array |
| $(i, j)$ | the spatial coordinates of array |

# TEKNIK PENGESANAN KABUR UNTUK PENJANAAN IMEJ LAKARAN KENIT

## ABSTRAK

Imej lakaran kenit digunakan dengan secara meluas dalam peranti elektronik untuk membantu pengguna dalam mengimbas imej asal yang mempunyai resolusi tinggi. Oleh itu, adalah penting untuk mempersembahkan imej lakaran kenit bersepadanan dengan imej asal. Imej kabur tidak harus kelihatan jelas dalam bentuk imej lakaran kenit, kerana keadaan ini mungkin mengelirukan analisis persepsi pengguna. Tujuan utama penyelidikan ini adalah untuk membangunkan satu algoritma pensampelan untuk menghasilkan imej lakaran kenit yang memasukkan maklumat kekaburan. Kaedah yang dicadangkan melibatkan tiga peringkat iaitu proses awalan, pengesanan kabur dan akhir sekali pensampelan menurun imej. Untuk proses awal, terbitan Sobel tertib pertama, magnitud kecerunan dan orientasi kecerunan adalah ditentukan. Dalam peringkat pengesanan kabur, maksimum tempatan, minimum tempatan dan orientasi kecerunan digunakan untuk mengira lebar pinggir. Imej lakaran kenit dengan maklumat kabur dihasilkan dengan menggunakan peta lebar pinggir purata sebagai pemberat yang mengintegrasikan maklumat kabur. Kaedah yang dicadangkan itu telah ditanda aras dengan menggunakan lima kaedah penghasilan imej lakaran kenit yang lain. Penilaian dilakukan melalui kaji selidik daripada 51 sukarelawan, dan juga berdasarkan pemeriksaan secara penglihatan. Keputusan menunjukkan bahawa kaedah yang dicadangkan mempunyai potensi yang tinggi untuk digunakan sebagai salah satu pilihan penghasilan imej lakaran kenit untuk mempamerkan gambar.

# BLUR DETECTION TECHNIQUE FOR THUMBNAIL IMAGE GENERATION

## ABSTRACT

Thumbnail images are widely used in electronic devices to help the user to scan through original high resolution images. Hence, it is essential to represent the thumbnail image correspondingly to the original image. A blur image should not appear to be a clear image in thumbnail form, where this situation might mislead the perceptual analysis of the user. The main purpose of this research work is to develop a down-sampling algorithm to create a thumbnail image which includes blur information. The proposed method has three stages, which are preliminary processes, blur detection and lastly image down-sampling. For preliminary processes, Sobel first order derivatives, gradient magnitude and gradient orientation are determined. In blur detection stage, local maximum, local minimum and gradient orientation are utilized to calculate the edge width. The thumbnail image with blur information is generated using the average edge width as a weight to integrate blur information. The proposed method has been benchmarked by using five other thumbnail generation methods. The evaluations are done through a survey of 51 volunteers, and also based on visual inspection. The results suggest that the proposed method has high potential to be applied as one of the thumbnail generation options for photo viewing.

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Photo capturing by digital camera is very convenient for most consumers, be it the process of photo taking or viewing the photo after the image is captured [1]. Today, digital camera has become a routine device, especially when it is being integrated into the smart phone with social media applications. Digital image becomes easily accessible through consumer electronics such as laptop and tablet. The usage of these electronic devices has expanded at a very fast pace, especially amongst young generation.

In year 2011, Americans have captured 80 billion photographs and more than 250 million photographs are being posted daily on Facebook. This number is expected to be increased each year [2]. While the camera manufacturers continue to improve photo quality and increase the resolution of the image captured by their products, the consumers are drowning in digital visual contents [3]. Thus, there is a need to determine ways to review and check the quality of the captured digital photograph.

Thumbnail image is commonly used as an intermediary for the user to check through the perceptual quality of the digital image in bunches. Recently, there is a need for thumbnail image with blur information. This type of thumbnail image is needed to assist the user to perceptually identify an image of good quality based on the thumbnail image. From there, the user will be able to classify the image into wanted or unwanted blur images in a bulky image folder.

### 1.2 Overview of Blur Detection in Image Processing.

For an image, generally it is important that an image is clear and sharp. However, there are also occasions where the blur is done purposely to make the image captured more meaningful, such as motion blur in a photo of a runner that is about to cross the ending line (i.e., motion blur on the body but clear on facial expression). Be it as it may, blur image in most occasions, is unwanted and many researches have magnificient works in this blur image branch. Generally, researches related to blur in digital image fall into two categories, one is blur analysis, and one is de-blurring process.

Blur analysis is the process where the image is analyzed in terms of bluriness of edge or bluriness of a certain region in image with quantitative parameter. Example of blur analysis is edge width analysis where the degree of blur is assumed to be proportional to the edge width [4]. Edge width data is mapped for the original image and the data can be used for further process, such re-sampling of the image. Other examples of blur analysis are Bayes discriminant analysis [5] which researches on gradient statistic of the blur object in image. There is also researches on calculation of local blur at boundary and blur magnitude averaging of an image using non-reference block based analysis [6].

Re-sampling of image after blur analysis involve down-sampling of image. Image of high definition will be down-sampled into thumbnail image. Normally, down-sampled image might not correspond to the original image. Thumbnail image generated via down-sampling process might appear to be sharper, or more blur than the original image. More down-sampling processes will be described in Section 2.2.

### 1.3 Problem Statements

Thumbnail image with blur information is important to allow the user to identify blur image corresponding to the original image after the image being down-sampled. Many issues need to be solved on the way towards the implementation of this project. As currently available thumbnail generation methods do not emphasize the blur of the original high definition image, thumbnail image generated sometimes does not corresponds to the actual quality of original image [7]. This situation is undesired as it affects the perceptual quality of the user. Therefore, a research is needed to enable thumbnail generation method that is able to embed the blur of the original image into thumbnail image [8].

The two main problems related to this research are listed as follow:

1. It is challenging to integrate blur information into thumbnail image. If the thumbnail image is too small, it is difficult for the user to observe the contents of the image [9]. In order to highlight the blur on the thumbnail image, blur sensitivity needs to be adjusted to suit most of the image data. This is because less sensitivity (or over sensitivity) to edge blur might produce undesirable thumbnail image.

2. It is hard to detect the existence of blur inside an image [10]. The way to detect blur object in image need to be researched in order to develop a suitable way to detect blur in image. It is indeed challenging and yet interesting to find the blur, which used to be in subjective perspective in a scientific way.

## 1.4 Project Objectives

Most of the thumbnail generation method produces sharper images, which are not correspond correctly to the original high resolution image. Therefore, the aim of this project is to produce an algorithm that is able to down-sample original image, and embed the related blur information into the output thumbnail image. In order to reach this aim, two objectives have been set. The objectives of this research project are:

1. To develop a blur detection algorithm to detect blur in the original high resolution image.
2. To develop a thumbnail generation method that is able to highlight blur in thumbnail image.

## 1.5 Project Scopes

The scopes of this project are listed down as follow:

1. The type of image used in this project is optical raster image. The other type of image such as vector image is not in the scope of this project. This is because raster image is a more common image to user. Furthermore, vector image does not have much problem with rescaling.
2. The analysis of the image in this project implements edge width analysis. The degree of blur is assumed to be proportional to the edge width of the image objects. There is no specific blur type concerned in this research. Others analysis is not in the scope of this project.
3. Image that has very low resolution (i.e, $200 \times 200$ pixels) is avoided for this project. This is because the main aim of this project is to generate thumbnail with blur information

from high resolution image. Lower resolution image has little value especially when it is being down-sampled to even lower resolution thumbnail image. Hence, low resolution image is not considered in this project.

4. De-blurring is not included in the implementation of this project. This is because the main focus of this project is to integrate blur into thumbnail image, rather than eleminating blur in the image. The blur region of the original high resolution image is integrated into thumbnail form in this process.

### 1.6 Organization of Thesis

There are five chapters in this thesis, which are summarized as follow:

**Chapter 1**

This chapter presents a brief introduction to blur detection research in image processing. It also includes the project's problem statements, project objectives, and the scope of the research.

**Chapter 2**

This chapter includes the literature review of past researches and studies on image processing. Related works regarding edge blur analysis is being surveyed. Various methods such as Bayes discriminant function, non-reference block blur detection and wavelet-based histogram with Support Vector Machine (SVM) have been included.

**Chapter 3**

This chapter describes the details of the proposed blur image with thumbnail information algorithm in this project. For a better understanding, the overall system flow is explained with the help of a flow chart. The process of data collection is also explained in this chapter.

**Chapter 4**

This chapter presents the experimental results, to evaluate the performance of the method de-

scribed in Chapter 3. Limitations of the proposed method are also presented in this chapter.

**Chapter 5**

This chapter concludes the findings from this research and gives a few constructive suggestions for the future work.

# CHAPTER 2

# LITERATURE REVIEW

This literature review is needed in order to gain related knowledge and foundation to this project. This is important for this research as it can give some insight to improve current method or invent new algorithms. This chapter will cover on imaging foundation and further to more advanced aspects, including a survey on various blur processing researches.

This chapter is organized as follows. Introduction to digital image will be given in Section 2.1. This section will cover vector image and raster image. Because thumbnail algorithms require down-sampling processes, next, Section 2.2 will describe six thumbnail down-sampling methods. Afterwards, Section 2.3 will describe two types of blur that are affecting digital image, namely complete blur and partial blur. This section will be extended with subsections regarding explanations on causes of blur such as depth of field, motion and out of focus. The study of other researchers' works related to this project will be presented in Section 2.4. Finally, Section 2.5 will summarize this literature review.

## 2.1 Digital Image

In this section, introduction is given regarding digital image. Generally, digital image can be categorized into raster image and vector image. The explaination of these two types of digital image will be covered in the next subsections. Between raster image and vector image, more emphasize will be given to raster image as it is more related to the research scope and algorithm implementation. The discussion on raster image will be further described in terms of color image and gray-scale image.