Exploration of Current Trend on Blur Detection Method Utilized in Digital Image Processing

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***Abstract*—Detection of blur in digital image, which is commonly preliminary step for de-blurring process, has becoming one of the growing research areas these days and has attracted many attentions from researchers. Research scholars have proposed new methods, or improved blur detection algorithms, based on edge sharpness analysis, low Depth of Field analysis, blind de-convolution, Bayes discriminant function, reference or non-reference block and wavelet based histogram with Support Vector Machine (SVM). The purpose of this paper is to explore the research trends (before year 1993 to year 2012) regarding the usage of blur detection algorithms for digital image processing researches. Because there are thousands of reliable literatures available, the trend is observed from the available online literature alone. Our scope of research has been limited only to search engine of IEEExplore®, ScienceDirect, and Google Scholar database. The searching for literatures will be classified according to their respective keyword for each method being utilized. We observed that low Depth of Field blur detection analysis is currently the most popular method, followed by edge sharpness analysis of blur detection. Google Scholar also has the most abundance source of online literature compared with IEEExplore® and ScienceDirect. Based on the trending graph, we observed that the researches in blur detection method are very positive, showing an overall increasing number of publication from year to year.**

***Index Terms*—Blur detection, literature survey, edge sharpness analysis, low depth field analysis, blind de-convolution, Bayes discriminant function, non-reference block, wavelet based histogram**

I. INTRODUCTION

Blur detection, one of the popular research areas in computer vision system is showing an increasing research trend. It is expected that computer vision technology will be the future of the manufacturing line, replacing most of the human operator works and cut operational cost in long term basis [1]. However, it is worth noting that up to this day, human work still has an upper hand on most of the industries over computer vision work [2]. Blur detection method can be applied as initial stage for de-blurring when the machine vision of manufacturing line is out of focus or due to rapid movement of the inspected product. Besides, there are applications for blur detection method for crime solving purposes, as part of the image enhancement for video surveillance system for a clearer picture of the criminal. In daily life routine, blur detection application can be used to de-blur precious image which is blurred. The blurring of image may due to many causes; the two commonly studied classification of the blur type is near-isotropic blur, which includes out of focus blur, and directional motion blur.

As study of the characterization and detection for blur region are needed in order to understand image information and evaluating image quality [3], developing of the blur detection algorithms for automatic detection and classification has become very functional in terms of computation and cost. Rugna and Konik [4] have shown in their work that blurry regions in image are more invariant to low pass filter process. The idea of their works has been widely accepted by researchers and it becomes an interesting research feature to classify blurry and non-blurry region. Works in [5] by Levin used a method based on inferred kernel to build an energy function to separate the image into two distinctive layers of blur and non-blur for further classifications. Other algorithm proposed by Elder and Zucker [6] only measures the blur extend of the blurry image, without classify the blurry and non-blurry regions of the image input.

The restriction of blur detection method has attracted many researchers to extend the edge of limitation. Many researchers have proposed extension, composite or improved algorithms which contributed to the development of the blur detection method. Thousands of reliable literatures based on blur detection method can be found online these days. Although we belief that there are much more research papers available but not online, the online literature alone is sufficient to give an overview of the research trend. Based on analysis on the past researches on the blur detection methods, blur detection can be classified in to seven categories. They are:

A. *Edge Sharpness Analysis Blur Detection in Digital Image*

- Common edge sharpness analysis methods use the contrast edge of object in the image for blur analysis.
- Using the Harr wavelet transform, to detect blur and extend of blurring [7].

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- Using perceptual-based no-reference objective image sharpness/blurriness metric by integrating the concept of just noticeable blur into a probability summation model [8].
- Using standard deviation of the edge gradient magnitude profile and the value of the edge gradient magnitude with weighted average [9].

B. Depth of Field (D.o.F.) Blur Detection in Digital Image

- Focusing on object detection in Object of Interest (OOI) technique in image by photographer.
- Works on low Depth of Field.
- Related methods in [10-12].

C. Blind De-Convolution Blur Detection in Digital Image

- Blind de-convolution works more efficient with correctly estimated blurring Point spread Function (PSF).
- Blind de-convolution can be non-iterative or iterative process.
- Related methods in [13]-[18].

D. Bayes Discriminant Function Blur Detection in Digital Image

- Based on statistical analysis of the image gradient of both sharp and blur regions.
- Examples of works are [19].

E. Non-Reference Block Blur Detection in Digital Image

- No reference to the original image signal information.
- Most convenient and robust compared with reduce-reference and full-reference methods.
- Examples of works in [20]-[24].

F. Directional Frequency Energy Blur Detection in Digital Image

- Direction estimation of the blur region is performed.
- Blur detection without PSF.
- Example of works in [25].

G. Wavelet-Based Histogram Blur Detection in Digital Image

- Discrimination of the gradient distributions between blurred and non-blurred image regions.
- Probability map can be constructed with wavelet gradient histograms
- Examples of works in [26]-[28].

Each of the blur detection method has its own advantages and disadvantages. Therefore, each of the application has their research value based on the type of application and signal input of data. We will analysis the research trend of above-mentioned blur detection method to give an understanding on how the researched method popularity goes.

To ease the presentation of this paper, this paper is organized into four main sections. The first section, which is this section, gives the background and the purposes of this research. Then, Section II explains the methodology on how this research will be carried out. Section III presents the outcome of this research, while the last section, which is Section IV, concludes our findings.

II. Methodology

As the number of research literature available online is very large, it is almost impossible for us to inspect every single literature in detail for the methodology they used or proposed as every single research paper is unique. In order to smooth the research and also for standardization of this review paper, we will classify these literatures based on their keywords. We assume that the keywords used by the literatures reflect exactly the blur detection approach used by that literature. The keywords used are listed in Table I.

TABLE I. The Keywords Used to Search Related Literatures

Method	Keyword
Edge Sharpness Blur Detection in Digital Image	"Edge Sharpness Blur Detection Digital Image"
Low Depth Field Blur Detection in Digital Image	"Low Depth Field Blur Detection Digital Image"
Blind De-Convolution Blur Detection in Digital Image	"Blind De-Convolution Blur Detection Digital Image"
Bayes Discriminant Blur Detection in Digital Image	"Bayes Discriminant Blur Detection Digital Image"
Non-Reference Block Blur Detection in Digital Image	"Non-Reference Block Blur Detection Digital Image"
Directional Frequency Energy Blur Detection in Digital Image	"Directional Frequency Energy Blur Detection Digital Image"
Wavelet Based Histogram Blur Detection in Digital Image	"Wavelet Based Histogram Blur Detection Digital Image"
Blur Detection in Digital Image (In General)	"Blur Detection Digital Image"

As there is abundance of reliable online literatures available, this paper will be restricted to three well-known database sources, which are Google Scholar, ScienceDirect and IEEExplore®:

A. Google Scholar (http://scholar.google.com.my)

- Google Scholar provides searching of literatures across almost all disciplines and sources, including journals, proceedings, abstracts, books, theses, and patents.

B. ScienceDirect (http://www.sciencedirect.com)

- ScienceDirect is one of the world's famous database for scientific, technical, and medical full text research papers.

C. IEEExplore® (http://ieeexplore.ieee.org)

- IEEExplore® is a well-known online database containing more specific scope regarding to the researches on electrical, electronic and computer engineering.

In order to check the popularity of each blur detection method, we will utilize the search engine of each corresponding website. Fig. 1 shows the different search engine interface available for IEEExplore®, Google Scholar and ScienceDirect. These user friendly interfaces are located on the left hand side of the corresponding website. By collecting data and presenting in graphical form, the popularity of the research trend can be interpreted by the number of research paper published.

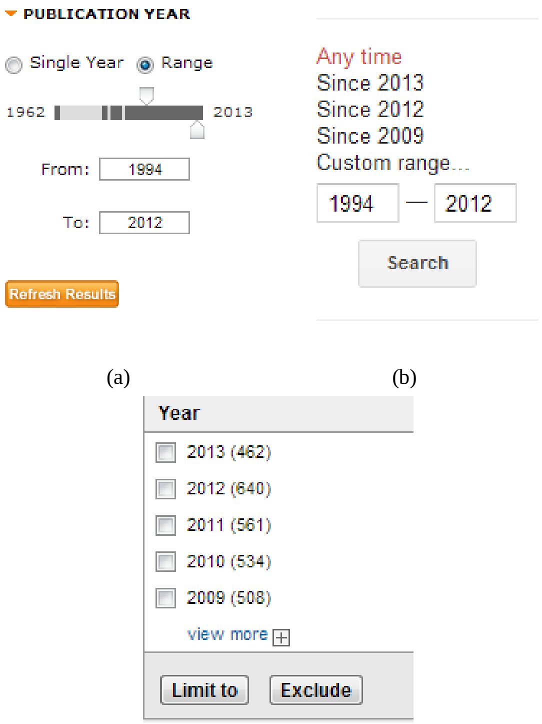

Figure.1. "Publication Year" feature provided by (a)IEEEXplore®, (b) Google Scholar and (c) ScienceDirect

III. RESULTS

To see whether the research on blur detection method in digital image is still a popular topic among researchers, keyword of "blur detection digital image" is used for data collections via corresponding database website. The number of publication from these three databases is then displayed as line graphs. Fig. 2 shows the trend extracted from IEEExplore® database, Fig. 3 shows the results from ScienceDirect, whereas Fig. 4 shows the publication trend of Google Scholar. A composite graph is not suitable to represent the data collected as the search results of publication number have a very high contrast with each other.

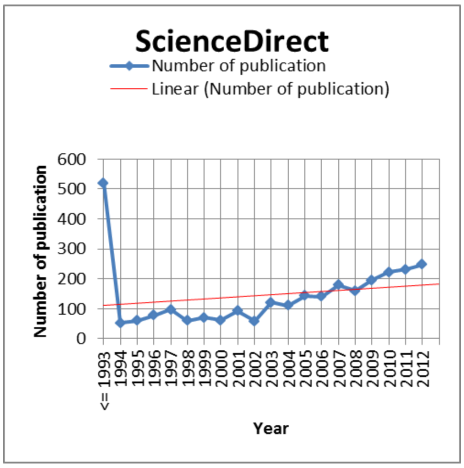

Figure.2. The trend on the researches regarding to blur detection method, observed from ScienceDirect database

As shown by these figures, the number of publications on blur detection method is the highest from Google Scholar database, followed by ScienceDirect, and IEEExplore®. This is because the content of IEEExplore® database is only restricted towards electrical, electronic, and computer engineering researches. However, if we observe the overall linear trend, which shows the growth of the research topic, we can see that ScienceDirect experience the lowest growing index and Google Scholar has the highest growing index on this research topic.

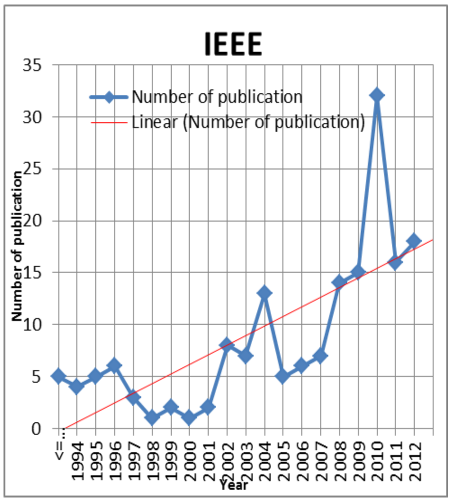

Figure.3. The trend on the researches regarding to blur detection method, observed from IEEExplore® database

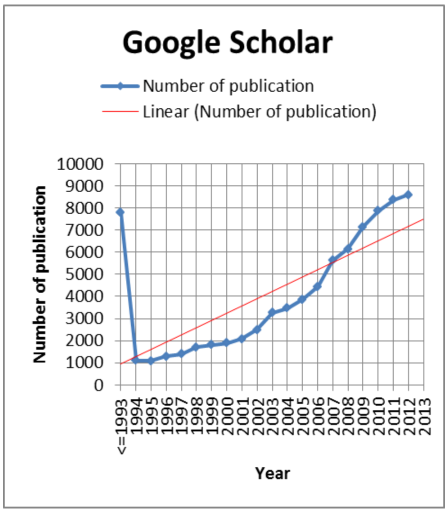

Figure.4. The trend on the researches regarding to blur detection method, observed from Google Scholar database

From Fig. 2, it shows that the research on blur detection in digital image in IEEE experienced fluctuation in the number of published paper regarding blur detection in digital image but it experienced a large boost in year 2010 and since then, steadily grow at year 2011 and year 2012. In ScienceDirect, the publication number had smaller fluctuation compared with IEEE but remains a growing trend over the years from year before 1993 to year 2012. Google Scholar had the fastest growing database over the year and it is expected to maintain its high growing linear gradient index. From the graphical presentations, we can see that blur detection methods are still growing and thousands of publications being published each year, therefore we can expect that more and more new and hybrid methods being introduced in the years to come.

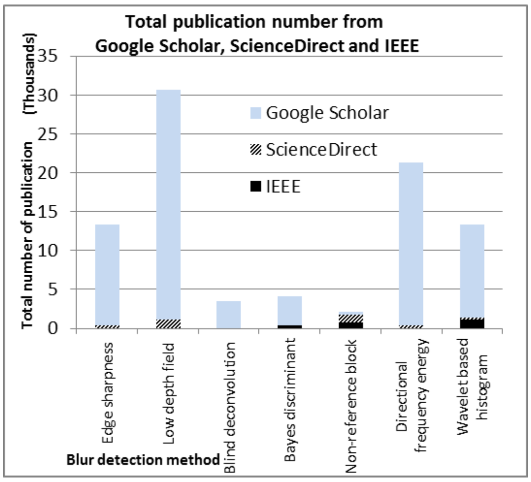

Figure.5. The bar graph showing the accumulated number of publications versus blur detection methods

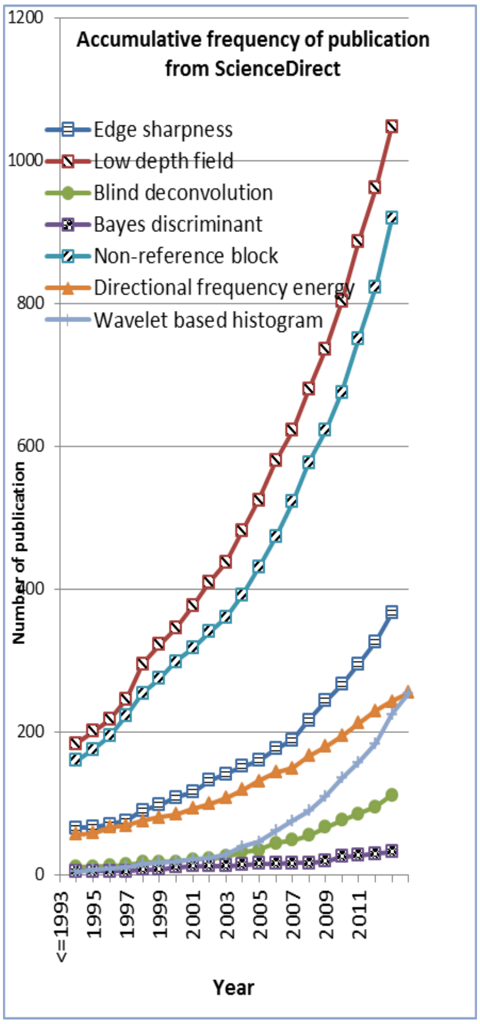

Figure.6. The trend on the research regarding to each blur detection method, observed from ScienceDirect database

In order to investigate the popularity each blur detection methods considered in this research, we inputted the keywords shown in Table I into the three respective search engines. The results are shown in Fig. 5. We assumed that there is no reoccurrence exists in the database. The range of year presented is from year before 1993 to year 2012. The popularity is measured by the number of publication available for each year. We can see from the composite graph shown in Fig. 5, low Depth of Field analysis on blur detection has the highest popularity and it followed by directional frequency analysis, edge sharpness analysis, wavelet-based histogram analysis, Bayes discriminant analysis, blind de-convolution analysis and finally non-reference block analysis.

Besides the total publication from each database, we need to know the popularity of each of the blur detection method in digital image. A composite graph is plotted using the ScienceDirect database for each of the blur detection method in this review paper. The range of data collection is from year before 1993 to year 2012, as shown in Fig. 6.

IV. Conclusion

From this survey, we can conclude that blur detection is still a popular research area with potential of further advancement in the future. This review also shows that each of the blur detection method has active research value and expected to increase for years to come.

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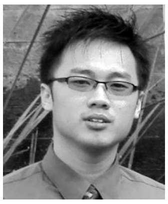

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