Faculty of Electronics and Computer Engineering

ACCURATE REAL TIME DETECTION FOR HALAL LOGO BASED ON FOURIER MAGNITUDE METHOD

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DECLARATION

I declare that this thesis entitle “Accurate Real Time Detection For Halal Logo Based On Fourier Magnitude Method” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Electronic Engineering.

Signature : .....

Supervisor Name : .....

Date : .....

ABSTRACT

The research works carried out is the analysis of object detection methods and development of a new method in recognizing the approved Halal logo by JAKIM and their implementation in Android device. Currently, many irresponsible entrepreneurs use imitation 'Halal' logo on their products. Consequently, Muslim users find it hard to determine the validity of 'Halal' logo used. This research aims to classify between JAKIM Halal logo and fake Halal logo. Beside that, the objective of this research is to develop an algorithm Fractionalized Principle Magnitude to recognize all 50 approved Halal logo. This research is divided into a three stages. In the first stage, the evaluations of the existing object detection methods in Android Smartphone is conducted. The evaluated object detection methods are Scale Invariant Feature Transform (SIFT), Speed up Robust Feature (SURF), Feature from Accelerate Segment Test (FAST), Good Feature to Track (GFTT), Maximally Stable Extremal Regions (MSER), Oriented FAST and Rotated BRIEF (ORB) and Center Surrounded Extrama (CenSurE). The characteristic of each object detection method is studied and compared in order to identify the best object detection method that can be applied in the recognition of JAKIM Halal logo. The second stage is the recognition of JAKIM Halal logo using Android Smartphone. In this stage, object detection methods with good result from previous stage is evaluated and compared with a newly developed simple yet effective logo recognition method based template matching technique in recognizing JAKIM Halal logo from fake Halal logos on Android phones. The last stage is the final work to complete Malaysia Halal logo recognition system because JAKIM also approved other 50 Halal logo from around the world other than JAKIM Halal logo. So in the last stage, a novel logo recognition method based on Fourier magnitudes and k-nearest neighbor classifier is developed to recognize all 50 Halal logos that approved by JAKIM. This novel logo recognition method is called Fractionalized Principle Magnitude (FPM) and have been compared with other logo recognition method such as Histogram of Gradient (HOG), Hu Moment, Zernike Moment and Wavelet Co-occurrence Histogram (WCH). The comparison is carried out based on efficiency, consistency and accuracy performances of each method. From the results, it shows that FPM obtains the highest average performance of 90.4% compared to those of 75.2% for HOG, 44.4% for Hu Moment, 64.4% for Zernike, and 47.2% for WCH.

ABSTRAK

Penyelidikan yang dijalankan adalah untuk menganalisis tentang kaedah pengesanan objek dan pembangunan satu kaedah baru dalam mengenalpasti logo Halal yang diiktiraf oleh JAKIM dan dilaksanakan pada Android. Kajian ini dibahagikan kepada tiga peringkat. Di peringkat pertama, penilaian terhadap kaedah pengesanan objek yang sedia ada diimplikasikan pada telefon pintar Android dijalankan. Terdapat tujuh kaedah pengesanan objek yang diuji iaitu "Scale Invariant Feature Transform (SIFT)", "Speed up Robust Feature (SURF)", "Feature from Accelerate Segment Test (FAST)", "Good Feature to Track (GFTT)", "Maximally Stable Extremal Regions (MSER)", "Oriented FAST and Rotated BRIEF (ORB)" dan "Center Surrounded Extrama (CenSurE)". Ciri-ciri setiap kaedah dikaji dan diuji untuk mengenalpasti kaedah pengesanan objek yang terbaik dan boleh diaplikasikan untuk mengesan logo Halal JAKIM. Peringkat kedua adalah mengenalpastilogo Halal JAKIM menggunakan telefon pintar Android. Pada peringkat ini, kaedah pengesanan objek yang terbaik berdasarkan ujikaji peringkat sebelum ini diuji dengan kaedah baru iaitu pengesanan logo yang lebih effectif berdasarkan teknik "template matching" dalam mengenalpasti logo Halal JAKIM daripada logo Halal yang palsu pada telefon pintar Android. Peringkat terakhir adalah kerja akhir untuk menyelesaikan sistem pengesanan logo Halal Malaysia ini kerana JAKIM turut mengiktiraf 50 Halal logo dari seluruh dunia berbanding logo Halal Malaysia. Oleh itu pada peringkat terakhir, satu kaedah pengesanan logo berdasarkan "Fourier magnitudes" dan "k-nearest neighbor classifier" dibangunkan untuk mengesan dan mengenal pasti 50 logo Halal yang diiktiraf oleh JAKIM. Kaedah pengesanan logo baru ini dikenali sebagai "Fractionalized Principle Magnitude (PFM)" dan kaedah ini telah dibandingkan dengan kaedah pengesanan logo yang lain seperti "Histogram of Gradient (HOG)", "Hu Moment", "Zernike Moment" and "Wavelet Co-occurrence Histogram (WCH)". Perbandingan ini dijalankan berdasarkan kecekapan, konsisten dan ketepatan setiap kaedah. Hasil dari keputusan penyelidikan menunjukkan FPM mempunyai prestasi yang tertinggi secara keseluruhannya iaitu 90.4% berbanding 75.2% untuk HOG, 44.4% untuk Hu Moment, 64.4% untuk Zernike dan 47.2% untuk WCH.

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LIST OF ABBREVIATIONS

AOT	-	Accuracy Over Time
CMYK	-	Cyan, Magenta, Yellow, And Key (Black)
CenSurE	-	Center Surrounded Extrema
DoG	-	Difference Of Gaussian
EBR	-	Edge-Based Region
EDH	-	Edge Directional Histogram
FAST	-	Features from Accelerated Segment Test
FLANN	-	Fast Library for Approximate Nearest Neighbors
FPM	-	Fractionalized Principle Magnitude
FN	-	False Negative
fps	-	Frame per second
FP	-	False Positive
GFTT	-	Good Feature to Track
HL	-	High-Low
HH	-	High-High
HOG	-	Histogram of Gradient
HSI	-	Hue-Saturation-Intensity
HSV	-	Hue-Saturation-Value
IBR	-	Intensity Extremal-Based Region
JAKIM	-	Jabatan Agama Kemajuan Islam Malaysia
JNI	-	JAVA native interface

JVM	-	JAVA Virtual Machine
JRE	-	JAVA Runtime Environment
LL	-	Low-Low
LH	-	Low-High
Mag	-	Magnitude
MAIN	-	Majlis Agama Islam Negeri
MPEG	-	Moving Picture Experts Group
MSER	-	Maximally-Stable Extremal Region Extractor
MSE	-	Mean Squared Error
NCC	-	Normalized Cross Correlation
NDK	-	Native Development Kit
OS	-	Operating System
RER	-	Repeatability Error Rate
RGB	-	Red Gray Blue
SAD	-	Sum of Absolute Differences
SDK	-	Software Development Kit
SIFT	-	Scale Invariant Feature Transform
SSD	-	Squared Different Matrix
SuRF	-	Speeded-Up Feature Transform Discrete
SVM	-	Support Vector Machine
TN	-	True Negative
TP	-	True Positive
WCH	-	Wavelet Co-occurrence Histogram
AOT	-	Accuracy Over Time

LIST OF SYMBOLS

log	-	Logarithm
dB	-	Decibel
λ	-	Lambda
Σ	-	Summation

LIST OF PUBLICATIONS

The research papers produced and published during the course of this research are as follows:

1. Khairul Muzzammil Saipullah, Nurul Atiqah Ismail and Yewguan Soo, 2013. Feature Extraction method for Classification of Approved Halal Logo in Malaysia using Fractionalized Principle Magnitude. *Journal of Engineering Management Reviews (EMR)*, 2(2), pp. 36-44.
2. Khairul Muzzammil Saipullah, Nurul Atiqah Ismail, Ammar Anuar, Nuraishah Sarimin, 2012. Comparison Of Feature Extractors For Real-Time Object Detection On Android Smartphone, *Journal of Theoretical and Applied Information Technology (JATIT)*, 47(1), pp.135-142. *(Scopus)*
3. Khairul Muzzammil Saipullah, Nurul Atiqah Ismail and Yewguan Soo, 2012. Feature Extractor for the Classification of Approved Halal Logo in Malaysia, *2012 IEEE Conference on International Conference on Control System, Computing and Engineering (ICCSCE)*, pp. 495- 500. *(Scopus)*
4. Khairul Muzzammil Saipullah, Ammar Anuar, and Nurul Atiqah Ismail, 2012. JAKIM'S Halal Logo Recognition System Based on Android Smartphone, *International Conference on Design and Concurrent Engineering (iDECON), 2012 Conference on*, pp. 175-178.

5. Nurul Atiqah Binti Ismail, Khairul Muzzammil Bin Saipullah, Ammar Anuar, Nuraishah Sarimin And Yewguan Soo, 2012. Analysis Of Real-Time Object Detection Methods For Android Smartphone, *2012 Conference on International Conference on Engineering and ICT (ICEI),* pp. 75- 80.

CHAPTER 1

INTRODUCTION

1.1 Background

Object detection has a lot of usages and importance to our life. Basically, object detection is used to understand the meaning or content of an image and it also can be used to identify and classify logo. A logo is a symbol that represents a company or product and shows the strength and value of a company or product. Certain companies spend a lot of money to come up with the right logo that able to represent their identity and it also must be simple so that it can be remembered and identified by consumer easily. Therefore, each logo has its own intellectual property and any plagiarism will be sued by the responsible organization.

The challenge in recognition a logo involves the sensitivity of the recognition regarding to the variation of size, background objects, orientations and lighting conditions of the logo that will significantly affect the recognition result. The lighting condition plays the main role in logo recognition where the changes of light will affect the RGB value of each pixel in the logo. Therefore, only a carefully constructed logo recognition method that considers all of the sensitive changes can achieve good logo recognition performance.

In Malaysia, Halal logo becomes a sensitive issue to Muslim consumers. The problem happens when the Muslim consumer get confuse in identifying the Halal product at the market. Department of Islamic Development Malaysia is the department responsible in monitoring the Halal issue. Halal logo certification has been implemented as a symbol

of Halal verifications and it needs to be requested by product owners, however the misused of the Halal logo by the irresponsible traders concerns the Muslim consumers. Other than Malaysian approved Halal logo, Department of Islamic Development Malaysia also approve others 50 Halal logo issued by 52 Muslim associations around the world. The only way to verify the Halal status of these foreign Halal products is by identifying their Halal logos. Current method to verify Halal status is by using short message service (SMS) and smartphone application. However, this system only verified the products that have Halal status in Malaysia and not for those Halal registered in other Muslim countries.

The main purpose of this thesis is to recognize the whole 50 Halal logos approved by Department of Islamic Development Malaysia and to perform Halal logo recognition on the Android smartphone. The smartphone is believed to be the fastest way to verify Halal product and most consumers have their own smartphone. A smartphone is built with advanced computing hardware compared to standard mobile phone. By implementing Halal logo recognition on the smartphone, the user can verify the Halal logo during their shopping. The detection method of Halal logo needs to be simple and accurate so that it can be embedded in Smartphone and can be used by Muslim consumers to recognize the Halal logo.

In the market, there are many different brands either local or international display on the product. Each product category is labeled with their own Halal logo. There are 52 Halal certification bodies accredited by Department of Islamic Development Malaysia that issued 50 Halal logo used in various Halal products around the world. Figure 1.1 shows 50 examples of those approved Halal logos. From the figure, we can see the differences between each logo in terms of color, shape and complexity. Muslim consumers in Malaysia need to recognize and remember each of those logos. Unfortunately, the user can

get confused in remembering all the logos. Therefore, this research was carried out to facilitate the Muslim consumers in Malaysia in identifying Halal products.

Figure 1.1: The example of Halal logo in the database

As the motivation of this problem, this research can be used to help users in the classification of the approved Halal logo. Since the logo can be differentiated using its visual information, the classification can be done using object detection and recognition method. From the Department of Islamic Development Malaysia website, the entire Halal product ingredients are permitted under Muslim law and also fulfill the following requirement;

1. The food or any parts of the product are free from the non-Halal animals regarding on Muslim law and also the animal which is not slaughtered according to the Muslim law.

2. The product or foods are free from any Najs (unclean) according to the Muslim law, is safe and not harmful.
3. The product is free from any part of the human body.
4. All the packaging process or manufactured equipment is not contaminated with the Najs according to the Muslim law.
5. During the preparation, process or packaging does not in contact or near with any food that does not meet the requirement or any substance will be considered impure by Islamic law (JAKIM, 2011).

The JAKIM's Halal logo is shown in Figure 1.2 and the samples of fake Halal logos are shown in Figure 1.3. The Halal logo contains eight cusp stars at the center of a circle. At the center of the logo, there is 'Halal' word written in Arabic and Roman. At the top and bottom of the circle there is 'MALAYSIA' word written in both, Arabic and Roman. The word 'Halal' at the center is separated between two small stars.

Figure 1.2: The JAKIM Halal logo

Figure 1.3: The fake Halal logo

Due to variety of Halal logo issue, a new method needs to be developed to differentiate the JAKIM Halal logo with the fake Halal logo. This method must be simple and efficient so that it can be embedded in smartphone and can easily be applied by the Muslim consumers when they are buying products. With appropriate object detection method, this goal can be achieved.

From the preliminary findings, it shows that Halal subject brings few issues and challenges in its accomplishment especially to non-Muslim business owner. Some of the issues are disparate of Halal definition where people only relate it as a special feature of animal slaughtering, but actually Halal is involved in all aspects in the preparation of the product including the ingredient, cleanliness and many more. Irresponsible usage of Halal related name to product by individuals or firms that are not registered to the Department of Islamic Development Malaysia is also a big issue. Some of the firms use the Arabic-sounded or Islamic names to attract the Muslim consumer to use their product. Our Muslim consumers always take things simple so they often instantly relate products with an Islamic name to Muslim operated company that automatically offers Halal goods.