

DEEP LEARNING-BASED
HALAL FOOD RECOGNITION

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DEDICATION

This project report is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Halal is the term used for permissible food according to Islam. Indicators such as Halal logo have been used to guide Muslims in identifying Halal food. Department of Islamic Development (JAKIM) in Malaysia has introduced a standard Halal logo for locally manufactured products. Problem arises when Muslims in Malaysia are travelling overseas, especially to non-Latin language country. It is difficult to find the ingredients used in the product, as it is written in non-Latin language, to determine whether it is a Halal or non-Halal product. Thus, this paper proposed the use of an image recognition system in overcoming the problem by classifying between Halal and non-Halal food based on deep learning algorithm, as the number of Malaysians who travel overseas is increasing every year. Convolutional Neural Networks (CNN) deep learning method is used to recognize and classify the images into Halal and non-Halal products due to its higher accuracy on image classification. The images of product packaging are downloaded from the Google Image, augmented, resized into a 100 x 100 pixels dataset, and injected into the model by using python with package of TensorFlow. The images are taken from various products, which are available in Malaysia, to train the CNN model as a prototype. The images of overseas product packaging are expected to be added into the model for further development. A testing set, independent from training set, which are taken by camera phone, is used to test the accuracy of the trained CNN model. Multiple CNN models have been trained by tuning the number of layers and other related parameters to reach the optimum architecture for this project. CNN architecture used in this project is compromises of three convolution layers and three max pooling layers, then followed by a fully connected layer and a softmax layer. The prototype has achieved more than 90% accuracy on classifying the images of the food packaging.

ABSTRAK

Halal adalah istilah yang digunakan untuk makanan yang dibenarkan menurut Islam. Petunjuk seperti logo Halal telah digunakan untuk membimbing umat Islam dalam mengenal pasti makanan Halal. Jabatan Kemajuan Islam Malaysia (JAKIM) telah memperkenalkan logo Halal piawai untuk produk buatan tempatan. Masalah timbul apabila umat Islam di Malaysia melancong ke luar negara, terutamanya ke negara bukan berbahasa Latin. Sukar untuk mereka mencari bahan-bahan yang digunakan dalam produk, kerana ditulis dalam bahasa bukan Latin, untuk menentukan sama ada ia adalah produk Halal atau bukan Halal. Oleh itu, kertas kerja ini mencadangkan penggunaan sistem pengecaman gambar dalam mengatasi masalah dengan mengklasifikasikan antara makanan Halal dan bukan Halal berdasarkan algoritma pembelajaran mendalam, kerana jumlah rakyat Malaysia yang melancong ke luar negara meningkat setiap tahun. Kaedah pembelajaran mendalam rangkaian neural konvolusional (CNN) telah digunakan untuk mengenali dan mengklasifikasikan gambar-gambar kepada produk Halal dan bukan Halal kerana ketepatannya yang tinggi dalam mengklasifikasikan gambar. Gambar pembungkusan produk dimuat turun dari *Google Image*, ditambah, diubah ukurannya menjadi 100 x 100 piksel set data, dan disuntikkan ke dalam model dengan menggunakan python dengan paket TensorFlow. Gambar-gambar tersebut diambil dari pelbagai produk, yang terdapat di Malaysia, untuk melatih model CNN sebagai prototaip. Gambar pembungkusan produk luar negara dijangka akan ditambah ke dalam model untuk kemajuan selanjutnya. Satu set ujian, bebas dari set latihan, yang diambil melalui telefon kamera, digunakan untuk menguji ketepatan model CNN yang terlatih. Beberapa model CNN telah dilatih dengan menala jumlah lapisan dan parameter lain yang berkaitan demi mencapai seni bina yang optimum untuk projek ini. Senibina CNN yang digunakan dalam projek ini terdiri daripada tiga lapisan konvolusi dan tiga lapisan penyatuan maksimum, kemudian diikuti oleh lapisan yang terhubung sepenuhnya dan lapisan softmax. Prototaip telah mencapai ketepatan lebih daripada 90% dalam mengklasifikasikan gambar-gambar bungkusan makanan.

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LIST OF ABBREVIATIONS

JAKIM		Jabatan Kemajuan Islam Malaysia
AI	-	Artificial Intelligence
NLP	-	Natural Language Processing
ML	-	Machine Learning
KNN	-	K-Nearest Neighbour
NN	-	Neural Network
ANN	-	Artificial Neural Network
DL	-	Deep Learning
DNN	-	Deep Neural Network
CNN	-	Convolutional Neural Network
RNN	-	Recurrent Neural Network
FNN	-	Feedforward Neural Network
RBFNN	-	Radial Basis Function Neural Network
MLPNN	-	Multi-Layer Perceptron Neural Network
MNN	-	Modular Neural Network
MNIST	-	Modified National Institute of Standards and Technology
ReLU	-	Rectified Linear Unit
ResNet	-	Residual Network
FPM	-	Fractionalized Principle Magnitude
Adam	-	Adaptive Moment Estimation
SGD	-	Stochastic Gradient Descent
AdaGrad	-	Adaptive Gradient Algorithm
RMSProp	-	Root Mean Square Propagation
IDE	-	Integrated Development Environment
FYP	-	Final Year Project

LIST OF SYMBOLS

I	-	Input Data Size
R	-	Receptive Field (Kernel) Size
S	-	Stride Size
P	-	Pooling Size
W	-	Net Weight
i	-	Count for Input Data
j	-	Count for Classes
m	-	Number of Training Data
n	-	Number of Classes
λ	-	Weight Decay
th	-	Threshold

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CHAPTER 1

INTRODUCTION

1.1 Problem Background

Halal is a term used to address permissible foods to be consumed by Muslims. Halal also refers to activities that Muslims do in their daily lives, where some activities are permissible to do according to Islam and some are not. In other words, Halal is a Arabic term, which refers to ‘permissible’ or ‘lawful’. Islam is not only a religion, it also a way of life. It covers every single matter in human lives including the way human dresses, the food human consumes, the activities human does, and the way human speaks. Everything must be parallel with al-Quran and Sunnah, the guidebook or reference for human especially for Muslims. Islam urges each Muslim to take care the cleanliness of their home, especially during prayer time. Islam also requires Muslims to take care the cleanliness in preparing food, which also refers to a clean and Halal food.

It has been mentioned several times in the Quran about term ‘Halalan toyibban’, means lawful and good in English. It was mentioned in surah al-Baqarah chapter 2 verse 168, surah al-Maaida chapter 5 verse 88, surah al-Anfaal chapter 8 verse 61, and surah an-Nahl chapter 16 verse 114 that emphasize Muslims to seek clean and Halal foods that are good for the health. This also includes the preparation of the food, the source of the food, the ingredient used to produce the food, and the way animals used in the food are slaughtered.

In Malaysia, a department called Jabatan Kemajuan Islam Malaysia (JAKIM) is established that responsible to handle the Halal issues [1]. As a result, a standardized Halal logo issued by JAKIM is used to identify Halal products in Malaysia. As stated in JAKIM website, the entire Halal product ingredient permitted under Syariah law and meets the following requirements: the product must be free from the non-Halal animals according to Syariah law and the animal, which slaughtered not parallel to the

Syariah law [2]. Then, the products are free from any Najis (impurity) according to Syariah law. Furthermore, the products must be free from any parts of human body as human body is not permissible to be consumed according to Islam. All the process or manufactured equipment must be clean according to Syariah law. During the preparation, process or packaging does not in contact with any food that does not meet the requirements, or any substance will be consider impure by Islamic law.

1.2 Problem Statement

Problem arises when Muslims in Malaysia are travelling overseas, especially to non-Latin language countries. It is difficult to find the ingredients used in the product, as it is written in non-Latin language, to determine whether it is a Halal or non-Halal product for those who does not learn the language used in the country they are visiting. According to statistics reported in [3]–[5], the number of Malaysian travels to overseas is increasing every year (see Figure 1.1). Consequently, the number of people who face this problem is also increasing as more and more people are traveling to non-Latin language countries each year.

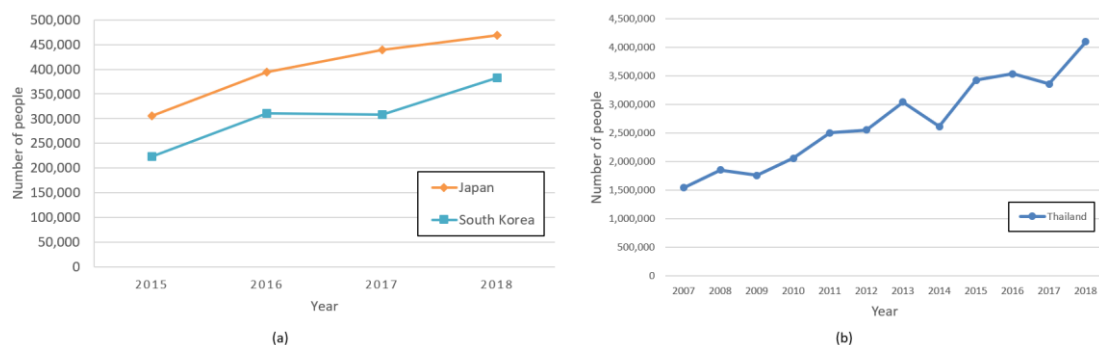


Figure 1.1 Malaysian tourists trending in non-Latin language countries. (a) Malaysian tourists in Japan and South Korea, (b) Malaysian tourist in Thailand.

Therefore, Halal food recognition based on the food packaging is proposed to overcome this problem. Muslims in Malaysia who are travelling overseas can identify Halal product without the needs of looking at the product ingredients even though Halal logo is absent from that product. The product is first verified by some trusted

religious scholars by investigating the product ingredients and directly contacting the product manufacturer, before it is included into the Halal food recognizer tool. Thus, the tool only needs to recognize the verified product by its food packaging and classifies the product into Halal or non-Halal food.

1.3 Research Objectives

The objectives of the research are:

- (a) To develop a deep learning algorithm in order to classify Halal and non-Halal food.
- (b) To have a higher classification accuracy for each product packaging.
- (c) To analyse the outcome of accuracy with different deep learning models.

1.4 Scope

This project stresses on taking self-created dataset as the input for the network training. The dataset is created by downloading and augmenting the images from Google Image. The pattern to be analyzed during the training and testing are Halal and non-Halal food packaging and the output of this project is accuracy of analysis.

1.5 Report Organization

This report consists of five chapters. The contents of each chapter can be generally described as follows:

- a) Chapter 1: This chapter consists of the background of the project interest, problem statement which leads to the idea of this project, objectives of the project, scope of project and report organization.
- b) Chapter 2: This chapter describes about project overview and literature review related to this project. Chapter 2 contains the compilation of the image classification results of previous publications.
- c) Chapter 3: This chapter illustrates the network and procedure used in this project including its details explanation of each layer in the network. Gantt chart also included in this chapter.
- d) Chapter 4: This chapter recorded all results obtained during testing and experiments. Detailed discussion on the results obtained is also included.
- e) Chapter 5: This chapter consists of project conclusion, and limitations observed for this project.

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