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DEVELOPMENT OF HALAL VERIFICATION AND TRACKING SYSTEM FOR HALAL-CERTIFIED RESTAURANTS IN BRUNEI DARUSSALAM USING AUGMENTED REALITY TECHNOLOGY

AK MOHAMMAD SYUKRI PG HJ METUSSIN

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science.

DEVELOPMENT OF HALAL VERIFICATION AND TRACKING SYSTEM FOR HALAL CERTIFIED RESTAURANTS IN BRUNEI DARUSSALAM USING AUGMENTED REALITY (AR) TECHNOLOGY

By

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May 2015

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The government of Brunei Darussalam is putting in efforts to ensure that every Muslim regardless whether they are citizens or tourists to be well informed on *'Hallalan Toyyiban'* food and beverages because consuming *'halal'* food is a priority for all Muslims. However, due to the abuse of fake *'halal'* certificates, limited numbers of *'halal'* certified restaurants in Brunei Darussalam and non-availability of proper systems to locate *'halal'* certified restaurants, Muslims in Brunei Darussalam are facing difficulties in finding genuinely *'halal'* certified restaurants. Therefore, a study was conducted with a primary objective to identify *'halal'* certified restaurants in Brunei Darussalam and to develop a prototype of *'halal'* Verification System using Augmented Reality (AR) Technology for *'halal'* certified restaurants in Brunei Darussalam. A list of *'halal'* certified restaurants is obtained from Brunei Halal Food Council which serves as a guideline for conducting observation to collect coordinates and questionnaire survey on every *'halal'* certified restaurant in Brunei Darussalam. Augmented Reality (AR) feature within Android environment were designed and developed using Android Software Development Kit. *"Salam Halal"* was the name given to the smartphone application that functions mainly to identify *'halal'* certified restaurants within user current location. Informative, user friendly and interactivity are the main features of the application. Prior to *"Salam Halal"* development, a field survey and a quantitative study were conducted with 108 *'halal'* certified restaurant's owners and managers to identify *'halal'* restaurants and to understand their perception of having *'halal'* certificates for their *'halal'* restaurants businesses. Once the application development was completed, 10 out of the 108 respondents were selected to as samples to further study perception towards *"Salam Halal"*, its effectiveness and how it can help in promoting their *'halal'* restaurants. Statistical analysis using *"Precision and Recall"* methods were used to analyze the data. All tests using the prototype's application was proven to be successful with the respondents able to locate the nearest *'halal'* certified restaurants and they admitted that AR technology can be very helpful in promoting *'halal'* restaurants. This compliment Brunei Darussalam's image as an Islamic country while promoting the guidelines of Islamic hygienic food preparation.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia Sebagai
memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN SISTEM PENGESAHAN DAN PENCARIAN RESTORAN BERSIJIL HALAL DI BRUNEI DARUSSALAM DENGAN MENGADAPTASIKAN TEKNOLOGI AUGMENTED REALITY

Oleh

AK MOHD SYUKRI PG HJ METUSSIN

Mei 2015

Pengerusi: Dr. Nurdeng Deuraseh, PhD
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Kerajaan Brunei Darussalam kini sedang berusaha untuk memastikan setiap umat Islam
tanpa mengira rakyat ataupun pelancong, agar peka tentang makanan dan minuman
yang "Halal dan Toyyiban". Ini adalah kerana memakan makanan yang halal adalah
keutamaan untuk semua orang Islam. Walau bagaimanapun, disebabkan oleh
penyalahgunaan sijil 'halal' palsu , jumlah restoran bersijil halal di Brunei Darussalam
yang terhad dan ketiadaan sistem yang sesuai untuk mencari restoran restoran yang
telah disahkan halal, umat Islam di Negara Brunei Darussalam menghadapi kesukaran
untuk mencari restoran restoran yang bersijil halal. Oleh itu, satu kajian telah
dijalankan dengan objektif utama adalah untuk mengenal pasti dimana restoran
restoran halal tersebut dan untuk membangunkan satu prototaip sistem pengesahan
halal menggunakan teknologi *Augmented Reality (AR)* bagi mencari restoran restoran
halal tersebut. Senarai restoran restoran yang telah diiktiraf halal diperolehi dari
Bahagian Kawalan Makanan Halal , dimana ianya digunakan sebagai garis panduan
untuk mengumpul koordinat lokasi restoran restoran halal dan untuk kajian soal selidik
pada setiap restoran yang halal di Negara Brunei Darussalam. Ciri ciri teknologi
Augmented Reality (AR) yang dimasukkan kedalam sistem Android bagi applikasi
telefon pintar telah direka dan dibangunkan dengan menggunakan perisian "Kit
Pembangunan Android". "Salam Halal" adalah nama yang diberikan kepada aplikasi
tersebut, dimana ianya berfungsi untuk mencari restoran restoran halal yang terdekat.
Sistem yang bermaklumat, mesra pengguna dan berinteraktif adalah ciri-ciri utama
aplikasi itu. Sebelum pembangunan aplikasi "Salam Halal", satu kajian lapangan dan
kajian kuantitatif telah dijalankan terhadap 108 orang pemilik dan pengurus - pengurus
restoran halal untuk mengenal pasti restoran halal mereka dan untuk mengetahui
persepsi mereka tentang kepentingan sijil halal terhadap perniagaan restoran halal
mereka. Setelah pembangunan aplikasi itu siap, 10 daripada 108 orang responden tadi
telah dipilih untuk mengkaji lagi mengenai persepsi mereka terhadap "Salam Halal",
keberkesanannya dan bagaimana ia boleh membantu dalam mempromosikan restoran
halal mereka. Analisis statistik dengan menggunakan kaedah "*Precision and Recall*"
telah digunakan untuk menganalisis data kajian. Hasil kajian dengan menggunakan
protataip aplikasi tersebut didapati berjaya, dimana para responden dapat mengesan
restoran-restoran halal yang terdekat dan mereka mengakui bahawa teknologi AR

boleh membantu dalam mempromosikan restoran-restoran halal mereka. Ini juga boleh membantu untuk mempromosikan imej Brunei Darussalam sebagai sebuah negara Islam dan juga mengekalkan islam sebagai gaya hidup.

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I certify that a Thesis Examination Committee has met on 05 May 2015 to conduct the final examination of Ak Mohd Syukri Pg Hj Metussin on his thesis entitled "Development of Halal Verification and Tracking System for Halal-Certified Restaurants In Brunei Darussalam Using Augmented Reality Technology" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science in Halal Product development.

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This thesis was submitted to the senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science in Halal Product Development. The members of the Supervisory Committee were as follows:

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Declaration by graduate student

I hereby confirm that:
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This is to confirm that:
- the research conducted and the writing of this thesis was under our supervision ;
- supervision responsibilities as stated in the Universiti Putra Malaysia(Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to;

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Member of
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Committee: _____

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LIST OF ABREVIATIONS

ADT	Android Development Tools
AITI	Info-communications Technology Industry
AR	Augmented Reality
BRIC	Brunei Religious Islamic Council
BKMH	Bahagian Kawalan Makanan Halal
GPS	Global Positioning System
IDE	Integrated development Environment
I-SSDLC-AR	Iterative Simulative Software Development Life Circle for Augmented Reality
MORA	Ministry of Religious Affairs
OS	Operating System
RFID	Radio Frequency Identification

CHAPTER 1

INTRODUCTION

1.0 Introduction

Initial stage of the research was discussed through the thesis's introduction that covers the scope and structure of the research. The preliminary part of the research describes the problem statement pertaining to the importance of 'Halal' food and its relation with the Augmented Reality (AR) Technology. The research questions and objectives of the research was derived based on current issue as explain through problem statement. The research question was also used to discuss the project significance and the definition of terminologies used in the research. In overall, the first chapter provides the purpose and direction that was set as guidelines in conducting the research.

1.1 'Halal' and Brunei Darussalam

'Halal' is a word derived from Arabic term that is defined as *"Permissible"*. According to Tabbarah, (1992) stated that *'Halal'* is an Islamic concept that is essential for all Muslims to understand as the concept covers the foods, drinks, relationship and various other aspects of individual life. *'Halal'* is the thing that is allowed, which is the opposite of *'Haram',* which is the practice of illegal actions in Islam. Committing and consuming *'Haram'* food may cause an individual to receive the punishment of Allah SWT set either in this world or the hereafter (Al-Qardawi, 2009).

Therefore, as a Muslim it is mandatory to continuously consumes *'Halal'* food and beverages. As what Allah Subhanahu Wataala has mentioned in the Al-Quran:

يَٰٓأَيُّهَا ٱلَّذِينَ ءَامَنُوٓا۟ كُلُوا۟ مِن طَيِّبَٰتِ مَا رَزَقۡنَٰكُمۡ وَٱشۡكُرُوا۟ لِلَّهِ إِن كُنتُمۡ إِيَّاهُ تَعۡبُدُونَ ﴿١٧٢﴾

"O *you, who have believed, eat from the good things which We have provided for you and be grateful to Allah if it is [indeed] Him that you worship*" (Al-Baqarah 2:172).

Brunei Darussalam is an Islamic country, and it has international recognition for having a stringent *'Halal'* certification system and standard which is monitored by Brunei Halal Food Control Division also known as (Bahagian Kawalan Makanan Halal, (BKMH)) under the Ministry of Religious Affairs (Brunei Ministry of Religious Affairs, 2012). Sparked by the rising awareness of Muslim consumers in Brunei Darussalam in the importance of *'Halal'* products and certification, this research would

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like to address the problems faced by Muslim consumers in Brunei Darussalam pertaining to the lack of *'Halal'* certificate used at the food and beverages premises.

The project aims to develop a *'Halal'* Verification and Tracking System using Global Positioning System (GPS) with Augmented Reality (AR) Technology that runs on Android Operating System (OS) smartphone devices.

1.2 An Overview on Augmented Reality (AR) Technology

Augmented Reality Technology (AR) is a wide range of technologies that project computer produced materials such as imageries, videos and textual onto user's observations of the real world (Ballagas, 2011). Zhou (2008) classified the application of AR by three (3) characteristics:

(a) A mixed of virtual features and the real-world
(b) A real-time interactivity
(c) 3D Projected, which means the display of virtual information or object, is fundamentally tied to real-world loci and orientation.

Ludwig and Reimann (2005) gave definition of AR as the real-time interaction between computer and human that include the virtual objects to be communicated directly to senses which are delivered by a video camera in real time interactivity, while Zhou, et. al. (2008) basically defines AR as technology that enables computer generated virtual image to overlay connect physical objects in the real world.

One of the core benefits of Augmented Reality (AR) Technology is that it offers a unique experience for the users to view the virtual objects which are highly interactive in the real time. Users can interact with the AR technology instantly anywhere there are. Due to current development of smartphone devices designed and manufactured with built-in camera, such interaction between users and AR technology are becoming more feasible for daily usage. When the built-in camera to view the real world, the AR technology will project virtual objects on the screen of the smartphones exactly what the camera viewed.

1.3 Problems Statement

Brunei Darussalam is an Islamic country and it is obligatory for Muslims in Brunei Darussalam to maintain the elements of Islamic characteristics. Brunei Darussalam has put great emphasis on the issues related to *'halal'* food. Halal Food Control Division (BKMH) was established in response to the command of His Majesty Paduka Seri Sultan Haji Hassanal Bolkiah, which was delivered on July 15, 1997.

Toward emphasizing on the importance of *'halal'* products; Brunei Ministry of Religious Affairs has launched the *"Strategic Plan 2010-2014"* and the strategic areas of focus within the field of *'halal'* food. Objectives of this Strategic Plan are (Kementerian Hal Ehwal Ugama, 2010):

1) Improving monitoring process and ensuring the food and consumables goods produced and marketed in the country is 'halal' and clean.
2) Increasing public awareness about the impact of *'halal'* and *'haram'* in food and consumables to their Islamic faith and act of worship.
3) To fully implement the halal certification standard in Brunei Darussalam and to make it to be more recognized internationally.

Friday sermons in Brunei Darussalam which also serves as the government's *'tongue'*, on 2nd April 2010 has made it clear that despite the government's initiatives to ensure that food products that are sold to Muslims is *'halal'* and clean, including monitoring the entry of fresh poultry and meat from abroad, marking the places to eat for Muslims with 'halal' logo, *'Not for Muslim'* signage and others, there are still some people in this country who smuggled supplies of dubious *'halal'* status of chicken and meat, smuggled alcohol and some of the Muslims ate at eateries that are not 'Halal' (Kementerian Hal Ehwal Ugama 2010). Therefore, *'halal'* food monitoring and certification enforcement is vital to the *'halal'* agency.

Since the beginning of the Order of Halal Certificate and Halal Label 2005 enforced, only 10 % out of 1,212 public eateries in Brunei Darussalam have been awarded 'halal' certificates or labels (Brunei Times 2013). It only represent less than 200 eateries across the country with the highest number is concentrated in Bandar Seri Begawan, where only 69 out of 494 licensed restaurants in Bandar Seri Begawan are halal certified. According to the Halal Food Control Unit, Syariah Welfare Department under the Ministry of Religious Affairs (MORA), only 410 applications for the *'halal'* certificates have been submitted (Brunei Times, 2013).

Since the numbers of *'halal'* certified restaurants is small, it is hard for the consumers to select the *'halal'* certified restaurants. Many of the eateries in Brunei Darussalam could not be properly identified whether it is *'halal'* or not due to small percentage of *'halal'* certified restaurants and some of the restaurants falsifies the *'halal'* logo by simply putting the sign *'halal'* that are not from the Brunei halal authority. According to Mohd Muslihuddin, (2013), there are no proper systems or facilities for Muslims in Brunei Darussalam to locate *'halal'* certified restaurants which are already limited in numbers.

With limited numbers of *'halal'* certified restaurants and the lack of proper facilities and system to locate *'halal'* certified restaurants, Muslims in Brunei Darussalam are facing difficulties in ensuring that the food they consume when eating at food and beverage premises are *'Hallayan Toyyiban'*. This scenario can also indirectly affect the status of the country, known for its philosophy of Malay Islamic Monarchy (MIB).

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Especially in recent years where Brunei Darussalam had just already implemented the Syariah Law.

1.4 Objectives

This study aims to achieve the following objectives:
1. To identify 'halal' certified restaurants in Brunei Darussalam.

2. To design an Augmented Reality (AR) 'Halal' verification and locator system that is capable of verifying the authenticity of Brunei 'halal' certified eateries for Muslim users in Brunei Darussalam.

3. To develop an Augmented Reality (AR) 'halal' verification and locator mobile application; *'Salam Halal'*.

1.5 Research Questions

Based on the problem statements above, the following research questions were asked:
1) Where are the *'halal'* certified restaurants in Brunei Darussalam?

2) What is the best model for application development to verify and locate *'halal'* certified restaurants in Brunei Darussalam?

3) How to develop a solution for Muslims to find *'halal'* certified restaurants in Brunei Darussalam?

1.6 Structure of Thesis

This thesis is written in six (6) chapters that discusses the development of *'halal'* verification system using Augmented Reality (AR) technology for *'halal'* certified restaurants in Brunei Darussalam. Various theories, principles and components relating to both variables are briefly discussed and explained throughout the thesis. Furthermore, through primary and secondary sources gathered, a detail analysis was carried for further understanding on the subjects. Finally, a solid in-depth discussion on final conclusion and future recommendations were conducted, as written in the final chapter.

Chapter one (1) discusses the current issues of 'Halal' food and beverages in Brunei Darussalam and the progress of the Augment Reality (AR) technology. The research approach is also further discussed in the objectives development and research questions

derived from problem statement. Moreover, the significance of the research is also discussed within this chapter. Overall, chapter one (1) provides the guiding principles in developing the android application prototype.

In chapter two (2), various theoretical concepts, principles and components which relates to Augmented Reality (AR) technology, *'halal'* industry and *'halal'* application systems in Brunei Darussalam are discussed. Secondary sources such as online journal articles, student's thesis, books and newspaper articles are synthesized and analyzed for better understanding of the subject matter. Furthermore, the software applications used in the development of the application is also briefly described in this chapter.

In **chapter three (3),** the methodology of the research provides detailed explanations on the stages involved in conducting the research. Seven (7) different stages were planned systematically to ensure the research is able to be completed within stipulated time period. Qualitative approach was adopted in conducting the research that involves two (2) main data type, which is the primary and secondary data. Primary data collection was conducted through questionnaire survey. In explaining the data significance, several sub chapters, i.e. The case study, sample size and the source of data were briefly explained.

Chapter four (4) explains the design and development of the android application in terms of the steps and functions of it. The proposed application of *'Salam Halal'* is a mobile application that allows users to view 'halal' dishes within the region of Brunei Darussalam and to share the dishes among users via *'Salam Halal'* account or by using Facebook account. In addition, interface of the application such as the home page, directory page, AR live view page and snap and share page are also deliberated

Chapter five (5) provides the solutions of the issues discussed in the problem statement. The data obtain was analyzed comprehensively in order to assess the current conditions of *'halal'* certified restaurants in Brunei Darussalam. Both primary and secondary data will be used as the core information utilized in the development of the android application prototype. Furthermore, the research achievement is also defined in this chapter.

Chapter six (6) is the final chapter of the thesis. The success or failure in achieving all three (3) objectives planned for this research will be explained in this chapter. Recommendation for future research, 'halal' product development and android application prototype are among the main subjects discussed in chapter six (6). Finally, the final insight and conclusion of the subjects are discussed.

1.7 Significance of Research

The research discusses and elaborates on the development of *'halal'* verification system using Augmented Reality (AR) technology for 'halal' certified restaurants in

Brunei Darussalam. It is meant to address issues on time constraint and information availability for Muslims in finding *'halal'* certified restaurants. In addition, genuine 'halal' certified certificate registered under Brunei Religious Islamic Council (BRIC) can also be identified through this application as it could be complimentary measure that can be adapted by the Government of Brunei Darussalam in registering current *'halal'* certified restaurants.

Every businesses aim to provide the best services and products while ensuring profit margin. Through this android application, restaurant owners will have another channel of marketing projected to attract large market group, hence leading to higher clients visiting the restaurants which in turn leads to higher revenue.

Rapid evolvement in technology shapes current generations as smartphones become the most important personal items in current era due to various purposes it serves. Through the android application development, Muslims who visits and lives in Brunei Darussalam is expected to gain greats benefits due to the fact that the application will assists them to observe the rules and practice of their religion better through identifying *'Hallayan Toyyiban'* food.

The findings of the study are expected to give useful input to the policy makers and assist the halal certification authority in Brunei Darussalam, Brunei Halal Food Control Division, Ministry of Religious Affairs, Ministry of Industry and Primary Resources and the Ministry of Health to monitor the concerns of the Muslim community in Brunei Darussalam for halal food.

Food operators and Restaurants in Brunei Darussalam, either halal certified or those who had not applied for halal certification, will be able to make this study as a benchmark to contribute to the growing concern and demand of halal sector in Brunei Darussalam. Meanwhile, the Muslim community in Brunei Darussalam is expected to gain knowledge and understanding relating to halal food. They are expected to always be careful and sensitive to any food to ensure that it is *'halal'*. This is because consuming food that is *'halal'* can also bring blessing from Allah Subhhanahu Wataala.

1.8 Previous study

References to other previous studies were done by looking at the studies conducted by researchers either of Brunei Darussalam or in other countries. There are a number of previous studies related to *'halal'* food and the Augmented Reality Technology, which has been referred by this research.

In a research which was conducted by Mohammad Muslihuddin Hj Mustafa (2013) for his research thesis, he discussed about the awareness and concern of halal food among the general Muslim population in Brunei Darussalam. It was found that the Muslim consumers in Brunei Darussalam, are very concerned with the food they consumed i.e.

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weather its *'halal'* or not. Based on his survey, Brunei Darussalam residents have good understandings on the concept of *'halal'* and the importance of it. In general, according to Muslihuddin Hj Mustafa, the population of Brunei Darussalam is actively seeking for a better system to indicate certified *'halal'* restaurants.

In another research by Abdul Tamin Sani (2000), he discussed about the effects of clean and unclean food, animal slaughter methods prescribed by legislation and approved by the Government of His Majesty Paduka Seri Sultan and Yang Di-Pertuan of Brunei Darussalam. His research also includes the types of recognized *'halal'* meat and unrecognized meat but this study was limited to regulations under the Halal Meat Act 1998 only. The study also involved a survey and the results showed that most people are very satisfied with the implementation of the law and actions of government. Especially from among whom that are concerned with the sale and entry of meat in Brunei Darussalam.

In the area of Augmented Reality (AR) Technology, a study was done at University of Oslo, Department of Informatics, by Glenn Ivar Husom, (2013). In his thesis research titled "The Augmented Reality Experience : Learning and Collaboration" , He investigated the advantages and disadvantages of Augmented Reality interface on user experience, how it affects the learning curve of the large software and what it can do for collaboration. A prototype has been developed and it has been tested. It was tested on six (6) users to get feedback on its advantages and disadvantages, comparing it with standard computer interfaces such as a keyboard and a mouse.

Overall, previous studies related to halal food and Augmented Reality technology can be divided into several aspects. Among them are the awareness and concern of halal food among the general Muslim population in Brunei Darussalam, slaughtering process, acts of the government and the advantages and disadvantages of Augmented Reality interfaces. In the context of the review of Brunei Darussalam, the previous studies that have been carried out are only limited to the halal awareness of general population in Brunei and effects of clean and unclean food according to the slaughtering process. The study of AR technology has also been limited to only its advantages and its disadvantages. The previous studies did not s delve into the issues of halal certification among restaurants in Brunei Darussalam and did not discuss on how the use of AR technology can be implemented to find and verify halal restaurants. This signifies the importance of this research study.

1.9 Definition of Terminologies

The definitions discussed in relation to each pertinent terminology are argued within the research scope.

1.9.1 Development

Development is a process in which something passes by degrees to a different stage especially a more advanced or matures stage (Oxford Dictionaries, 2013).

1.9.2 Halal verification

According to Brunei Ministry of Religious Affairs (2005), *'halal'* verification involves the verification of the 'halal' status issued by the BKMH under the Halal Certificate and Halal Label Order, 2005. When exhibited in any place of business, the Halal Certificate shall mean that the food in relation to which the certificate is referring:

a) Neither is nor consists of or contains any part or matter of an animal that a Muslim is prohibited by *'Hukum Syara'* to consume or that has not been slaughtered in accordance with *'Hukum Syara'*;

b) Does not contain anything that is considered to be impure in accordance with *'Hukum Syara'*;

c) Has been prepared using an instrument that is free from anything which is considered to be impure in accordance with *'Hukum Syara'*; and

d) Has not in the course of preparation or storage, been in contact with or close proximity to any food that fails to satisfy paragraph (a), (b) or (c) and anything that is considered to be impure in accordance with Islamic guiding principles.

1.9.3 Augmented Reality (AR)

Augmented Reality (AR) is a developing form of experience in which the Real World (RW) is enriched by computer-generated content focus to specific locations or activities. It is an animated, direct or indirect, view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data (Steve et. al., 2013).

1.10 Summary

As a summary, it could be summarized that there are significant importance in determine *'halal'* certified restaurants for the Muslim consumers in Brunei Darussalam. A system that is easily accessible and suits the current generation who are technological savvy in identifying *'halal'* restaurants is needed. Hence, the development of an android application will indirectly strengthen Brunei Darussalam's status as a Muslim Country. Next, Chapter two (2) discusses various literature reviews pertaining to the research.

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