Faculty of Cognitive Sciences and Human Development

FOOD RECOGNITION AND CALORIES CALCULATION SYSTEM USING MOBILE AUGMENTED REALITY

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Grade: A

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Final Year Project Report ☑

Masters ☐

PhD ☐

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FOOD RECOGNITION AND CALORIES CALCULATION SYSTEM USING MOBILE AUGMENTED REALITY

CHONG CHIAO WEN

This project is submitted
in partial fulfilment of the requirements for a
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The project entitled 'Food Recognition and Calories Calculation System using Mobile Augmented Reality' was prepared by Chong Chiao Wen and submitted to the Faculty of Cognitive Sciences and Human Development in partial fulfillment of the requirements for a Bachelor of Science with Honours (Cognitive Science)

Received for examination by:

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ABSTRAK

Pembangunan mampan dan pertumbuhan ekonomi di Malaysia telah menyebabkan pembandaran pesat di negara ini. Perbandaran negara ini telah meningkatkan taraf hidup yang telah mendedahkan rakyat kepada pelbagai rawatan kesihatan. Pada tahun 2006, National Health and Morbidity Survey melaporkan bahawa terdapat 29% daripada orang dewasa di Malaysia yang berlebihan berat badan dan 14% daripadanya gemuk. Warga memerlukan bimbingan mengenai berapa banyak pengambilan kalori untuk setiap hidangan. Oleh itu, matlamat untuk menjalankan penyelidikan ini adalah untuk merekabentuk dan melaksanakan system realiti berperantara untuk membimbing pengguna tentang pengambilan kalori untuk makan mereka. Permohonan ini akan membantu para pengguna mengetahui maklumat tentang makanan yang dimakan untuk meningkatkan kesedaran dengan mengenali imej makanan dan memaksimumkan kalori makanan yang dikira. Sistem ini boleh mendidik pengguna dengan maklumat makanan serta-merta daripada mencari melalui internet. Sistem ini telah menerima maklum balas positif berdasarkan System Usability Scale (SUS) yang diberikan kepada 15 pelajar UNIMAS. Markah purata SUS telah mencapai 76.5 di antara 15 responden yang menunjukkan bahawa sistem ini mempunyai kebolehgunaan dan kebolehlaksanaan yang tinggi. Aplikasi ini bertindak sebagai buku panduan mudah alih digital yang mudah digunakan.

ABSTRACT

The sustainable development and economic growth in Malaysia have cause a rapid urbanization of the country. The urbanization of the country has increased the living standards that has exposed the citizens to various health treats. In year 2006, the National Health and Morbidity Survey reported that there are 29% from Malaysian adults were overweight and 14% of them were obese. Citizens need guidance on how much calories intake for every meal. Thus, the aim to carry out this research is to design and implement a mobile augmented reality application to guide the users on calories intake for their meal. This application will help the users to know the information on the food that ate in order to increase awareness by recognizing the food image and super impose the calculated calories of the food. The system can educate the users with food information instantly instead of searching through the internet. The system has received a positive feedback based on the System Usability Scale (SUS) that given to 15 UNIMAS students. The result of average SUS score has achieved 76.5 among the 15 respondents that indicated that the system has high usability and learnability. This app acts as a digital mobile guidance book that is convenient to use.

CHAPTER ONE

INTRODUCTION

1.1 Background of study

The sustainable development and economic growth in Malaysia have cause a rapid urbanization of the country. The urbanization of the country has increased the living standards that has exposed the citizens to various health treats. This research is conducted to design a mobile augmented reality system that increase the awareness on the food calories intake when citizens are having meals. Moreover, the prototype can show and calculate the calorie intake of the meal.

1.2 Problem statement

The analysis of Food and Agriculture Organization of the United Nations (FOASTAT) shown that the dietary energy of the worldwide has been increased and the calories per capita is increased globally from the mid- 1960s to the late 1990s in the developing countries (Bruinsma, 2002). According to Popkin *et al.* (2012), the trend of diet in 1970's has begun with the processed foods that with more amount of oils and sugar food. The diets quality in United States is getting worse and cause the rate of obesity is rising across the United States and Europe (Popkin *et al.*, 2012). According to United Nations Development Programme (2015), almost 30 percent of the world population has overweight problem and among 62 percent of the populations are from the developing countries. In addition, the percentage of overweight in children is predicted to double by 2030. The research done by Mansor and Harun found that 72.8% Malaysia has upgraded and live in the urban area due to the rapid urbanization of the world. The urbanization of Malaysia has led to a stressful lifestyle of the citizens and at the same time the health issue has increased (Mansor & Harun, 2014). The statistic shown from the National Health and Morbidity Survey reflected that

in year 2006, there were 29% of Malaysian adults had overweight problem and 14% from them were obese. This is a very bad situation that the citizens do not aware on how much intake of calories that been eaten every moment. On the other hand, cell phone (Mobile) is capable enough to do computational tasks. In the year 2008, Malaysian Communication and Multimedia Commission (MCMC) conducted a survey and the result shown that Malaysia recorded to have 26 thousand of mobile users in that year that led Malaysia to rank second in ASEAN in the number of mobile phone users (Zulkefly & Baharudin, 2009). Another research found out there were 70% of the world's population own at least one mobile phone and there were 85% of Malaysian own mobile phone (Osman et al., 2012). These searches shown that the mobile phone usage in Malaysia is gaining by years. Therefore, the purpose of this study is to design and apply mobile augmented reality application to recognise food and calculate the calories of the food. In addition, as almost everyone has smart phone and is powerful enough to run such systems. Thus, to educate the society, a food recognition and calories calculating mobile augmented reality application is developed.

1.3 Research objectives

The general objective of this research is to design and apply the food awareness system using the mobile augmented reality. The specific objectives are as below:

1. To design and apply food recognition module.
2. To design and apply calories calculation module.
3. Design a mobile augmented reality prototype to test and validate the system.

1.4 Significance of the study

Using this app users can manage their eating habit to become healthier instead of eating high calories food that could cause heath disease. With this application, citizens can always be aware on the calories intake for every meal. Besides, users can easily determine the calories of the food as the application will show out the calories and name of the food.

1.5 Scope of the study

The area that been focussing in this research is to design and implement Mobile Augmented Reality system under the food and nutrition field. The platform that targeted was in Android platform that users allow to scan the food images. There were eight types of food images that aimed to be scanned and showing together with their information such as food name, food calories, weight per serving, and the video about the food.

1.6 Definition of terms

1.6.1 Augmented reality

Augmented reality (AR) is a relatively new technology that allows mixing virtual information with real world in such a way enhance the user knowledge (Zlatanova, 2002).

1.6.2 Mobile Augmented Reality Systems

Mobile Augmented Reality Systems (MARS) providing the augmented reality technology that is not restricting on the users' locations to a special equipped area (Höllerer & Feiner, 2004).

1.6.3 Unity 3D

It is a technology that act as game engine or game authoring tool that allow everybody to build video games (Creighton, 2010).

1.6.4 Vuforia

Vuforia is an AR SDK that been using by mobile device that allows the augmented reality system to have real-time execution. This software has underlying computer vision technology to recognize and track object that captured from the real-time video camera (Simonetti & Paredes, 2013).

1.6.5 Calories

Calories is the amount of energy that a person obtained from the food and beverage that consumed and the energy will be used for the physical activities (Nordqvist, 2017).

1.6.6 Research Framework

It is a step to identify the main processes to achieve the objectives of the project (National Research Council, 2005).

CHAPTER TWO

LITERATURE REVIEW

2.1 Augmented reality

The increase of demand in the usage of mobile phone has introduced the brand new mobile and wearable computer application to become familiar and feasible (Oui, Edmund, & Rehman, 2011; Mekni & Lemieux, 2014) that eventually has become an important part of our daily life.This has increased the technology of the augmented reality that provide a platform to discover to a specially equipped area (Mekni & Lemieux, 2014). The technology consociates to the real-world environment which user can interact with it to display information, solving of queries (Mekni & Lemieux, 2014).

Augmented reality (AR) is a technology that provides a new way of information which allows virtual information to superimpose upon real world environment (Oui, Edmund, & Rehman, 2011). The augmented reality systems can recognize the real-world objects by using marker based and marker-less based systems and past studies had shown that it was difficult to keep the makers (Weng et al, 2013). AR can be categories between the technology of Virtual reality and telepresence (Silva, Oliveira & Giraldi, 2003). Virtual reality (VR) is a technology that generate a 3D environment that allow the user to interact and feel the artificial environment by using the tool or device (Silva, Oliveira & Giraldi, 2003). This environment can stimulate the emotion of the user as the user could be "enter" totally into the space.

2.2 Augmented Reality Application

There are few researches from past study that carry out in the food industry. A related field that estimate the food calories based on the food actual size (Tanno et al, 2018). The study has been come to a new approach which estimate the food calorie with CNN and Augmented Reality (AR) based on the actual size of food estimated (Tanno et al, 2018). To assist citizen on taking care of their eating habits, this model has implemented to record the meals based on the actual size of the food that been intake every day. Deep learning is used for the memory capacity and image processing of the device. Thus, the Inception-v3 and fine-tune pre-trained ImageNet models in Keras Deep Learning framework were used to process the memory, making inferencing, and classification (Tanno et al, 2018). These models have been used because it has a highly accuracy in recognition, fast in making inference, and light in memory (Tanno et al, 2018).

Another study has been carried out by the researcher from Vietnam with a title of "A Deep Learning based Food Recognition System for Lifelog Images" by detecting the eating moments, enhancing the images detected, and recognize the food that in the eating moments (Nguyen et al, 2018). Comparison between hand-crafted featured (SIFT, SURF, HOG) and CNNs (Alex Net and GoogleNet's architectures) were implemented to find the optimize algorithm (Nguyen et al, 2018). The result of this research shows that the GoogleNet architecture is the best model that can reach to accuracy of 95.97% (Nguyen et al, 2018).

Similarly, another study has implemented by Kawano and Yanai (2014) which used Fisher Vector and liner one-vs-rest SVMs to recognize food that unable user to record the food habits. The name, calories, and nutrition of the food will be shown on screen and recorded to the web by sending the records to the server. The experiment has used 100 types of food categories to test the system and the classification has reached 79.2% (Kawano & Yanai, 2014). There are three steps

in this food recognition system: (1) an interactive and real-time food recording system running on consumer smartphone, (2) using Fisher Vector on a mobile device, and (3) automatic adjustment of the given bounding box (Kawano & Yanai, 2014). The Fisher Vector encoded HOG patch and Color patch. Histogram of Oriented Gradients (HOG) is used because the description is simple and process faster than the SIFT and SURF and it can extract feature more densely which assist the recognition accuracy (Kawano & Yanai, 2014). The classifier that used is linear kernel SVM which can be executed offline. With the combination of both, the parameter vales that used in recognition can be stored in the main memory of Fisher Vector (Kawano & Yanai, 2014).

A study has been conducted by Waltner *et al.* (2015) which assist an individual to food shopping decision making on the dietary management by a mobile augmented reality technology. By using the Random Forest classification and multiple colour feature spaces, the nutrition information will be shown in the system according to the individual. The concept of the functional eating diet which is also known as a modern diet is used to give advice on which fruits and vegetables to buy to improve the user's health. Another study from Zhang et al. (2015) has did the research of food recognition and nutrition estimation with dense HOG, dense SIFT, and SVM classifier. This mobile food recognition system is implemented successfully which it can recognize the food that presented by snapping the picture of the food and estimate the calorie and nutrition content. In addition, the system is implemented as an Android smartphone application which achieved over 85% accuracy when detecting 15 categories of food.

CHAPTER THREE

METHODOLOGY

3.1 Methodology: Rapid Application Development (RAD)

Rapid Application Development (RAD) is a development lifecycle or methodology that created for the computer system development faster and valuable resources. There are four fundamental stages in RAD methodology to determine the requirement planning, user design, construction, and implementation (Kettemborough, 2003). The stages are repeated to enhance or modify the system.

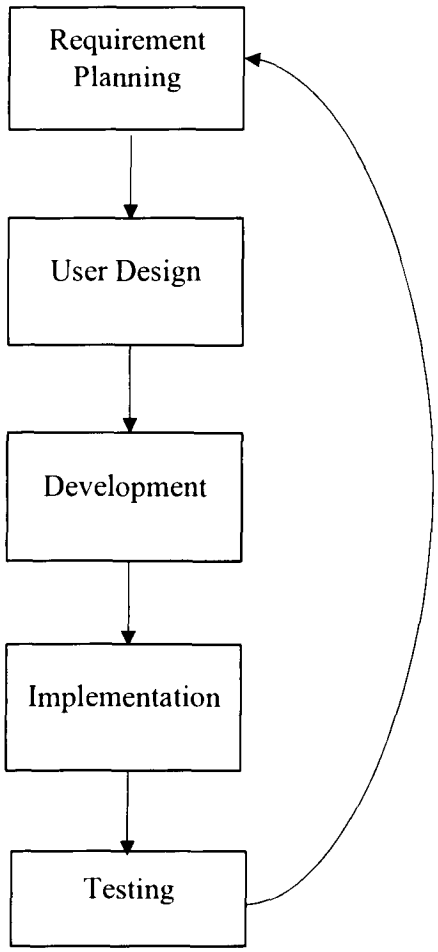

Figure 1. Diagram of Rapid Application Development.

3.1.1 Requirement Planning

This is known as a Concept Defining Stage which is to determine the business functions and area that the system will provide for the user. Thus, the discussion will carry out between the system developer and all the users that involve finding out their needs, requirements, constraints, and scopes. In this research, the discussion between the students from UNIMAS was carried out to discover the requirement of students. 10 students were interviewed to collect the user requirement and the data were recorded. The collected user requirements were analysed to discover what the respondents needs. The result revealed that most respondents believed it is well-known that society needs an assistance in calories calculation. Therefore, to solve this problem, the requirement of this project was allowing to scan the food images by mobile device and the system will recognize the food image. The recognized food image will show the food information for instances the food name, food calories, weight per serving, and a video to be played about the food. These requirements were collected from the respondents and suitable to build in a mobile augmented reality system.

3.1.2 User Design

This stage is also known as the Functional Design Stage which the prototype will be created to represent the system process, inputs, and outputs. It is an iterative process that enable users to understand and have the chance to change the requirement that meet their needs. The designed that planned was an app that has functions that user can scan the food image and the food name, calories, weights per serving will be shown upright on the food image. Besides, the video with play button will be shown on the food that recognized.

3.1.3 Development

It is a stage of Development System that similar to the System Development Life Cycle (SDLC). The tools that chosen were the Unity 2018.3.12f1 and Vuforia Engine 8.1. Vuforia is a software that has the technology to recognize the image in real-time which is suit to the objective of this project, thus, this software has been chosen as one of the software to be used. Besides, the latest Unity is supporting the Vuforia Augmented Reality, so, Unity was chosen to develop the app. In this stage, the user which is student from UNIMAS will still participate in changing and improving requirement because the actual screens or reports are developed.

3.1.4 Implementation

Deployment Stage is composed of final user testing, training, data conversion, and finally, the implementation of the application system. The new system was built and will be operated soon. At the very beginning, tutorials were given by the supervisor to learn on the basic of the Unity and Vuforia. Additional information was searched from past paper to know how to build a mobile augmented reality app. Supervisor has given lessons on the way to build the app. Furthermore, he gave a lot of guidance during the implementation of the app in term of the design of the app, way to upload images, way to use Unity and Vuforia, way to import assets and more. The guidance from supervisor was given until the app was developed successfully.

3.1.5 Testing

The implemented system was tested by the targeted users. Feedback from the users will be recorded and change of requirement might happen, so the steps will be iterated. The targeted users in this research are students from UNIMAS and the developed system was given to them to test and feedback that given from them was recorded to improve the system.

3.2 Research Framework

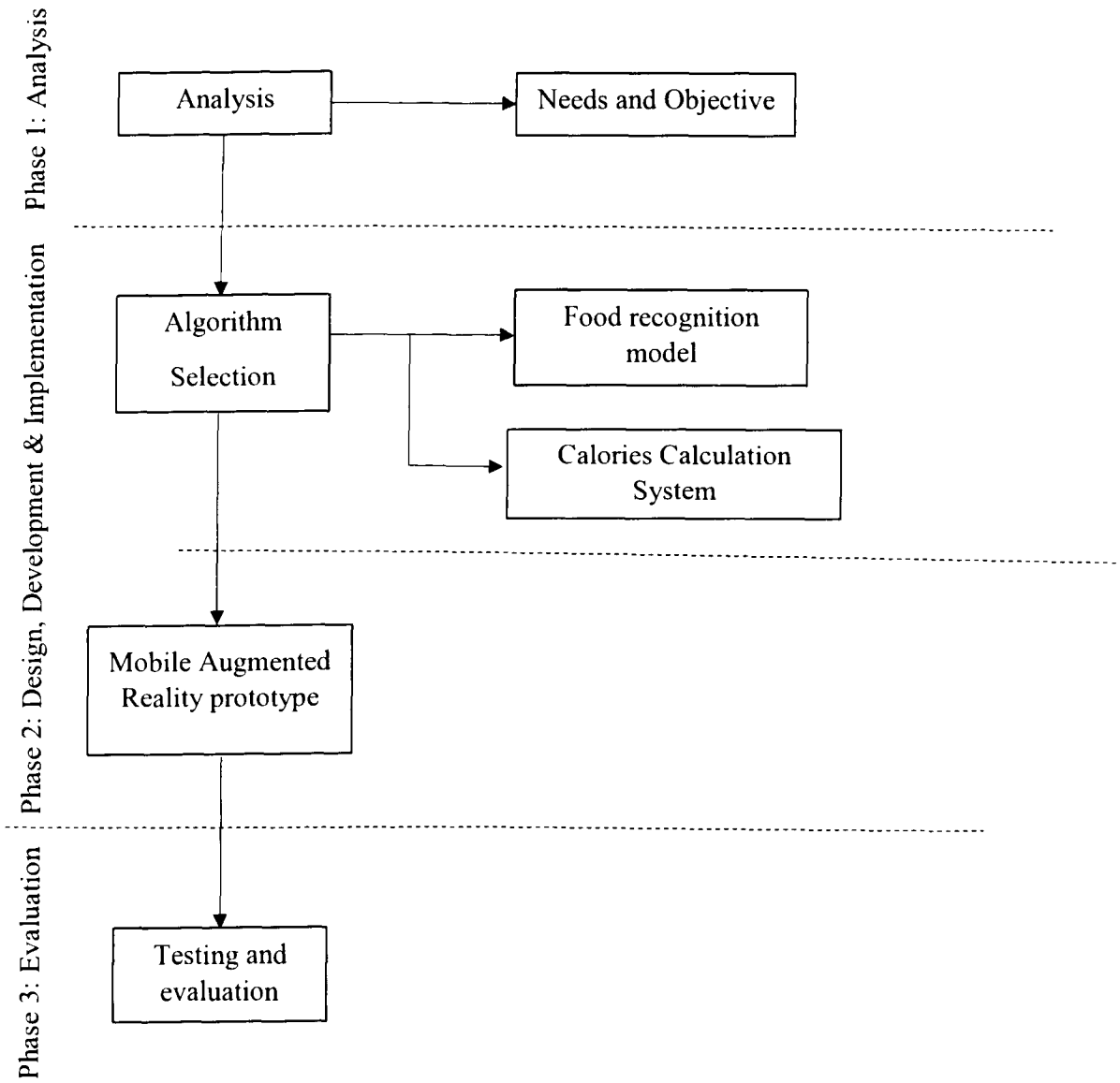

Figure 2. Research framework for the system

3.3 System Flow Chart Diagram

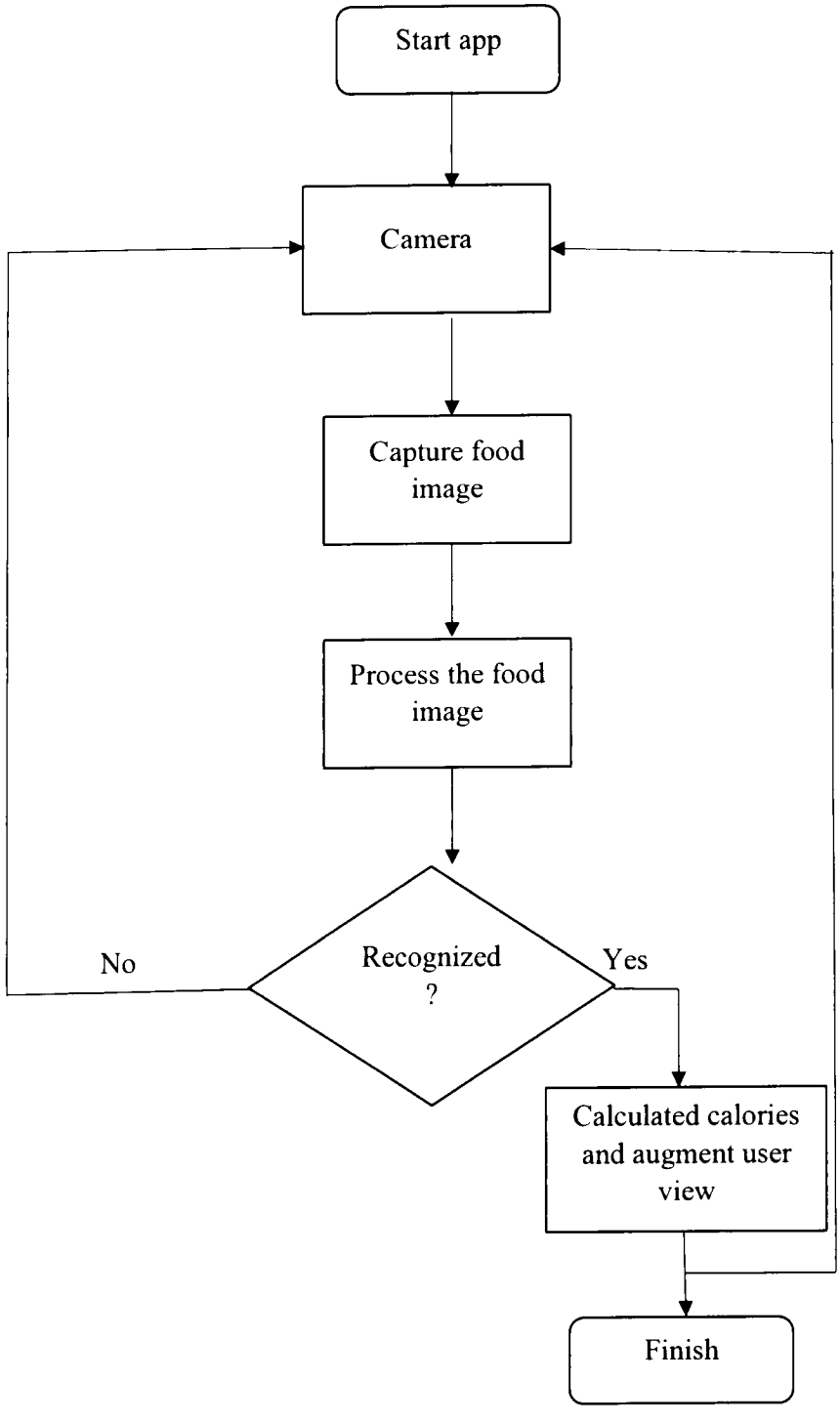

Figure 3. System Flow Chart diagram of food recognition.