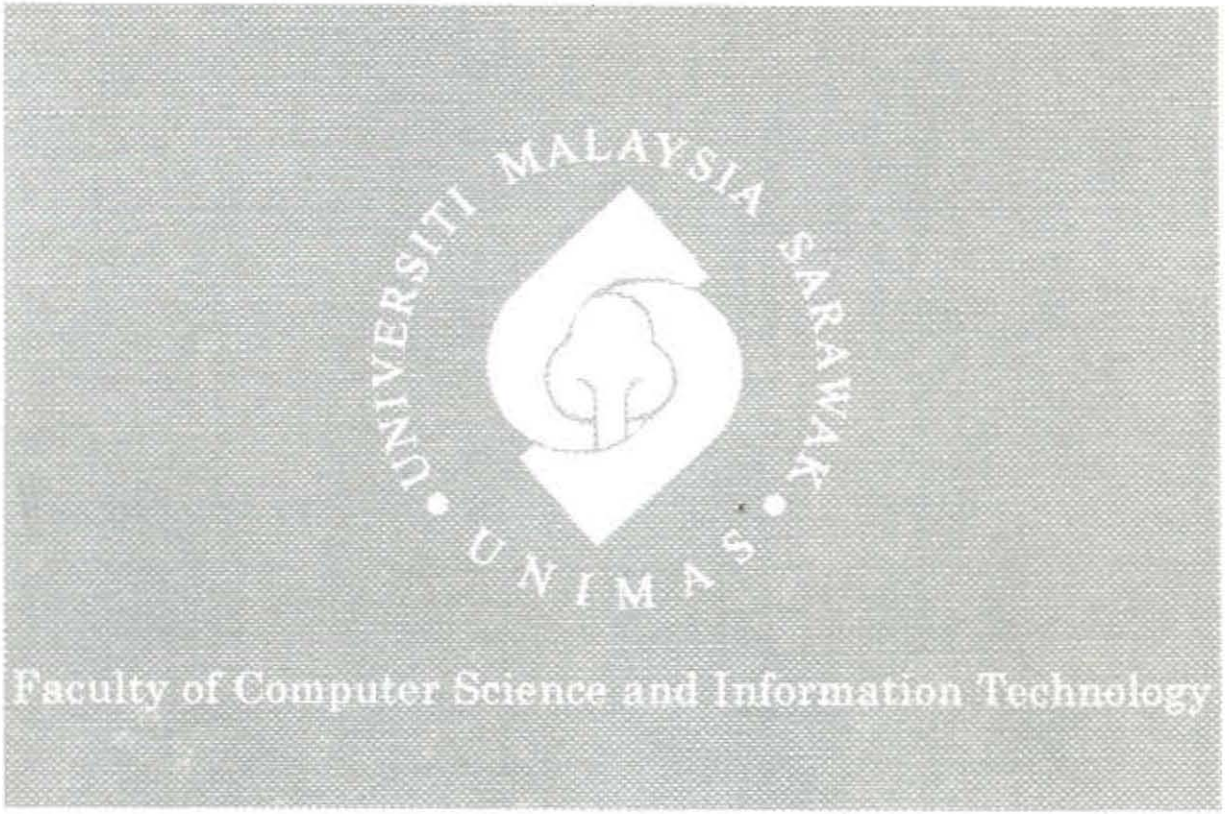


# *MULTI-MARKER APPROACHES FOR DEVELOPMENT OF AR APPLICATION- CASE STUDY ON TOURISM SPOT RECOGNITION*

Hue Boon Kee

Bachelor of Computer Science with Honours
(Information System)
2014

# MULTI-MARKER APPROACHES FOR DEVELOPMENT OF AR APPLICATION – CASE STUDY ON TOURISM SPOT RECOGNITION

Hue Boon Kee

This project is submitted in partial fulfillment of the
requirements for the degree of
Bachelor of Computer Science with Honours

Faculty Computer Science and Information Technology
UNIVERSITI MALAYSIA SARAWAK
2014

# PEMBANGUNAN APLIKASI *AR* DENGAN MENGGUNAKAN PENDEKATAN MULTI - PENANDA
## - KAJIAN KES TENTANG PENGENALAN PADA SPOT PELANCONGAN

Hue Boon Kee

Projek ini dikemukakan sebagai keperluan untuk
Ijazah Sarjana Muda Sains Komputer dengan Kepujian

Fakulti Sains Komputer dan Teknologi Maklumat
UNIVERSITI MALAYSIA SARAWAK
2014

**UNIVERSITI MALAYSIA SARAWAK**

## THESIS STATUS ENDORSEMENT FORM

**TITLE** Multi-Marker Approaches for Development of AR Application-Case Study on Tourism Spot Recognition

**ACADEMIC SESSION:** 2014

HUE BOON KEE

**(CAPITAL LETTERS)**

hereby agree that this Thesis* shall be kept at the Centre for Academic Information Services, Universiti Malaysia Sarawak, subject to the following terms and conditions:

1. The Thesis is solely owned by Universiti Malaysia Sarawak
2. The Centre for Academic Information Services is given full rights to produce copies for educational purposes only
3. The Centre for Academic Information Services is given full rights to do digitization in order to develop local content database
4. The Centre for Academic Information Services is given full rights to produce copies of this Thesis as part of its exchange item program between Higher Learning Institutions [ or for the purpose of interlibrary loan between HLI ]
5. ** Please tick ( √ )

| | | |
|---|---|---|
| ☐ | CONFIDENTIAL | (Contains classified information bounded by the OFFICIAL SECRETS ACT 1972) |
| ☐ | RESTRICTED | (Contains restricted information as dictated by the body or organization where the research was conducted) |
| ☑ | UNRESTRICTED | |

Validated by

PROF. DR WANG YIN CHAI
Director
Centre of Excellence for Image Analysis and Spatial Technologies
Universiti Malaysia Sarawak

(AUTHOR'S SIGNATURE) (SUPERVISOR'S SIGNATURE)

Permanent Address

A-148 TAMAN KOPERASI,
27000 JERANTUT,
PAHANG D.M.

Date: 16th JUNE 2014 Date:

Note * Thesis refers to PhD, Master, and Bachelor Degree
** For Confidential or Restricted materials, please attach relevant documents from relevant organizations / authorities

## ACKNOWLEDGEMENT

First and foremost, I would like to express my greatest gratitude and appreciation to all who have contributed directly or indirectly toward to success of this final year project. I would like to appreciate the Faculty of Science Computer and Information Technology, University Malaysia Sarawak for providing me an opportunity to apply my knowledge learnt in the past four years and new exploring on my topic into this final year project.

My deep appreciation and thanks I owe to my supervisor, Professor Dr. Wang Yin Chai, for his willingness to help me out and spend a lot of time guiding me towards this project completion. I would like to express my gratitude to all lecturers of Faculty Science Computer and Information Technology for providing their knowledge and experiences in this four years that benefit me so much and helping me to complete this final year project.

Last but not least, my gratitude and appreciation also goes to all of my friends and those who have helped me out directly and indirectly until this project reached its end.

# TABLE OF CONTENT

# LIST OF FIGURES

## LIST OF TABLES

# LIST OF ABBREVIATION

| | |
|---|---|
| 2D | 2- Dimension |
| 3D | 3- Dimension |
| AR | Augmented Reality |
| ADK | Accessory Development Kit |
| API | Application Programming Interface |
| DAT | Digital Audio Tape |
| FOV | Field of View |
| GPS | Global Positioning System |
| ID | Identification |
| INS | Inertial Sensor |
| JDK | Java Development Kit |
| JPEG | Joint Photographic Experts Group |
| Lat-Lng | Latitude-Longitude |
| LOD | Linked Data |
| LoG | Laplacian of Gaussian |
| MB | Megabyte |
| MP | Megapixel |
| NFT | Natural Feature Tracking |
| PNG | Portable Network Graphics |
| POI | Points of Interest |
| RAM | Random Access Memory |
| REVV | Residual Enhanced Visual Vector |
| RGB | Red, Green and Blue |
| SDK | Software Development Kit |
| SIFT | Scale-Invariant Feature Transform |
| SURF | Speeded Up Robust Features |
| XML | Extensible Markup Language |

## ABSTRACT

*Augmented Reality systems are moving beyond the laboratory and into the tourism field, especially tourism spot recognition. However, they still exists the problem of inaccurate recognizing the natural object such as a building in the tourism-intensive areas. In this study, we proposed the solution of the problem using multi-marker approaches using AR technology. Vision marker as the natural object recognize via vision based method capture by using camera live view. Vision based method is aided by an artificial marker which is Global Positioning System (GPS) used as a reference of user position and location. Natural object recognition in this proposed solution used to provide accurate tourism information, such as the historical information and location of the target building to tourists.*

*The significance of the project is to augment the physical environment with virtual reality by using a list of suitable markers and designed a framework of the solution in the problem domain.*

# ABSTRAK

Sistem Realiti Augment mula diaplikasikan di luar makmal dan digunakan dalam bidang pelancongan, terutamanya dalam pengenalan tempat pelancongan. Namun demikian, sistem ini dikesan masih menghadapi satu masalah iaitu sistem ini tidak dapat mengesan dan mengenal objek semula jadi seperti sebuah bangunan di kawasan pelancongan intensif dengan tepat sekali. Kajian ini telah mencadangkan tentang penggunaan pendekatan multi- penanda dalam teknologi AR untuk menyelesaikan masalah tertentu. Penanda penglihatan terhadap objek semula jadi dapat dikesan atau dikenal melalui kaedah berasaskan visual dengan menangkap visual tersebut dengan menggunakan live view kamera. Kaedah berasaskan visual ini dibantu oleh penanda tiruan yang juga dikenali sebagai Sistem Kedudukan Global (GPS) dan digunakan sebagai rujukan kedudukan pengguna dan lokasi. Cadangan penyelesaian masalah pengenalan objek semula jadi ini adalah bertujuan untuk memberikan maklumat tentang pelancongan dengan tepat, seperti maklumat sejarah dan lokasi bangunan sasaran kepada para pelancong.

Kepentingan projek ini adalah untuk mengenalkan persekitaran fizikal melalui realiti secara maya dengan menggunakan senarai penanda yang sesuai terhadap tempat tersebut dan mudah merangka kerja larutan terhadap masalah yang domain

# CHAPTER 1 : INTRODUCTION

## 1.1 Introduction

Augmented Reality (AR) is a grand vision can enhance a user's perception by fusing computer-generated virtual object onto a real scene to virtually augment reality (Azuma, 1997). AR systems are moving beyond the laboratory and into the tourism field.

Majority tourism spot recognition application on mobile augment intuitive information by location-based sensor, such as a Global Positioning system (GPS) are used as a reference of absolute position and posture (Dunser et al., 2012; Narzt et al., 2003; Taketomi et al., 2009). GPS has the problem of accurate localization and signal reflection in a natural environment is still an opened field of research (Reitmayr & Drummond, 2006; Zendjebil et al., 2008). A purely vision-based recognition on the natural object is rarely achieved in real time, because restricted to unique scene models and selected landmarks or point of interest (POI). Indeed, vision-based methods lack of robustness and accuracy due to light-condition. A hybrid approach, integrating vision-based method with GPS technologies, can compensate for the respective weaknesses in AR touring application (Ababsa et al., 2009; Jiang et al., 2004; Reitmayr & Drummond, 2006).

This project aims to carry out a case study of the multi-marker approaches for tourism spot recognition that have been developed in tackling the problem. A multi-marker approaches contained vision marker and artificial marker. Vision marker as the natural object (landmark building) recognize via vision based method capture by using camera live view. Vision based method is aided by an artificial marker which is GPS used as a reference of user position and location. Natural object recognition used to provide related information, such as the historical information and location of the target building to tourists.

## 1.2 Problem statement

Capture and recognize the natural object such as landmark building is a challenge in AR technology. A single marker has insufficient information to represent different perceptions of the natural object. The large variations in lighting and bad viewing conditions also as a capturing issue related to digitizing the environment influenced the quality of tourism spots capturing. Besides that, limited direction and single viewpoint captured to the natural object might cause failed to access information instantly and accurately.

## 1.3 Objective

The main purpose of this project is to capture and recognize the tourism spot to provide the accurate tourism information to tourists. A multi-marker approaches contained vision marker and artificial marker help to improve the accuracy of natural object recognition. The project aims to achieve a few objectives listed as below:

(a) To identify natural and artificial markers which are suitable for the natural object recognition

(b) To propose, design, and integrate multiple marker for AR application development for tourism application

(c) To apply and develop AR-based tourist information system prototype using the proposed multiple markers

## 1.4 Methodology

There are three main phases in my research project which are identified marker(s) in phrase 1, in phase 2 foeus on the propose approaches, and implement the prototype in phase 3.

### Phase 1: Identifying Natural and Artificial Markers

By reviewing from the existing system, study the behavior of various natural and artificial markers used in the current AR technology. The review will cover method and technology needed to apply in the system. This phase also compares different kinds of natural object of the topics. These requirements are collected to make a decision on which marker is the preferred marker and suitable for the tourist building recognition.

### Phase 2: Propose, Design, and Integrate Approaches

Multiple marker integration approaches, which is a vision marker (vision-based recognition) integrates with artificial marker (sensor-based recognition). Design phase will then be taken place after a solution is proposed. This chapter has been described the details about the entire module which will be covered in the system which are database generation modules, registration module, recognition module, and rendering module. A detailed architecture framework will to be designed appropriately.

### Phase 3: Apply Approaches to Implement Propose Prototype

This stage focuses on develop and implement the multi-markers approaches for AR-based tourist information system prototype. A framework in mobile Android platform applied in AR technology will be done. Once the solution is being implemented, experiment of the natural object recognition will be carried out to evaluate the solution delivered. Evaluation methods also has proposed in this phase to estimate and determined the natural object recognition accuracy.

All the results and data will be documented properly to ease the future enhancement or to contribute as a reference in the field of tourism spot recognition.

## 1.5 Scope and Limitation

There are a few scopes have been identified in this project as listed below:

(a) This project will only focus on natural object recognition, building is the preferred as the recognize target to provide tourist the information about the landmark or tourism spot. Unlike banner of the building, a building has its specific natural feature and geography located information so that we can capture it with different view angles and distance.

(b) This project will use appropriate location data and natural landmark. First focus on the tourism-intensive areas that near the Waterfront in Kuching, Sarawak. The point of interest (POI) for selected landmark included museums, temples, mosque, and war memorial.

(c) The proposed system is standalone system did not need any client-server service or network connection.

The first limitation was only can recognize one target building in a time, the proposed system cannot be detection multiple building and obtain correct information simultaneously. The second limitation was the target tourism spot was focus 4 or maximum 10 landmark or POIs. More flexible and extra places might under account of future enhancement.

## 1.6 Significance of Project

The significance of the project is to augment the real environment with virtual reality by using a list of suitable markers and designed a framework of the solution to the problem domains. Integrate natural and artificial markers to increase the recognition accuracy on the natural objects and provide accurate tourist-related information. Development of project that augment intuitive information and capturing tourist spot using AR technology based on the framework proposed.

## 1.7 Expected Outcome

This project is expected to produce a case study of different approaches in recognizing the natural tourist spot to provide accurate information to tourists. This project is also to augment the physical environment with virtual reality by using a list of suitable markers. At the end of the project, an *Android* mobile framework with multiple marker approaches for AR-based tourist information system will be proposed.

## 1.8 Outline of Project

The outline of this report consists five chapters which included the introduction, literature review, requirement analysis and design, implementation and testing, and conclusion and future work.

### Chapter 1: Introduction

This chapter delineates the problem statement, objectives, scope, and significance of the project, project schedule, expected outcome and the outline of the project.

### Chapter 2: Literature Review

This chapter shows the literature review and study for some similar existing systems, tools and techniques. It includes studies on the natural and artificial markers used in the tourist travel

building. After that the comparisons of the reviewed system are summarized in the table. This chapter will end with a proposal of our solution based on literature reviews done.

**Chapter 3: Requirement Analysis and Design**

This chapter will outline the analysis and research that has been carried out in order to produce the information and data required to design the framework. Besides, the system requirements, development software tools, and system flows were discussed.

**Chapter 4: Implementation and Testing**

This chapter will describe the details of implementation of the project based on the design from chapter 3. The evaluation of the project was examined after the testing section. In the end, the installation of the project was demonstrated to users.

**Chapter 5: Conclusion and Future Work**

This chapter contains the summary of the project. The limitation, future work and conclusion of the project are discussed in details. The achievement toward to the objectives of this project is discussed at the end of this chapter.

# CHAPTER 2 : LITERATURE REVIEW

## 2.1 Introduction

In order to achieve objectives and understand requirement of this project, background studies are carried out by review on several existing tourist spot recognition systems. This chapter requires understanding about the overall concept, the components and technologies included in those systems. Details of the four selected systems were studied and analyzed. Several existing and similar systems are reviewed in order to fully understand and discover the fundamentals and essential components of building recognition system. This section also helps to choose suitable marker and able to develop the best application as possible. A shot summarizes and discussion on proposed method will contribute in the Section 2.5.

## 2.2 Augmented Reality Mobile Tourist Information System

The recent trend of mobile application boom has made tourism agencies and even governing bodies thinking about how they can value add people on the go. Outdoor AR is one of the services that makes use all of these capabilities. An outdoor AR combines the user's view of the real world with context specific information and used to identify the location and orientation of the user when they are touring. A brief review of outdoor AR touring application on the mobile device market, we can simply divide them into several categories such as tourist spot recognition, building reconstruction, routing and navigation, tourism information browsing, and interaction feedback.

The idea of combining a 3D model on cultural site for building reconstruction is not recent. ARCHEOGUIDE project proposed by Vlahakis et al. (2001) present the *ArcheoGuide* project that reconstructs a cultural heritage site in *Olympia, Greece*. With this system, visitors

can view and learn ancient architecture and customs. Another 3D reconstruction system named ARsoucting used for modeling urhan scenes presented by Reitinger et al. (2007). *ARsoucting* system provides an expert mobile user interface which enables the collection of heterogeneous data within an unknown environment. The reconstruction engine requires at least three different views in order to generate an initial 3D model. Lee et al. (2012) present a novel mobile outdoor AR application, CityViewAR for providing AR information visualization bout destroyed buildings and historical sites that were affected by the earthquakes on a city scale. This application allows user to efficiently access geography located information and provided in a number of 2D map views 3D models of buildings on site, and list views.

For the tourist navigation system can guide a user to a particular destination via 2D or 3D AR content or virtual path. *INSTAR* system proposed by Narzt et al. (2003) mixes video images with 3D graphics to provide an AR view of the real world for mobile navigation. The AR navigation system is built upon a core framework where GPS is used for keeping track of the car. Nurminen and Oulasvirta (2008) using a realistic 3D model was found to be more efficient than a top-down view of the same model, representing a 2D map. Tokusho and Feiner (2009) introduced an AR street view system using a GPS sensor and a digital pedometer. A sensor-based approach has advantages that a position and a pose of devices can be obtained without complex processing.

Recently, mobile device based outdoor AR systems have become readily available. One of the most popular applications is AR browsers that show virtual points of interest (POIs) overlaid on top of the phone's camera view. Systems can be used to show virtual representations of POI superimposed over the real world, and applications such as *Layar*, *Wikitude* and *Junaio*. The *Layar* AR Browser launched in 2009 for *iOS* and Android capable devices. There are many

potential applications, such as for tourist guides, as a restaurant finder, providing directions to the subway, or even artistic installations. Other useful information, such as WiFi spots, ATMs, car parks, transportation, local news items, and weather can also be displayed in the AR view.

The above review applications are the brief research on different categories of outdoor AR touring application. From this little research give an overview on current touring applications and found that basic requirement for an effective support of mobile on-site needs of tourists. Current outdoor AR systems required work accurately and in real-time to provide access to location-based information, which are relevant to the immediate surroundings of tourists. Besides that, the timely and updated variable contents such as texts, images, sounds, and videos also a basic requirement for tourist. For the tourist spot recognition system and concept will detailed discuss in the Section 2.3.

## 2.3 Reviewing of Existing System

In this section, the existing tourism building pot recognition of AR system has been reviewed to identify various markers used for access location-based information, natural object recognition methods, architecture used, and tourism content presentation of the proposed tourist information system. The four relevant systems were vision-based recognition by using a Feature Landmark Database, Hybrid Localization System, Landmark Guide System, and Residual Enhanced Visual Vector (REVV) of the four systems were further discussed in the section below.

### 2.3.1 Feature Landmark Database

This paper proposes by Sato et al. (2008) introduced a novel method for extrinsic camera parameter estimation using a still image and feature landmark database that contains multi-dimensional and multi-view data. A vision marker works together with the feature landmark database by applying structure from motion method to the video sequences that capture the natural object, such as landmarks and buildings. The vision-based recognition proposed in this paper capable to estimate 6-*DOF (degree of freedom)* extrinsic camera parameters from a single image input. There are two phases carried out in the system: offline phrase for landmark database construction and online phase for camera parameter estimation using a landmark database as shown in Figure 2-1.

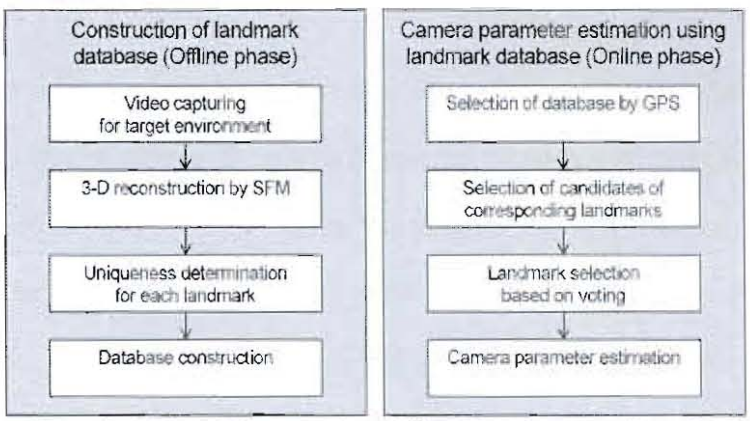


Figure 2-1 Flow Diagram for offline phase and online phase

In the offline phase focuses on construction of the landmark database on the server side, which is develop by applying structure from motion to the omnidirectional video streams. The rough position of the user given by the embedded GPS on the mobile device is used to select the database from amount of landmark database. Each landmark contains hundred images of target landmarks which retains own 3D coordinates and some information acquired from different observation position. Next, visually similar landmarks (natural objects) with its natural features

of the input image are selected using *SIFT (Scale-Invariant Feature Transform)* descriptor and *LoG (Laplacian of Gaussian)* based scale detector as shown in Figure 2-2. In order to select unique landmarks, the uniqueness for landmark is computed by using *SIFT* distances of N-top nearest landmarks.

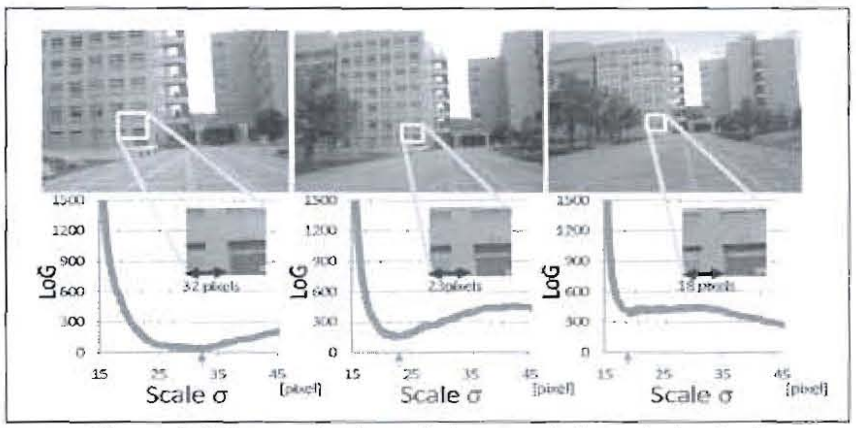


Figure 2-2 Determination of characteristic scale by *LoG*

In the online phase, camera parameter estimation using a landmark database is carried on to find the correct correspondences from a large number of visually similar landmarks, and then gradually discard the candidates of landmarks. To estimate the camera position of the client, the server needs both an input image and rough position that is measured by the embedded GPS from mobile devices. Unique landmarks are then selected and corresponded with image features. The outliers included in the corresponding pairs of landmarks are eliminated by verifying the space consistency based on the input image captured from a unique position and a unique posture. Finally, 6-*DOF* camera position and posture are estimated by solving perspective n-point problem *(PnP)* problem with *RANSAC* based outlier elimination.