Campus Safe: Safeguarding GPS-Based Physical Identity and Access Management (PIAM) System with A Lightweight Geo-Encryption

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FACULTY OF COMPUTING AND INFORMATICS
UNIVERSITY MALAYSIA SABAH
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DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, equations, summaries, and references, which have been duly acknowledged.

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ABSTRACT

Universiti Malaysia Sabah (UMS) has transformed itself into an attraction point for tourists who travel to Sabah in recent years. The increase in the number of tourists who visit UMS has raised concerns on campus safety issues. The registered tourists cannot be identified and tracked, so they may do whatever they want and go wherever they like. Some restricted areas such as the faculty, Dewan Canselori hall or even the hostel will become the place for the tourists to challenge to go. Recent industrial solutions to overcome the problem includes using manual registration, using 125kHz proximity card, using mobile application to scan QR code and others. These industrial solutions can obtain visitors' personal information without detecting their real-time location at a large area such as in UMS. Recent mobile apps that rely on QR code scanning in the campus entrance gates lack the real-time GPS tracking system to track the visitor's location. This project aimed to develop a GPS-based Physical Identity and Access Management (PIAM) System for UMS security division to address these gaps. Subsequently, this project embedded with a lightweight Geo-Encryption algorithm to preserve the privacy of real-time GPS location. The objective of this project includes, (i) To investigate the lightweight geo-encryption in terms of their computation speed, generated ciphertext, and key size by using literature review and experimental approach. (ii) To design and develop a GPS-Based Physical Identity and Access Management System in web Firebase platform by using prototype approach. (iii) To evaluate the usability performance of the developed GPS-Based Physical Identity and Access Management (PIAM) System by using the System Usability Scale (SUS) approach. Literature review and experiment aimed to select the fastest lightweight geo-encryption algorithms and the smallest ciphertext and key size. The user's requirements will be collected using a quantitative questionnaire online surveying tool. Some qualitative research methods such as interviews with the officer from the security division and observation at the main entrance gate of campus will also be performed to determine the Standard Operation Procedure (SOP) of access control and management in UMS security division. The collected user and system requirements will be used to design and develop the proposed project. Data Flow Diagram (DFD) will be used to develop the system flow, while Entity Relationship Diagram is used to design the system's database. The selected lightweight geo-encryption algorithm will be implemented in the proposed system,

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which develops by using Java language. Business logic and interfaces of the system will be tested by using unit testing and system integration testing while user acceptance testing (UAT) with system usability scare (SUS) approach will be used to test the usability performance of the proposed system. The project's expected outcome is a GPS-Based Physical Identity and Access Management System with the selected lightweight geo-encryption algorithm that can be used to support the control access and management operations of UMS security division.

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ABSTRAK

Campus Safe: Melindungi Identiti Fizikal Berasaskan GPS dan Sistem Pengurusan Capaian (PIAM) dengan Penyulitan Geo Ringan

Universiti Malaysia Sabah (UMS) telah mengubah dirinya menjadi tempat tarikan pelancong yang melancong ke Sabah sejak beberapa tahun kebelakangan ini. Peningkatan jumlah pelancong yang melawat UMS telah menimbulkan kebimbangan terhadap isu keselamatan kampus. Pelancong yang berdaftar tidak dapat dikenal pasti dan dijejaki, jadi mereka boleh melakukan apa sahaja yang mereka mahu dan pergi mana-mana sahaja yang mereka suka. Beberapa kawasan larangan seperti fakulti, Dewan Canselori mahupun asrama akan menjadi tempat untuk dicabar oleh pelancong. Penyelesaian industri terkini untuk mengatasi masalah tersebut termasuk menggunakan pendaftaran manual, aplikasi mudah alih untuk mengimbas kod QR dan lain-lain. Penyelesaian industri ini boleh mendapatkan maklumat peribadi pelawat tanpa mengesan lokasi masa nyata mereka di kawasan yang luas seperti di UMS. Aplikasi mudah alih terkini yang bergantung pada pengimbasan kod QR di pintu masuk kampus tidak mempunyai sistem penjejakan GPS masa nyata untuk menjejak lokasi pelawat. Projek ini bertujuan untuk membangunkan Sistem Identiti Fizikal dan Pengurusan Capaian (PIAM) berasaskan GPS untuk bahagian keselamatan UMS bagi menangani jurang ini. Selepas itu, projek ini dibenamkan dengan algoritma Penyulitan Geo yang ringan untuk memelihara privasi lokasi GPS masa nyata. Objective projek ini termasuk, i) Untuk menyiasat penyulitan geo ringan dari segi kelajuan pengiraan mereka, teks sifir yang dijana, dan saiz kunci dengan menggunakan kajian literatur dan pendekatan eksperimen. ii) Untuk mereka bentuk dan membangunkan Sistem Pengurusan Identiti Fizikal dan Akses Berasaskan GPS dalam platform Firebase web dengan menggunakan pendekatan prototaip. iii) Untuk menilai prestasi kebolehgunaan Sistem Pengurusan Identiti Fizikal dan Capaian (PIAM) Berasaskan GPS yang dibangunkan dengan menggunakan pendekatan Skala Kebolehgunaan Sistem (SUS). Kajian literatur dan percubaan bertujuan untuk memilih algoritma penyulitan geo ringan terpantas dan teks sifir dan saiz kunci terkecil. Keperluan pengguna akan dikumpul menggunakan alat tinjauan dalam talian soal selidik kuantitatif. Beberapa kaedah kajian kualitatif seperti temu bual dengan pegawai bahagian keselamatan dan pemerhatian di pintu masuk utama kampus juga

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akan dilakukan bagi menentukan Standard Operation Procedure (SOP) kawalan capaian dan pengurusan di bahagian keselamatan UMS. Keperluan pengguna dan sistem yang dikumpul akan digunakan untuk mereka bentuk dan membangunkan projek yang dicadangkan. Rajah Aliran Data (DFD) akan digunakan untuk membangunkan aliran sistem, manakala Rajah Perhubungan Entiti digunakan untuk mereka bentuk pangkalan data sistem. Algoritma penyulitan geo ringan yang dipilih akan dilaksanakan dalam sistem yang dicadangkan, yang dibangunkan menggunakan bahasa Java. Logik perniagaan dan antara muka sistem akan diuji dengan menggunakan ujian unit dan ujian integrasi sistem manakala ujian penerimaan pengguna (UAT) dengan pendekatan kebolehgunaan sistem (SUS) akan digunakan untuk menguji prestasi kebolehgunaan sistem yang dicadangkan. Hasil jangkaan projek ini ialah Sistem Pengurusan Identiti Fizikal dan Capaian Berasaskan GPS dengan algoritma penyulitan geo ringan terpilih yang boleh digunakan untuk menyokong capaian kawalan dan operasi pengurusan bahagian keselamatan UMS.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The risk of the crime of 2.3 million students who represent 4% of the population started to further their studies in universities is higher than others in Britain (Wootton *et al.*, 2016). Statistics from the Office of National Statistics show that 19% of full-time students were the victims of crime in 2014-2015, compared to 16% of all adults in the general population. For the number of crimes such as burglary, violence, domestic violence, mugging, robbery, and theft, full-time students have a higher possibility of becoming a victim than the general population. There are various issues of personal safety faced by specific student groups. Recent reports show that women on university campuses who represent 56% of fresh university students in the UK are at risk of sexual harassment and assault (Wootton *et al.*, 2016).

Those problems in universities in Britain may also happen in universities in Malaysia and Universiti Malaysia Sabah (UMS). The issues that may occur are vandalism, littering, break into a restricted area without permission, and many more. This project proposes a GPS-based location encrypted visitor tracking system named Physical Identity and Access Control (PIAM) system. Campus Safe: Safeguarding GPS-Based Physical Identity and Access Management (PIAM) system Mobile App with lightweight Geo-Encryption is a mobile application used to track the real-time location of the visitors in UMS. The real-time location of the visitors will be encrypted with a lightweight geo-encryption algorithm to protect their privacy. The visitors just need to install the PIAM system and turn on the GPS location information function in their mobile phone at UMS Eco Campus Visitor Information Centre before entering and visit UMS.

The accessibility and availability of Wi-Fi in UMS are significant obstacles to implement in the proposed application. In UMS, Wi-Fi is only provided at some

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specific areas such as faculty, library, and hostel. The places which provided Wi-Fi service usually will not become the attraction point of visitors, while ODEC beach, UMS peak, and UMS Pink Mosque, which don’t offer Wi-Fi service, always become the destination of visitors. The possible solution is to install Wi-Fi at EcoCampus Visitor Information Center (EVIC) and allow the Wi-Fi to be used by the visitors who don’t purchase the data package to install the proposed application on their mobile phone. While using the proposed application, the real-time location of visitors will be encrypted and stored in the storage of their smartphones. When their smartphones are connected to Wi-Fi or data, the encrypted real-time location will be synchronized to the system's database.

This proposed project aims to develop a GPS-Based Physical Identity and Access Management (PIAM) system with a lightweight Geo-Encryption. This chapter consisted of 7 sections: introduction, problem background and motivation, problem statements, problem objectives, project scope, organization of the report, and conclusion part.

1.2 Problem Background

Physical Identity and Access Management (PIAM) system focus on enterprise, company, or organization to manage identity lifecycle by processing physical identification, authentication, and access management. According to market research company information, the global market of the PIAM system is expected to reach US$861.5 million by 2022, with a CAGR of 15.7 percent from 2016 to 2022. The growth of the PIAM system market is because of the increased security and operational management concerns, compliance mandates, and technology development (Strom, 2017). PIAM system can be implemented in many fields such as in university, working area, tourist attraction, or even in an airport. PIAM is a solution to help unify identity management, integrate different physical security systems and automate processes and facilitate controls of employees, suppliers, and other identities at airports (Kuchel, 2013).

While UMS still relies on a traditional manual approach to register visitors, granting and controlling their access manually, physical identity issuing and access control models in the recent industry market are dominated by 125kHz proximity cards and QR Scanner mobile applications. 125kHz proximity card is a contactless

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