

**WIA3002 ACADEMIC PROJECT I**

Faculty of Computer Science and Information Technology

Department of Artificial Intelligence

University of Malaya

**WeCare**

**Indoor Positioning Module**

Name : Ong Jia Aun

Matrix Number : WEA150022

Supervisor : Dr. Zati Hakim Binti Azizul Hasan

Table of Contents

[Abstract 3](#_Toc514194488)

[Project Introduction 4](#_Toc514194489)

[Problem Statements 5](#_Toc514194490)

[Project Objectives 5](#_Toc514194491)

[Module Problem Statement 6](#_Toc514194492)

[Module User Requirements 6](#_Toc514194493)

[Module Objectives 6](#_Toc514194494)

[Literature Review 7](#_Toc514194495)

[Research Methodology 8](#_Toc514194496)

[System Analysis and Design 9](#_Toc514194497)

[Technical Implementation 9](#_Toc514194498)

[Conclusion 10](#_Toc514194499)

[Industry Collaboration Initiative 11](#_Toc514194500)

[References 12](#_Toc514194501)

# Abstract

# Project Introduction

Safety is defined by Oxford Dictionaries as “the condition of being protected from or unlikely to cause danger, risk, or injury”. However, it is near impossible to get away from being injured while at work no matter how small the injury might be. According to Census of Fatal Occupational Injuries (CFOI), private construction industry is ranked first in number of fatal injuries, and fourth in fatal injury rates across all industry. In Malaysia, the construction industry is ranked fourth in number of accidents and highest fatal injuries and fatal injury rate. Yet, contractors, especially here in Malaysia, are lack of appropriate approach to comply with the Occupational Safety and Health Administration (OSHA) standard to ensure their worker’s safety in the site.

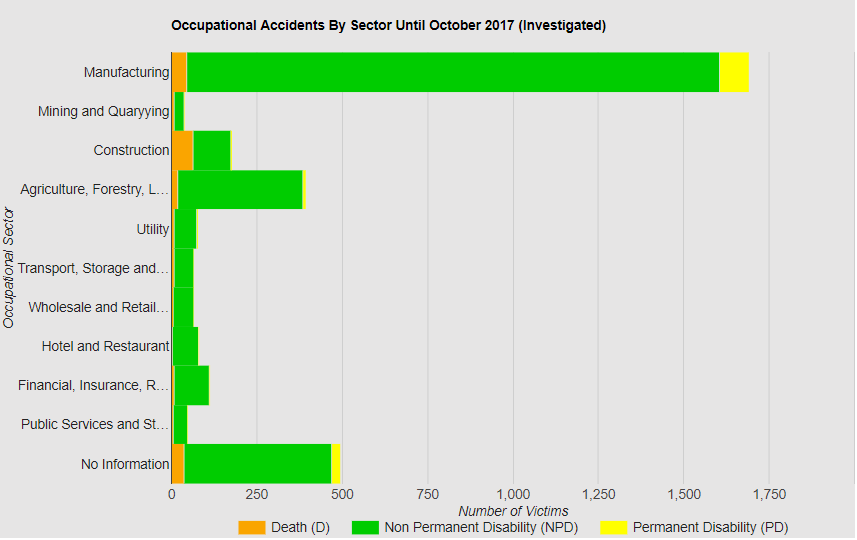


Figure 1 Graph provided from OSHA

Besides that, there is an obvious lack of immediate two-way communication between site supervisors and the workers. This is crucial and felt when there is an accident happen at the construction site. Sometimes, the difference of a few seconds is life or dead matter. Being able to send out SOS signal to site supervisor when accident occurs will enable the supervisor to react faster and more efficient.

In recent years, with the rise of Internet of Things, there have been many new proposed solutions in the market. Among these solutions comes a common theme, to be able to track user location and be able to have a source of health indicator of the user. WeCare is in the vein of this theme. WeCare aims to provide the solution for an organization to monitor the safety of its members or staffs while being a cost-effective and robust system.

# Problem Statements

Construction site workers, especially in Malaysia, usually does not comply to the OSHA standard of equipment requirement. This is very dangerous as it increases the rate of injury significantly. With buildings getting taller and bigger, so do construction sites. Site supervisors are having a hard time to determine where a worker might be at a given time. Thus, it might be hard for the supervisors to react on time when an accident occurs.

Current market trend indicates that the worker health status and location is important to keep track as it provides some indicator to an accident might occur.

# Project Objectives

The main objectives of the project are:

* To be able to monitor the heart conditions of the workers in real time.
* To be able to track the locations of the workers in real time.
* To enable two-way communication between the site supervisors and workers.

# Module Problem Statement

The wearable device that is using for the project provides three important positioning data:

* Global Positioning System (GPS)
* Cellular tower (Cell tower)
* WiFi Service Set Identifier (SSID), Basic SSID (BSSID) and Received Signal Strength Indication (RSSI)

However, the only ready-to-use data for positioning is GPS. For cell tower and WiFi data, additional processing is required to be able to get any meaningful information. Besides that, solely relying on GPS is not feasible as GPS module in the device might fail.

# Module User Requirements

The module-specific user requirements are:

* To be able to provide a usable positioning data in indoor environment
* To provide more than one way for positioning at outdoor environment

# Module Objectives

The module-specific objectives are:

* To come up with an indoor positioning system using the data provided from the device.
* To be able to switch between using GPS and the indoor positioning system when in outdoor or indoor environment

# Literature Review

According to a most research papers, many argue that GPS does not work well in indoor environment [1][2]. One of the main issue is that GPS it relies on connection with the satellites that are orbiting the planet. Hence, a cover above a GPS module affects its connection and thus its result. This is especially true when in the lower levels of a high rise. Thus, the accuracy of GPS in indoor environment suffers and makes it unsuitable for indoor location estimation.

An alternative to using GPS is by using cell tower triangulation [1][3]. Cell tower triangulation has been used in mobile phones for a long time. It works by detecting nearby cell tower, which will return Mobile Country Code (MCC), Mobile Network Code (MNC), Cell Tower Area Code, Cell Tower ID and RSSI. By having a database of cell tower information, trilateration algorithm can be used to calculate the location the device [4].

One of the most used mode for indoor positioning system is using WiFi-based [1]. There have been many research papers published on this topic and most of it involve roundtrip time-of-flight (RTOF), time of arrival (TOA) and or time difference of arrival (TDOA). In this project, RSSI is focused due to the limitation of the wearable device.

# Research Methodology

# System Analysis and Design

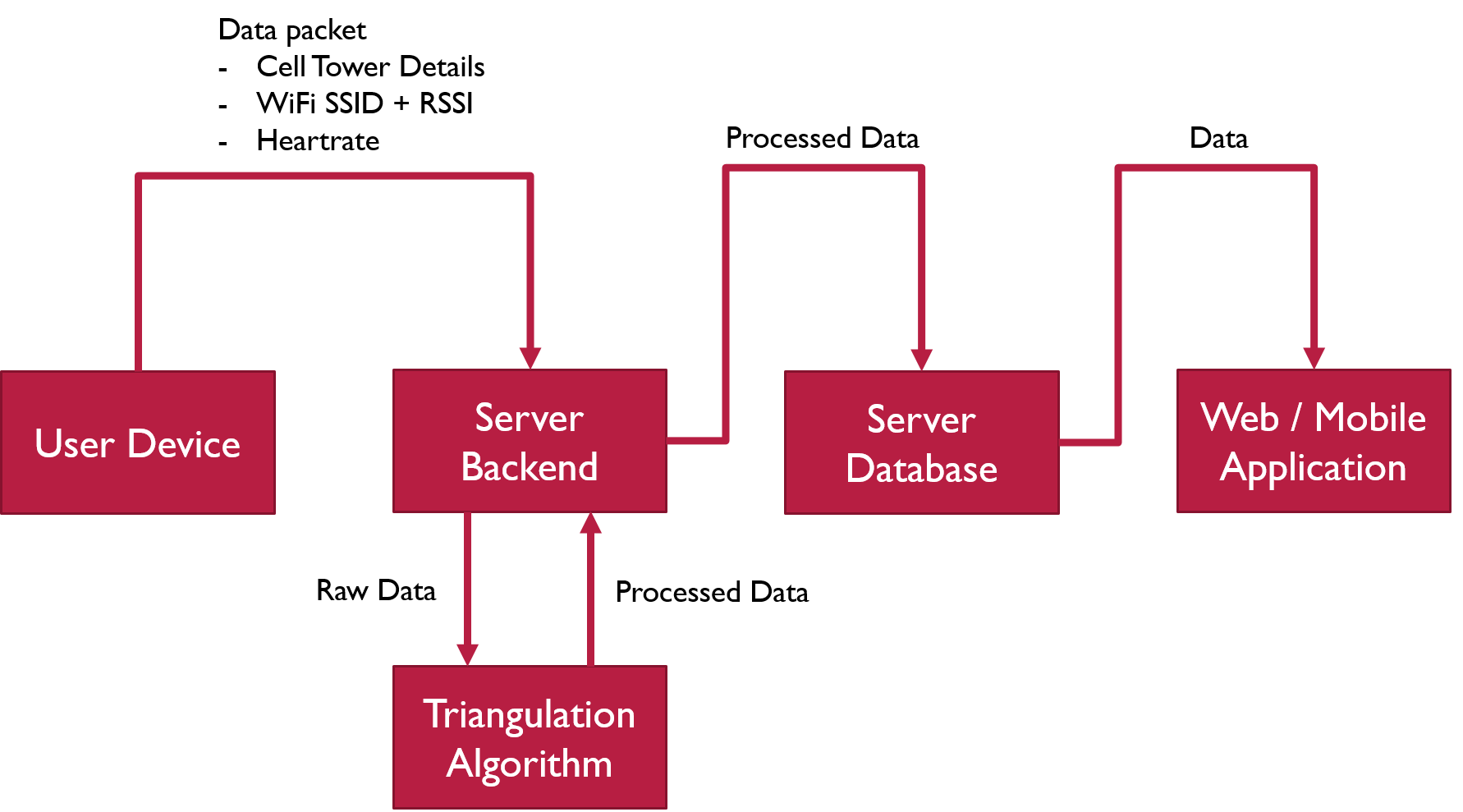


Figure 2 Data flow in the system

The system work as a whole with a wearable device connected to the server backend. In the server backend, data packets from the device will be interpreted and pass to this module for indoor positioning before injecting into server database. Site supervisor will then access the data from a web application or mobile application.

# Technical Implementation

The proposed solution is work with the available but limited data gather from the device data packet. Due the severe limitations, trilateration algorithm is the way to go for implementing indoor positioning.

The programming language used for the implementation of the algorithms is PHP. This is to facilitate the integration of modules because that the algorithm is going to be running with the server backend, which is written in PHP.

With cell tower database, it can be acquired from free online open source, which is roughly 6 to 7 GB worth of data in csv format. SQLite3 database is chosen for the conversion of csv file as it is super lightweight and is readily available as native extension for PHP. Using a database speeds up query time exponentially, from roughly 5 seconds to read the csv file to less than 0.1 second. As for WiFi database, it has to be manually input by user as not all WiFi access points (AP) is stored in open source database.

With database ready, trilateration algorithm can be implemented and tested. For quick deployment, a simple basic trilateration algorithm is used [Figure 2].

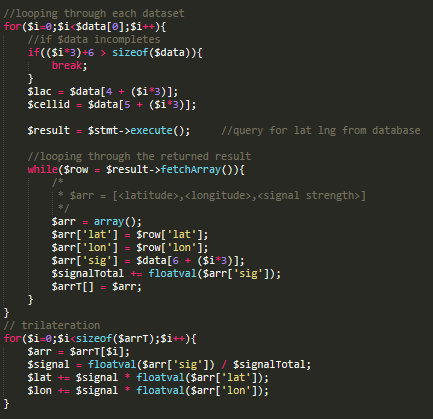
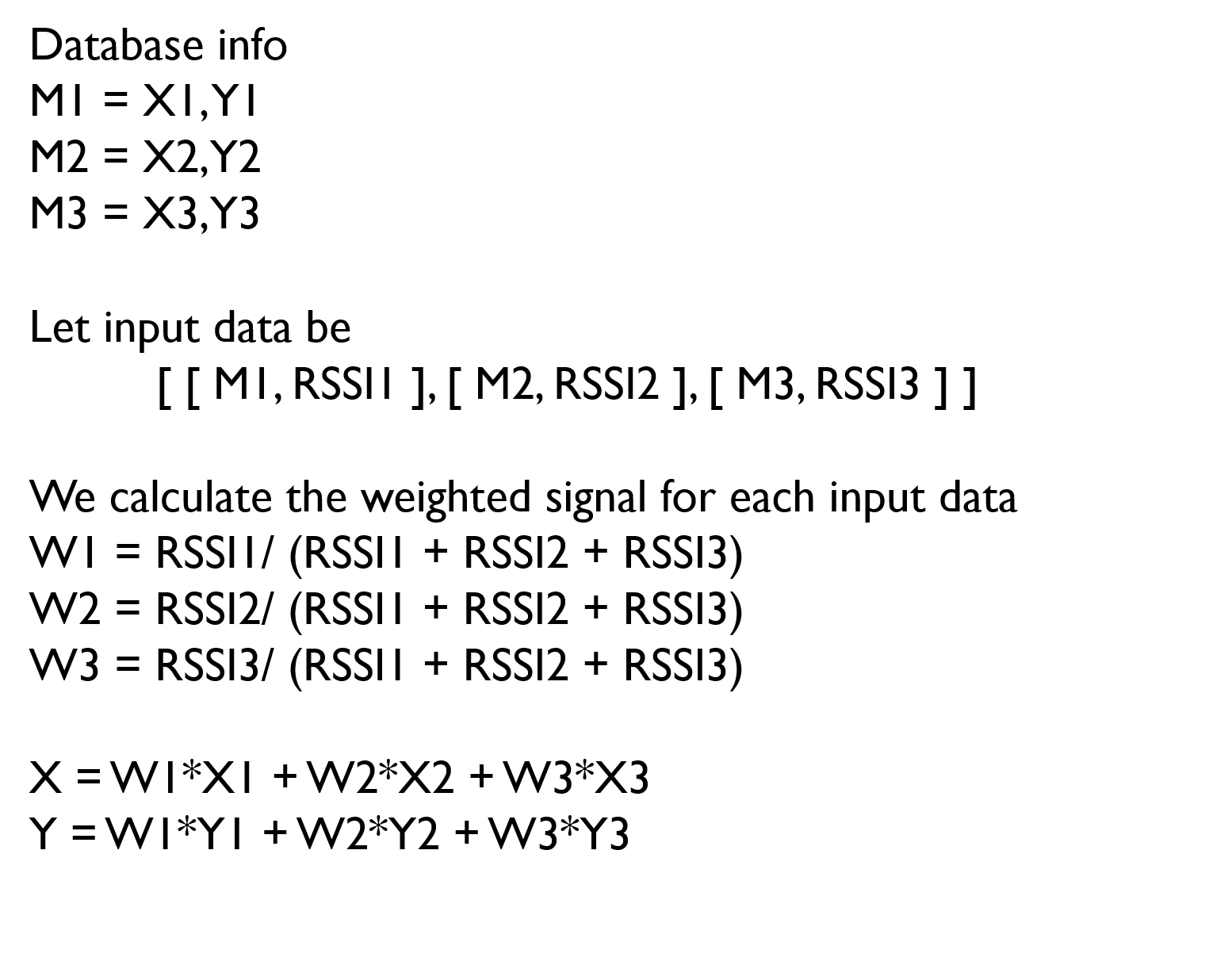


Figure 4 Pseudocode and Implemented Code

Several thousand data packets are gathered from the device from the server backend module logs. The algorithm is tested against the data packets to see if the algorithm works well against the unstable and moving wearable device in a vehicle as well as in indoor environment.

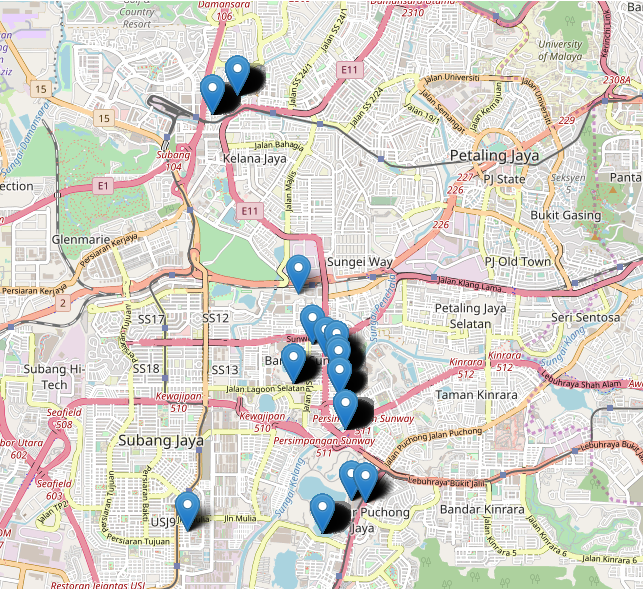


Figure 5 Testing on sample data packets

As shown in Figure 3, the algorithm provides promising result on indoor positioning using cell tower data. The sample data packets are from a device moving along the Lebuhraya Damansara-Puchong (LDP), in MDT office at Sunway Pinnacle, and in an apartment unit at Lily and Rose Apartment, SS26. The plotted location deviates from the actual location, noticeably a few stray markers on the lower left corner on the map, but it is normal and acceptable as cell tower trilateration has an accuracy of at best 50 meters.

# Conclusion

# Industry Collaboration Initiative

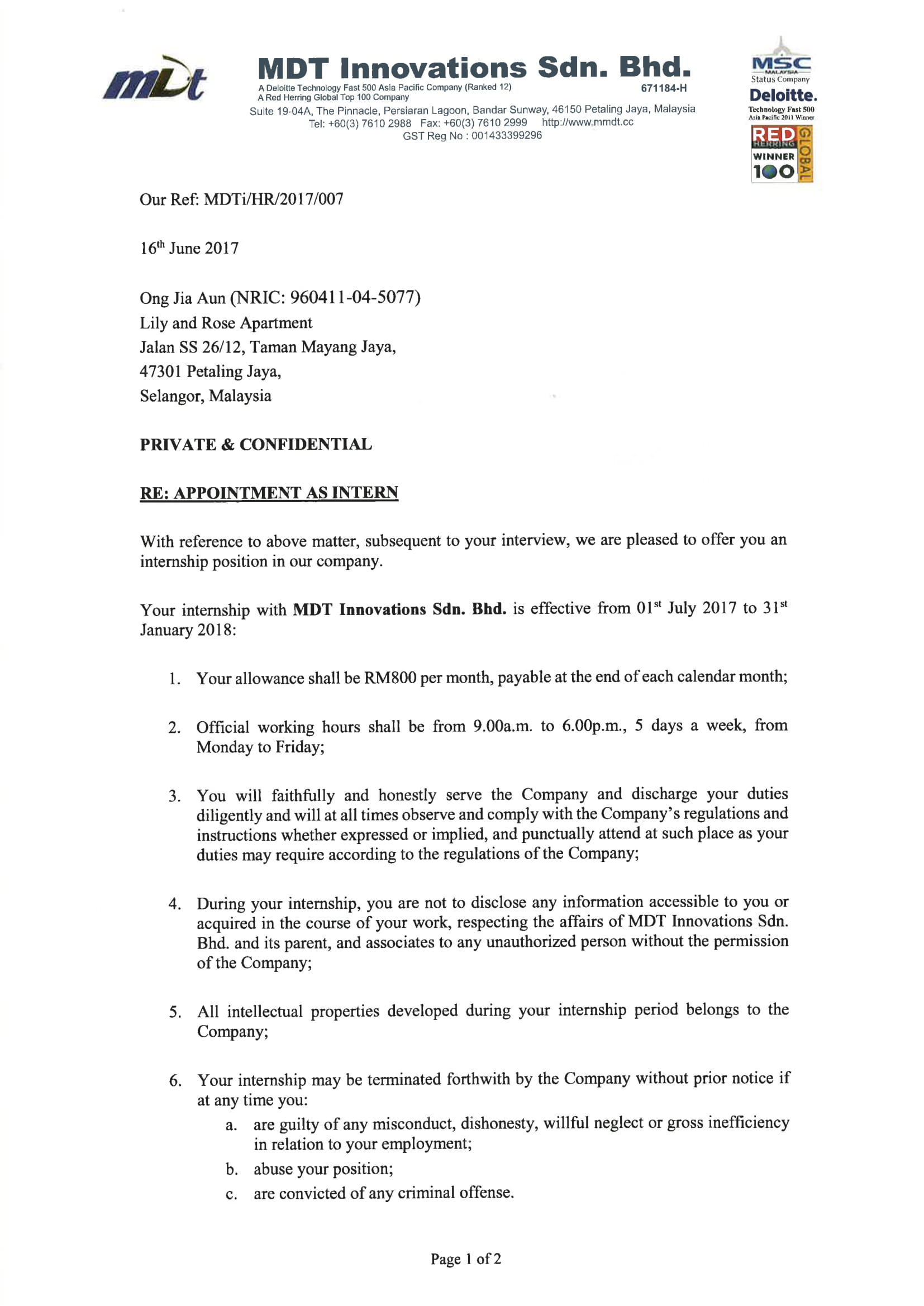


Figure 6 Internship offer at the collaborator's company

# References

1. Liu, H., Darabi, H., Banerjee, P., & Liu, J. (2007). Survey of wireless indoor positioning techniques and systems. *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews)*, *37*(6), 1067-1080.
2. Dedes, G., & Dempster, A. G. (2005, September). Indoor GPS positioning-challenges and opportunities. In *Vehicular Technology Conference, 2005. VTC-2005-Fall. 2005 IEEE 62nd* (Vol. 1, pp. 412-415). IEEE.
3. Yang, J., Varshavsky, A., Liu, H., Chen, Y., & Gruteser, M. (2010, September). Accuracy characterization of cell tower localization. In *Proceedings of the 12th ACM international conference on Ubiquitous computing* (pp. 223-226). ACM.
4. Rida, M. E., Liu, F., Jadi, Y., Algawhari, A. A. A., & Askourih, A. (2015, April). Indoor location position based on bluetooth signal strength. In *Information Science and Control Engineering (ICISCE), 2015 2nd International Conference on*(pp. 769-773). IEEE.
5. Gu, Y., Lo, A., & Niemegeers, I. (2009). A survey of indoor positioning systems for wireless personal networks. *IEEE Communications surveys & tutorials*, *11*(1), 13-32.
6. Hazardous Work (Occupational Safety and Health). (2018). Retrieved from <http://www.ilo.org/safework/areasofwork/hazardous-work/lang--en/index.htm>
7. Census of Fatal Occupational Injuries (CFOI) - Current and Revised Data. (2018). Retrieved from <https://www.bls.gov/iif/oshcfoi1.htm>
8. Idris, N. (2018). Website Department of Occupational Safety and Health Malaysia - By Sector. Retrieved from <http://www.dosh.gov.my/index.php/en/occupational-accident-statistics/by-sector>