



**UNIVERSITI PUTRA MALAYSIA**

***TRACKING ELDERLY ALZHEIMER'S PATIENT WITH  
RADIO FREQUENCY LOCALIZATION SYSTEM***

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RADIO FREQUENCY LOCALIZATION SYSTEM**



By

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**December 2012**

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Humans are sometimes affected by Alzheimer Disease (AD) when aging. AD has major implications on patient safety and care. The elderly Alzheimer's patient encounters risk of losing all of their memory capability and are unable to live a normal life accordingly. The short memory problem may lead the patients to wander aimlessly and this may lead them to danger. Hence, the Alzheimer's patients need to be closely monitored to ensure their safety. Some Alzheimer's patient would be sent by their family to a day care center for day care. The caregivers in day care center have a tough job in monitoring closely the many Alzheimer's patients at the day care center because of the limited number of caregivers on duty. A motivation of this research is to reduce the caregiver burden. In this research, an assistive technology tools called Alzheimer's Real Time Location System (ARTLS) was developed to fulfill the research objectives' of developing Alzheimer's Real Time Location System (ARTLS) using Active RFID Localization System (ARFIDLS), to understand spatial movement to enhance the monitoring and care management of the residents and lastly to determine the level of

suitability of the ARFIDLS in accommodating the AD. The research methodology is implementing ARFIDLS in accommodating the ARTLS functions. The ARTLS is implemented on several Alzheimer's patients who are residents at the Alzheimer's day care center. After a successful system implementation on the residents, an analysis on the resident's visiting area zone and movement sequence pattern percentage is held for determining residents' daily routine and behavior problems of wandering aimlessly. An analysis of the system performance and system suitability for tracking the Alzheimer patient also been carried out in this thesis. From the research analysis, the residents visiting frequency to each visit area zone is known. it was found also that the residents had a high percentage of movement sequence pattern disagreement. These demonstrate that the residents are wandering aimlessly every day. A suitable selection criteria for radio frequency localization system in accommodating the ARTLS were determined in this thesis. As a general results, ARTLS relieves the caregiver's burden and enhances residents' safety by close monitoring of the wandering movements of the residents in real time. Hence, the care for residents will be more efficient and enhanced with better care management practice by the caregiver.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Sarjana Sains

## **MENGESAN PESAKIT TUA ALZHEIMER DENGAN SISTEM LOKASI RADIO FREKUENSI**

Oleh

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Manusia kadang-kadang dipengaruhi oleh penyakit Alzheimer (AD) apabila proses penuaan berlaku. Penyakit ini mempunyai implikasi yang besar terhadap penjagaan dan keselamatan pesakit. Pesakit tua Alzheimer menghadapi risiko kehilangan semua keupayaan memori mereka dan kurang upaya untuk menjalani kehidupan yang normal dengan sewajarnya. Kurang upaya terhadap keupayaan memori pendek boleh menyebabkan pesakit Alzheimer merayau tanpa tujuan dan membawa mereka kepada bahaya. Oleh itu, pesakit Alzheimer perlu diperhatikan dengan lebih rapat untuk memastikan keselamatan mereka. Sesetengah pesakit Alzheimer akan dihantar oleh keluarga mereka ke pusat jagaan harian untuk penjagaan harian. Penjaga di pusat jagaan harian mempunyai pekerjaan yang sukar dalam memantau rapat bilangan pesakit Alzheimer yang ramai di pusat jagaan harian mereka kerana jumlah penjaga yang terhad bagi untuk keseluruhan pusat jagaan harian tersebut. Motivasi kajian ini adalah untuk mengurangkan beban penjaga. Dalam kajian ini, satu alat teknologi bantuan dipanggil Sistem Lokasi Semasa Alzheimer (ARTLS) telah dibangunkan

untuk memenuhi objektif penyelidikan iaitu membangunkan sistem lokasi semasa Alzheimer (ARTLS) menggunakan sistem lokasi identifikasi aktif radio (ARFIDLS), untuk menganalisis pergerakan pesakit yang boleh membantu dalam pengurusan penjagaan pesakit yang lebih baik dan akhir sekali untuk menentukan tahap kesesuaian ARFIDLS dalam menampung penyakit Alzheimer. Metodologi kajian yang digunakan adalah menggunakan ARFIDLS yang sesuai dalam menampung ARTLS. ARTLS telah digunakan keatas beberapa pesakit Alzheimer yang berada di pusat jagaan harian Alzheimer. Selepas sistem berjaya digunakan ke atas pesakit, analisis ke atas kawasan zon yang dilawati pesakit dan corak urutan pergerakan pesakit diadakan untuk menentukan rutin harian dan masalah tingkah laku merayau tanpa tujuan oleh pesakit. Analisis ke atas prestasi sistem dan kesesuaian system dalam menjejaki pesakit Alzheimer juga dijalankan dalam tesis ini. Daripada analisis kajian, frekuensi lawatan pesakit ke kawasan zon lawatan diketahui. Didapati juga bahawa pesakit mempunyai peratusan yang tinggi bagi corak urutan pergerakan yang tidak sama. Ini menunjukkan bahawa pesakit merayau tanpa tujuan setiap hari. Kriteria pemilihan yang sesuai untuk sistem lokasi radio frekuensi dalam menampung ARTLS diperjelaskan dalam tesis ini. Sebagai hasil umum, ARTLS melegakan beban penjaga dan meningkatkan keselamatan pesakit dengan pemantauan rapi pergerakan pesakit dalam masa nyata. Maka, penjagaan ke atas pesakit akan menjadi lebih efisien dan dipertingkatkan dengan pelaksanaan pengurusan penjagaan yang lebih baik oleh penjaga.

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I certify that an Examination Committee has met on **date of viva voce** to conduct the final examination of **Mohd Fadhil bin Abuhan** on his **Master Science** thesis entitled "**Tracking elderly Alzheimer's patient with Radio Frequency Localization System**" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the Master of Science (GIS and Geomatic Engineering)

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## DECLARATION

I declare that this thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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**MOHD FADHIL BIN ABUHAN**

Date: 4 December 2012

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## LIST OF ABBREVIATIONS

|         |   |
|---------|---|
| AD      | Alzheimer's Disease   |
| ALZ-MAS | Alzheimer Multi Agent System  |
| ARTLS   | Alzheimer's Real Time Localization System                                     |
| ARFIDLS | Active Radio Frequency Identification Localization System                     |
| GPS     | Global Positioning System   |
| GNSS    | Global Navigation Satellite System  |
| HAT     | Hierarchical Addressing Tree  |
| LAURA   | Localization and Ubiquitous Monitoring of Patients for Health<br>Care Support |
| NA      | Network Architecture  |
| PAN     | Personal Area Network   |
| PMS     | Personal Monitoring System  |
| PLTS    | Personal Localization and Tracking System                                     |
| RFID    | Radio Frequency Identification  |
| RSS     | Receive Signal Strength   |
| RTLS    | Real Time Localization System   |
| UWB     | Ultra Wide Band   |
| ID      | Identification  |
| JerryTS | Jerry Tracking System   |
| TOA     | Time of Arrival   |
| TOM     | Tracking Objects Moving   |
| Wi-Fi   | Wireless Fidelity   |
| WLAN    | Wireless Local Network  |

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Nowadays, elderly aged 60 and over is a fast growing age group. This is due to life expectancy of those age group is increasing by years. According to World Health Organization (2002), in between the years 1970 and 2025, a growth of about 223% or 694 million elderly is expected globally. It is also expected by year 2025, elderly aged 60 years old and above will total up to 1.2 billion people and by year 2050 this will be up to 2 billion people. 80% of these elderly populations are expected to come from the developing countries.

The rising number of elderly also contributes to the rising of number of chronic disease affecting the elderly. As the chronic disease number rises, the number of patients with Alzheimer Disease (AD) also rises. Alzheimer's disease is a disease that can lead a person to gradually lose his basic abilities to live the daily life accordingly. The basic abilities include the short and long term memory, orientation, judgement, thinking and concentration (Gruetzner, 2001). One of the effects of AD is the patients safety is in jeopardy as the patients tend to wandering aimlessly in worst scenario.

It was reported by Prince et al. (2011), 36 million people worldwide are estimated to be affected by AD. The numbers will double every 20 years to 66 million by 2030 and 115 million by 2050. Low and middle income countries have high increases of AD numbers with 58% and expected to rise

up to 71% by 2050. Malaysia is listed as the middle income country and thus Malaysia is an aging country that has many elderly Alzheimer's patient.

According to Department of Statistics Malaysia (2010), the total population in Malaysia based on 2010 census is 28.3 million. World Health Organization (2012), reported that the elderly aged 60 years old and above make up to 8% of Malaysia's population, and the annual growth rate from 2000 until 2010 of this group was 1.9%. According to World Health Organization (2009), Malaysian life expectancy at 60 years old is 18 years. This means that on average, the elderly can live up to 18 years old.

The prevalence rate of dementia or AD in Malaysia was at 14.3% based on population study of 2,980 people Malaysian communities aged 60 years and over (Hamid et al., 2010). According to World Health Organization (2008), about 28 elderly out of 1,965,462 elderly aged 60 years and above in Malaysia is estimated to have died due to AD and other dementia.

Elderly Alzheimer's patients and their caregivers will encounter extreme challenges as the disease progressively deteriorate with time. Many challenges must be faced such as the cost of AD care. The quality of life such as the ability to socialize with others for both patients and caregivers also diminishes. For the community and the country, the AD is a public health problem that may affect the economy and advancement of the nation.

This enormous public health problem needs to be surmounted wisely. The elderly Alzheimer's patients face many problems and need to be assisted by the caregiver for their life survival. Monitoring the movements of the Alzheimer's patients by the caregiver is very important.

Some Alzheimer's patients are sent by the primary caregiver such as the patient's family members to the Alzheimer day care center for day care to reduce the primary caregiver's burdens. The Alzheimer day care center may have problems with giving close care services to their residents. The day care center cannot always give good and close care services to the residents because the number of day care center personnel are outnumbered by the entire residents in the day care center. So, the crucial measure in helping the caregiver in caring the patient closely is by providing an assistive technology for the caregiver to monitor closed the patients in real time. This is the gap that can be filled and can help to improve the quality of life of the caregiver and the AD patient.

A tracking system meant for real time monitoring in preventing the Alzheimer's day care center residents from danger which can be a solution in reducing these caregiver burdens. The tracking system should be suitable to support the residents and not interfere with the resident's daily routine and privacy.

### **Problem statement and motivation**

Alzheimer's disease (AD) is a public health problem. The elderly Alzheimer's patient will encounter a memory problem that inhibits the patient to live alone. The memory problems will lead the elderly patient to wander about without causes and endanger their life (Faucounau et al., 2009). According to World Health Organization (2008), deaths causes by AD and other dementia is estimated 539,947 people while in the South East Asia region it is about 40,807 people. As the death toll cases by AD is rising, so is the cost for AD

care. It was reported also by WHO (2009), the total expenditure on health per capita for Malaysia in 2009 is USD 677 million and this is 4.8% of Malaysia's gross domestic product.

For Alzheimer's patient survival, the patient needs to be closely monitored by their caregivers. Maybe for one patient, the caregiver can control the situation. But for the outnumbered day care center caregivers, the care would be tough and would be a major burden to the caregivers. The caregiver needs an assistive technology tools to reduce their caregiver burdens in monitoring the residents safety.

### **1.2 Aim and Objectives**

The aim of this study is to develop the ARTLS and implement it at the Alzheimer's day care center. Patient movement data will be analysed to check for conformance and randomness of movements. Our study objectives are as follows.

1. To develop Alzheimer's Real Time Location System (ARTLS) using Active RFID Localization System (ARFIDLS).
2. To understand spatial movement to enhance the monitoring and care management of the residents.
3. To determine the level of suitability of the ARFIDLS in accommodating the Alzheimer patient.

### **1.4 Scope of study**

The study is implemented using existing Active Radio Frequency Identification Localization System (ARFIDLS). The study area is at the

Alzheimer's Taman Seputeh Day Care Center, Kuala Lumpur. Analysis of the AD patients frequency of visits within in the day care center is analyzed.

### **1.5 Outcome of the study**

The Alzheimer's Real Time Location System helps reduce the caregiver burdens. The spatial movement analysis gives benefit to the caregiver in enhancing the care management quality and improving the caregiver and patients quality of life.

### **1.6 Thesis layout**

This thesis is divided into five chapters. The first chapter, Chapter 1 is an introduction of the study. In Chapter 2, a literature review of the AD, RTLS, and Active Radio Frequency Localization System (ARFIDLS) is provided. In Chapter 3, a study methodology for implementation of the tracking system, data collection and data analysis is provided. In Chapter 4, results of resident's spatial movement, data analysis and discussion regarding the challenges during study is provided. Finally, chapter 5 concludes our present work and suggests possible future work.



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