# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## DEVELOPMENT OF A WIRELESS NURSE CALL SYSTEM WITH AUTOMATED FALL DETECTOR USING ZIGBEE

This report is submitted in accordance with the requirements of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Computer Engineering Technology (Computer Systems) with Honours.

by


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Tajuk: DEVELOPMENT OF A WIRELESS NURSE CALL SYSTEM WITH AUTOMATED FALL DETECTOR USING ZIGBEE

Sesi Pengajian: 2018/2019

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**DECLARATION**

I hereby, declared this report entitled DEVELOPMENT OF A WIRELESS NURSE CALL SYSTEM WITH AUTOMATED FALL DETECTOR USING ZIGBEE is the results of my own research except as cited in references.

Signature: ……………………………………
Author : TUAN NURUL AIN BINTI TUAN ABDULLAH
Date:

**APPROVAL**

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours. The member of the supervisory is as follow:

Signature: ……………………………………………….

Supervisor: SHAMSUL FAKHAR BIN ABD GANI

Signature: ……………………………………………….

Co-supervisor: TG. MOHD FAISAL BIN TENGKU WOOK

**ABSTRAK**

Projek ini bertujuan untuk digunakan pada sektor perubatan. Sistem ini dapat digunakan untuk mengenalpasti sekiranya pesakit terjatuh atau memerlukan bantuan, sistem ini akan memaklumkan kepada jururawat secara automatik melalui paparan skrin LCD pada kaunter jururawat. Selain itu, jururawat juga dapat memeriksa rekod kejatuhan pesakit melalui maklumat yang direkod pada laman sesawang. Sistem ini terdiri daripada alat pengesan, peranti kawalan, skrin LCD dan laman sesawang . Kejadian jatuh akan dikenalpasti menggunakan alat pengesan yang dilekatkan pada pesakit. Seterusnya peranti kawalan akan menghantar isyarat kepada alat keluaran yang akan memaparkan nombor katil pesakit pada skrin LCD dan segala isyarat kecemasan yang dihantar kepada peranti kawalan akan direkod pada laman sesawang. Jika pertolongan dapat dihulurkan secepat yang mungkin kepada pesakit, kemungkinan besar pesakit tersebut akan terselamat daripada kecederaan yang mungkin akan mengorbankan nyawa.

# ABSTRACT

This project is designed for use in the medical sector. This system can be used to identify if a patient accidently falls, this nurse call system will inform the nurse automatically. In addition, nurses can also identify the patient's falling record through the website. This system consists of a detector, control device, LCD screen, and website. Falling events will be identified using the sensor and the control device will send the output signal to the LCD display. Next the web site will record all emergency signals sent to the control device. If help response can be issued to the falling person as soon as possible, there is a high chance that the patients will not suffer serious injury thus saving his or her life.

## ACKNOWLEDGEMENT

First and foremost, Thankful to Allah swt, because I can finish my PSM this semester successfully and I would like to express my sincere gratitude to my project supervisors, Mr. Shamsul Fakhar Bin Abd Gani for his continuous guidance throughout the project and help me in completing my degree final year project. I would like to thank him for his contribution to my project by sharing me with his experience on how to handle the project and how to do research on topics that related to my project. He has shared me with his knowledge and helped me throughout the process of developing the project. He provided me an opportunity to explore to more technological knowledge by using technology device in my project. He has also provided me suggestion when faced difficulties in doing the project. Besides that, he has helped me in dealing with critical situation and problem solving. Without his guidance and encouragement, this project might not be able to be completed on time. Thank you so much for his contribution.

I would also like to thanks to all my friends who has supported me throughout the process of implementing my final year project. Thank you for their encouragement and support through all the ups and downs during the process of completing this project. Besides that, I would like to thanks to my family for supporting me all the way. Lastly but not least, I appreciated all the help and thanked you so much.

# DEDICATION

Special dedicated to my beloved parent, siblings and friends who give me encouragement and support to help me in completing my final year project successfully. My supervisor, Mr. Shamsul Fakhar Bin Abd Gani also gave me a lot of guidance throughout the project implementation. Thank you.

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## LIST OF ABBREVIATIONS , SYMBOLS AND NOMENCLATURES

| | | |
|---|---|---|
| GHz | - | GigaHertz |
| HTML | - | Hypertext Markup Language |
| IEEE | - | Institute of Electrical and Electronics Engineers |
| IP | - | Internet Protocol |
| LCD | - | Liquid Crystal Display |
| LED | - | Light Emitting Diode |
| MB/s | - | MegaByte per second |
| MEMS | - | Micro-Eletro-Mechanical Systems |
| PHP | - | Hypertext Preprocessor |
| PWM | - | Pulse Width Modulation |
| RFD | - | Reduced Function Device |
| SQL | - | Structured Query Language |
| USB | - | Universal Serial Bus |
| VoIP | - | Voice over Internet Protocol |
| WEP | - | Wired Equivalent Privacy |
| Wi-Fi | - | Wireless Fidelity |
| WLAN | - | Wireless Local Area Network |
| XAMPP | - | Cross-Platform (X), Apache (A), MySQL (M), PHP (P), Perl (P) |

# CHAPTER 1
# INTRODUCTION

## 1.0 Project Background

This nurse call system was automatically recording all emergency information related to the patient. and it has been affected the time and date of the emergency. Each patient was pressed the emergency button in case of an emergency but if the patient falls and is unable to press the emergency button, the detector was detected the condition of the patient and inform the nurse automatically. Furthermore, any information received will be recorded on the website for future referrals by nurses. However, Studies have shown, the previous system was designed, and the system was only able to detect the downfall after it had occurred, and the system would send an alarm to the caregivers. Although acknowledging that the fall tracking system can help the victim, the best way to reduce the fall victim and consequently is to prevent it from happening (Majumder 2016). Technology that is available today has the capability to allow the nurse to monitor patient's condition via web updated and it can detect the fall as soon as possible. Therefore, the development this system is capable to relieve patients from suffering serious injury thus saving his or her life and can help in analyzing the records of each patient's fall. Although this system cannot prevent the victim from falling, it will reduce the time taken for the victim to receive treatment and minimize the risk of serious injury.

## 1.1 Problem Statement

Currently, the system of nurse call is working manually. Normally, the patient needs to press the emergency button to inform the nurse. Furthermore, assistance from nurses based on the bell pressed by the patient and the nurse is also responsible for recording the time the fall occurred to the patient, this causes the nurse to make the assumption of the fall of the incident occur without knowing the real time. Then, the nurse should check the condition of the patient by walking from one bed to another to ensure that the patient is always safe. The manual system is made hard and took a lot of time to nurses and patients. At the same time, the head of the nurse also needs to determine the condition of each patient by asking the nurse at all times. It will make them wasting time to always keep track of all the information that happens to every patient.

## 1.2 Objective

- To develop a nurse call system with fall detector sensor capable of sending a notification wirelessly to the nearby nurse system.
- To develop an online database that stores call or fall history received from the system.

## 1.3 Scope of Project

The scope of this system is to develop the system for the transmission of data from ward to nurse center using XBee ZigBee wireless module and assuming the distance between ward and nurse center is not more than 100m, this is because the transmitter range for this XBee module is not more than 100m on indoor area.

# CHAPTER 2

# LITERATURE REVIEW

## 2.0 Introduction

In order to make this project successful, some studies and research have been consulted to find the relevant information about the development of fall detectors from a few generations and what are the suitable devices that can be used and has a potential to improve in the future. Therefore, the appropriate switch selection will be carried out. Then, the ZigBee wireless protocol will be reviewed evaluated and compared with another wireless module. Next, different Arduino usage with working principles will be differentiated. All studies and information collected are based on the main components and topics related to this project. Information obtained is collected from several sources such as articles, journals, and the internet. All this information is used in this project as a guide to ensure that the project developer process is working smoothly and can be done within the specified timeframe.

## 2.1 Development of a fall detector system

This paper discussed the improvement of development fall detector from a few back generations by comparing benefit and weakness of systems used for each generation and It was categorized into three groups of generation:

- First-generation system
- Second-generation systems
- Third-generation systems

### 2.1.1 First-generation systems

According to Ward *et al.* (2012), first-generation systems is a fall detector that totally depends on a patient by raising an alarm to detect a fall through pulling a cord or press button. But this system is not suitable for use because it relies on the user to track the downfall. The system is known as a "Community alarm" used as a small device that worn as a pendant around the neck, and its cost is very effective for health and social care services. Unfortunately, with the use of this system, it can cause a serious injury to the patient. This is because, it is impossible if the person is unconscious or unable to reach the alarm when they fall.


Figure 2. 1: First-generation system for nurse call

### 2.1.2 Second-generation systems

The second generation is an improvement from the first-generation systems that comprise fall detection devices and lifestyle monitoring systems that is Intelligent devices based on accelerometers. So that the patient does not have to rely entirely on the emergency button to get help.

It is useful for collect data on the user's normal gait and activity to inform alerts regarding falls detecting with high sensitivity and specificity rate. But, It also difficult to find the right algorithm to achieve this balance, This is because of an overlap in the degree of acceleration associated with falling and the degree of acceleration associated with normal activities of daily living, such as sitting down abruptly (Chen *et al.* 2005; Ward *et al.* 2012)


Figure 2. 2: Second-generation systems for fall detector

#### 2.1.2.1 Automatic Fall Detection System Based on Combined Use of a Smartphone and a Smart watch

Next, Casilari and Oviedo-Jiménez ( 2015) has highlighted on usage of a single element . This paper discussed the used of additional devices to through research on the fall detection system that benefits from the detection done by two popular personal devices: Smartphones and smart watch that is used to tracks and analyses the patient's movements. Then, the development of this system shows that the Android application developed for fall detection algorithm is quite different from the previous technology, which considering the fall only if it is simultaneously and independent tool detected by the two Android devices (which can interact via Bluetooth communication).

Through the use of wearable devices (Smartphones and smartwatch) that capable of functioning as a direct detector tool by measuring physical variables that display user movements without relying on limited zone monitoring specification. Then, the use of smartphones as one of the devices that joining the Smartphone for the fall detection system is the best way to improve the ergonomics of the system and the range of built-in acceleration.

The experiment was done by simulation of three types of fall that is through the fall of the front, side and back. Through all the tests that have been made, smart watches are worn on the right wrist while the smartphone is in the pocket of the pants on the right thigh.

Based on the investigation, it is shown that a poor specificity of 60% is accomplished by depends based whether on Smartphone or smart watch, but by utilizing both devices, it appears that the range of the specificity framework for the four analyzed calculations has expanded 5–15%. This improvement is accomplished based on the moderate decrease in the sensitivity of fetch. The reality that wrong positives recognized can be clarified by one device is neutralized by the correct identification of the other Android device.

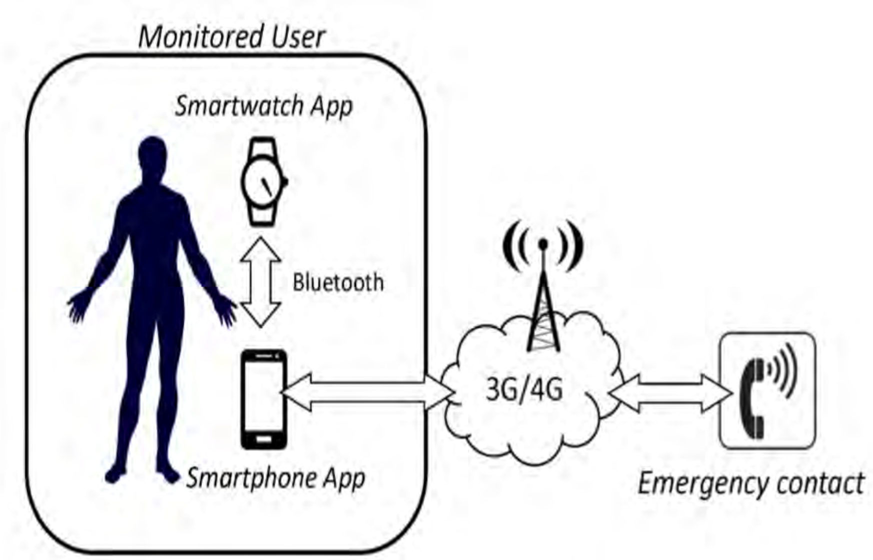


Figure 2 .3: Basic Architecture of the Fall Detection System (Casilari and Oviedo Jiménez 2015)

Table 2 .1: Results using only the Smartphone to detect the falls (Casilari and Oviedo-Jiménez 2015)

| | Sensitivity | | | | Specificity | | | |
|---|---|---|---|---|---|---|---|---|
| | Type of Fall | | | | Type of ADL | | | |
| Algorithm | Forwards | Backwards | Lateral | Global | Walk | Sit/Stand | Other | Global |
| Basic Threshold | 100.0% | 100.0% | 90.0% | 96.7% | 100.0% | 90.0% | 60.0% | 83.3% |
| Fall Index | 80.0% | 100.0% | 100.0% | 93.3% | 100.0% | 100.0% | 60.0% | 86.7% |
| Two-phase | 100.0% | 90.0% | 90.0% | 93.3% | 90.0% | 100.0% | 80.0% | 90.0% |
| iFall | 90.0% | 90.0% | 100.0% | 93.3% | 100.0% | 100.0% | 80.0% | 93.3% |

Table 2 .2: Results using only the smart watch to detect the falls (Casilari and Oviedo-Jiménez 2015)

| | Sensitivity | | | | Specificity | | | |
|---|---|---|---|---|---|---|---|---|
| | Type of Fall | | | | Type of ADL | | | |
| Algorithm | Forwards | Backwards | Lateral | Global | Walk | Sit/Stand | Other | Global |
| Basic Threshold | 100.0% | 90.0% | 80.0% | 90.0% | 100.0% | 100.0% | 70.0% | 90.0% |
| Fall Index | 90.0% | 100.0% | 100.0% | 96.7% | 100.0% | 80.0% | 60.0% | 80.0% |
| Two-phase | 100.0% | 90.0% | 100.0% | 96.7% | 100.0% | 100.0% | 80.0% | 93.3% |
| iFall | 100.0% | 100.0% | 90.0% | 96.7% | 90.0% | 100.0% | 80.0% | 90.0% |

Table 2 .3: Combination of Smartphone and smart watch (Casilari and Oviedo-Jiménez 2015)

**Table 1. Combination of smartphone and smartwatch.**

| | Sensitivity | | | | Specificity | | | |
|---|---|---|---|---|---|---|---|---|
| | Type of Fall | | | | Type of ADL | | | |
| Algorithm | Forwards | Backwards | Lateral | Global | Walk | Sit/Stand | Other | Global |
| Basic Threshold | 85.0% | 70.0% | 80.0% | 78.3% | 100.0% | 100.0% | 80.0% | 93.3% |
| Fall Index | 95.0% | 90.0% | 90.0% | 91.7% | 100.0% | 95.0% | 80.0% | 91.7% |
| Two-phase | 95.0% | 90.0% | 90.0% | 91.7% | 100.0% | 100.0% | 100.0% | 100.0% |
| iFall | 100.0% | 95.0% | 95.0% | 96.7% | 100.0% | 100.0% | 95.0% | 98.3% |

Table 2 .4: Number of false positives detected after 24 hours continuous monitoring (Casilari and Oviedo-Jiménez 2015).

| Algorithm | No. of false positives |
|---|---|
| Basic Threshold | 5 |
| Fall Index | 4 |
| Two-phase | 2 |
| iFall | 4 |

One of the important aspects that need to be emphasized when using Android as one of the fall detectors is power consumption. But, power is obtained through the use of batteries on the devices. Fixed calculation of the algorithm or continuous reading of embedded sensors can lead to running out of battery in wearable devices, it makes the system impractical in tracking peripherals. Evolution capabilities for Smartphone's and smart watches have been detected in the diagram below. both devices are fully charged at first and their status is periodically checked for monitoring throughout the process without running other applications.

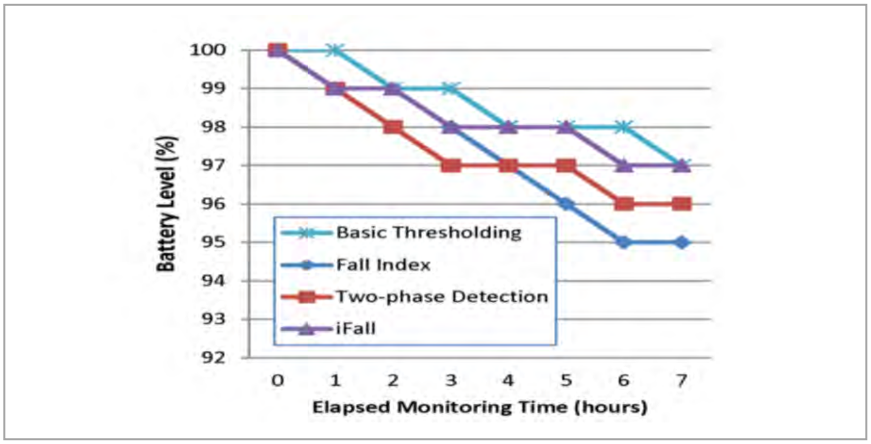


Figure 2. 4: Evolution of the battery level in the Smartphone (Casilari and Oviedo-Jiménez 2015).

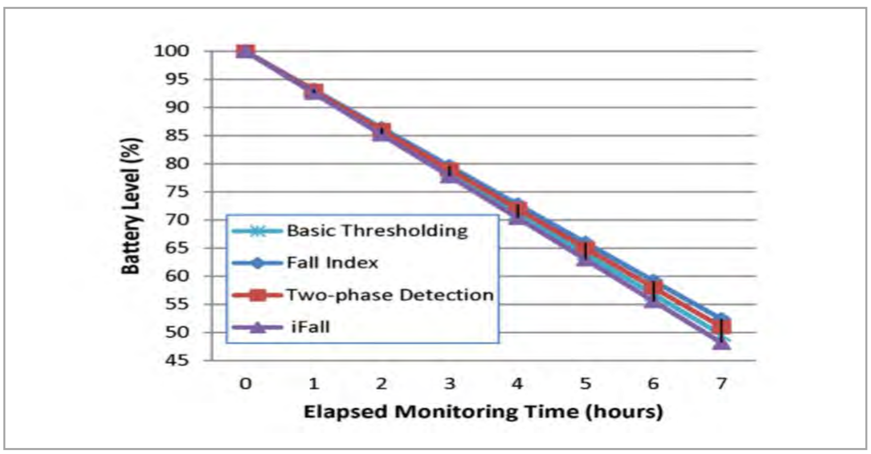


Figure 2. 5: Evolution of the battery level in the smart watch (Casilari and Oviedo-Jiménez 2015).