UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DEVELOPMENT OF FALL DETECTOR USING ARDUINO THROUGH GSM FOR HEALTH CARE USE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Electronic Engineering Technology (Telecommunications) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for degree of Bachelor of Electronic Engineering Technology (Telecommunications) with Honours. The member of supervisor is as follow :

....
(PUAN SITI ASMA BINTI CHE AZIZ)

ABSTRAK

"Development of Fall Detector using ARDUINO through GSM for Health Care Use" adalah salah satu sistem pengesan di mana ciptaan baru yang boleh digunakan oleh semua lapisan masyarakat, terutamanya bagi orang kurang upaya atau warga tua. Kejadian jatuh boleh menyebabkan trauma, kecacatan dan kematian jika tanpa disedari dengan cepat. Sebelum ini, pelbagai penyelesaian pengesanan kejatuhan telah dicadangkan untuk mengurangkan kes itu. Ia digunakan untuk mewujudkan satu sistem pengawasan dipercayai untuk orang tua dan orang kurang upaya dengan keperluan yang tinggi dari segi ketepatan, spesifikasi dan sensitiviti. Dalam projek ini, sistem pengesanan jatuh dipertingkatkan adalah dicadangkan untuk memantau orang tua dan kurang upaya yang berdasarkan pecutan dipakai pada pergelangan tangan pesakit. Konsep ini adalah untuk mempunyai sistem pengesanan kejatuhan yang menghantar SMS untuk memberitahu dan orang berkenaan yang menjaga atau ke doktor pada masa kemungkinan. Mesej menghantar menggunakan Sistem Global untuk Komunikasi Mudah Alih (GSM) dan melaluinya kejatuhan boleh dikesan secara tidak sengaja dalam persekitaran penjagaan kesihatan rumah dengan pemantauan pecutan. Postur badan berasal dari perubahan pecutan dalam tiga paksi yang diukur menggunakan enam paksi pengesan (MPU6050). Dengan menggunakan maklumat yang diperolehi daripada pecutan, kesan jatuh boleh dikesan dengan membezakan dari aktiviti harian dan jatuh sebenar. Nilai pecutan dalam setiap paksi berbanding ambang dan juga melambatkan 10 saat untuk mengurangkan penggera palsu. Algoritma sistem ini dilaksanakan oleh Arduino Nano. Pengesanan jatuh diprogramkan untuk mengesan badan secara berterusan. Semasa pengesanan jatuh, peranti menghantar mesej berbentuk teks melalui modem GSM, dan berkomunikasi kepada telefon pintar.

ABSTRACT

"Development of Fall Detector using ARDUINO through GSM for Health Care Use" is one of the detector system where new creation that can be used by all levels of society, particularly for disable people or elderly. Fall incidents can cause trauma, disability and death among older and disable people if unnoticed in time. Various fall detection solutions have been previously proposed in order to reduce the case. It is used to create a reliable surveillance system for elderly and disable people with high requirements on accuracy, specification and sensitivity. In this project, an enhanced fall detection system is proposed for elderly and disabled person monitoring that is based on accelerometer worn on wrist of the patient. The concept is to have a fall detection system which sends SMS as to notify and concerned people in charge or to the doctor at the time of eventuality. The message send using Global System for Mobile Communications (GSM) and accidental falls can be detected in home healthcare environment with the monitoring of accelerometer. The body posture is derived from the changes of accelerometer in three axes which is measured using 6 axis sensor (MPU6050). By utilizing information gathered from an accelerometer, the impacts of falls can be logged and differentiate from the normal daily activities. The accelerometer values in each axis are compared with threshold and also delay of 10 second to reduce the false alarms. Algorithm of this system is executed by Arduino Nano. Detection of fall is programmed to trace the body continously. During the detection of fall, the device sends a text message through GSM modem, and communicates it to the mobile phone.

DEDICATION

Alhamdulillah, praise to the Almighty Allah S.W.T

This thesis is dedicated to:

My beloved parents Wan Mohammed Azmi bin Md Saman and Azizah bt Che'Man. To my brothers and sisters Wan Mohammed Affiq, Wan Mohammed Adsyraf, Ainnur Mardhiah and Ainnur Maisarah. A big appreciate to my supervisor, Madam Asma Binti Che Aziz, my lecturers, my friends, Ifwat Izzati binti Muhammad Amru, Nur Amiera Ashraf binti Abdul Razak, Nor Farhana binti Asir, Nur Anis Farhana Binti Rashid, Nurfarah Izzati binti Ismail, Nur Farhana Intan Suhaila binti Rizalman, Siti Nur Shahira binti Shapri, Muhammad Zhariff bin Asri and all my friends.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

Al	-	Aluminium
ANOVA	-	Analysis of Variance
ASEAN	-	Association of Southeast Asian Nations
AT	-	Annual Turnover
CDC	-	Centers for Disease Control and Prevention
F	-	F Test (ANOVA)
FMM	-	Federation of Malaysian Manufacturers
GSM	-	Global System for Mobile Communication
GPS	-	Global Positioning System
IT	-	Information Technology
IDE	-	Integrated Development Environment
LU	-	Least Used
MEMS	-	Micro-Electro-Mechanical-Sensor
MU	-	Moderately Used
NOYP	-	Number of Years in Operations
SMS	-	Short Message Service
WHO	-	World Health Organization

CHAPTER 1

INTRODUCTION

1.0   Project Background

In advanced era, human use of technology to make life easier and faster in long distance and short in time. This project of " Development of Fall Detector using Gsm for Health Care Use" is the project that use the technology in telecommunication system. The evolution in telecommunication that apply in this project is GSM. A combination of software and hardware such as circuit is use to operate this project. Normally, the fall detector system has a few type with same function as to detect the fall events. However, mostly fall detector system is link to telecommunication technology. By referring on few research and literature review, the intention wants to develop the simplest fall detector system as it can successful functionable among user. In this project, few main component and circuit are used, for instance like an accelerometer. Accelerometer is one of component that use to complete the project. It can calculate and measure the static acceleration of gravity in tilt-sensing of the user application. It is also resulting from the fast motion, shock or vibration. Arduino system is an open source electronic prototyping platform that enable which based on easy to-use hardware and software. This system has an own a software to setup to run the program. The Arduino will function after receiving the data from accelerometer. In that time, automatic Arduino sent the hint and signal to GSM and buzzer. All component active if the person in charge turn ON the activated button. After that, GSM notification also included in the system. GSM used to sent the message to user to inform the about falls situation in time. Last component that used is buzzer. The push button will operate automatically after arduino has sent the hint to GSM. Thus, the person in charge or medical staff is notified.

1.2   PROBLEM STATEMENT

There is difficulty when your loved one falls. According to Centers for Disease Control and Prevention (CDC) by Goh Yongli et al.(2012), one out of three adults age 65 and older fall each year. According to World Health Organization (WHO) (2017), falls are the second significant cause of accidental or unintentional injury deaths world wide and also about 37.3 million falls that are serious injured reported to medical attention occur every year. This unfortunate event occur due to unable to press the medical alert button to call for help. This is where Fall Detection comes in to help patient. Moreover, the time taken for the medical staff to help the patient is long will lead to critical situation also one of the serious problem. Time is one of the key factors that determine the severity of a fall. Many older fallers are unable to get up again without assistance and any subsequent long lie can lead to another dangerous disease.

Another possible trouble could be false detection. These can occur if there is a sudden movement and then user perhap s lays down or sits in a chair without any futher movement. As results, medical staff will come without nofity it was a false detection. Therefore, improvement of this project will make the medical staff or the person in charge aware to the right situation.

Besides, all sensors have their limitation in detection. As sample, accelerometer detects the changes of velocity of movement. In order to detect the falls, it may not detect the accurate reading during the fall event. Therefore, a combination with MEMS gyroscope and accelerometer are a better way to detect falls.

Another problem for this system is data obtained from both sensor might be complex. It is can be major issues because the data obtained as the level of accuracy can be used to detect fall signals. Different types of sensor component might detect different reading of fall also depends on instruction or command apply in every microcontroller software that used.

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1.3 OBJECTIVES:

This project will accomplish according to the criteria of objective;

   i.   To study and understand the operation of Fall Detector system that involves GSM, accelerometer, gyroscope and ARDUINO Nano.

  ii.   To analyze the measurement of accelerometer that detect the falls

 iii.   To design and develop the Fall Detection System using GSM in health care field.

1.4 SCOPE OF PROJECT

This project will focus on the development of fall detection algorithms and their implementation in Arduino programming language for upload onto the Arduino Nano board. It will also examine the programming used on the laptop computer until to successfully establish a connection. Then, it communicate with the device. Fall detector device is a wearable device which defined as electronic sensor that must be worn by user at under or top of clothing. About 90 % of the systems are in the used for of accelerometer devices. Moreover, the hardware choice and decisions based on the which accelerometer, GSM component and peripherals to use in the device will be looked at. This project will be marketed at hospital and in medical industry. It also can be market in all farmacy outlets.

1.5 PROJECT OUTLINE

In this part, the project outlines will explain in detail about the content. It is organized according to several chapters, chapter 1, 2, 3, 4 and 5. There are involved Introduction of the Project, Literature Review, Methodology, Results and lastly Conclusion. It is arrange in order to make it more structured and clearly.

Chapter 1

In this chapter,the content is about the explaination on overall project concept in introduction. This chapter will interpret about the Project Background, Problem Statement, Objectives and the Scope of the project. Chapter 1 is as a guideline for the project to be done in a duration of time.

Chapter 2

This chapter is about the Literature Review. It is covers the previous studies, finding and researchers that related to this project. The explaination of theory, application features and specification of the equipment will be disscussed use in this chapter. Mostly, it is based from the information that used inside the researchers and references also included to prove it is from relevent sources.

Chapter 3

In this chapter, the methodology part will be discuss. In methodology part, all steps, methods,project flow chart of planning project process, project flow chart of project process, and block diagram. This chapter is include the way on how to design the project. The project process on how the project operate also will be discussed in this chapter.

Chapter 4

This is the important part which is the result part. The results are divided into two; the simulation and experiment. As for simulation, it is use Arduino software Proteus software. Both results will be purpose in this chapter.

Chapter 5

It is a Conclusion part as the last chapter in this project. This chapter concludes overall of this project fall detection. The conclusion related to the result obtain from the previous chapter. This chapter also will compare to the Objectives of the project whether the project able to accomplish or not. Moreover, this chapter include the discussion about recommendation for future work, results and innovation of the project from the rsearchers.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A brief study or research based on literature review has been conducted for understanding the limitations of the development of fall detector using GSM for health care use. A paper on developing fall detector has been presented in where the fall detector would detect the fast or sudden movement of user. In this chapter, the theory and concept are about a fall detector and it is related to the technology in telecommunication by the evolution of GSM. The literature review also will explore, collect and gather the information on some similarities and comparison between the available researches, studies, project and devices that using the technology telecommunication. In addition, literature review will discuss on the selected equipment compare to others and the reasons. Detailed literature review gives us four types approaches to detect fall namely: wearable accelerometer, gsm, combination of gsm and arduino. It is the work on starting process to induce the ideas about the projects. It is also provide extra understanding, important and valueable information.

2.1.1 Impact of Falls

Fall is an event where suddenly go down onto the ground or towards the ground without intending to or by accident. Falls can occur even at home, outside and also in hospitals. Thus, unintentional fall are rapidly throughout the ages and have been the common factor of critical injuries especially for the erlderly society. Increase in numbers of patients leads in difficulties of manual

monitoring by medical staff or the person in charge. Thus, the probability of patient to fall is high. Falls can lead to fatal because of head injuries and also due to not being treated in time. It is not only causing physical damage but also psychological trauma.

According to David McCullough (2014) in health- medical report said that 35% have fallen in the last two years and 32% of them living alone while suffering fall in last year. Lack in confidence is one of the impact that goes beyond the physical. Over 21% of older people who had suffered a fall have lost in confidence with 10% saying they are currently less independent. However, after the patients or elderly had experienced fall, it brings trauma to themself. Thus, it leads to negative effect and lower quality of life. Therefore, fall detector system is develop in order to reduce the fall incidence.

2.2.2   Fall Detection System

Detection system is similar to a security system. The fall detection system using the concept of monitoring system and detect to respond if any fall incident. The monitoring system is among the applications that need electronic surveillance that is provided in interior and exterior section of detection sensors.

According to Yoosuf Nizam et al.(2016), this system will clarify the activities of human on daily life to identify an unintentional fall. The authors are implement various sensors and techniques to differentiate between daily activities and during human fall. The system also using four significant interacting function such as delay, detect, alert and respond. In this project which fall detection system, develop by using gyroscope and accelerometer The objective of using both sensors is to know the position in three axis, x,y,and z axis of the people who is falls down. When a fall is detected, the system automatically initiates a message to the medical assistance as a kind ask of help is needed. The device is place around wrist as the shown in Figure 2.1 below.

Figure 2.1 : Wrist band fall detector.

(Source:http://www.assistivetechnologyservices.com/falldetectionfalla lertmandownalert.html)

Another study by Graciela E et al. (2016) on IoT fall detection system for elderly using Intel Galileo Development Boards Generations. The authors used a system oriented IoT development which can acquired by the low income population. However, in certain area which unpresence of coverage, IoT unable to use. That is the reason why the project is GSM application of SMS.

2.1.2.1 Categories of people that suitable to use fall detection system

Fall detector suitable for elderly, heavily disabled, patient with diabetes,traumatic brain injury congestive heart failure, stroke diseases and many disease that they need to wear wheelchair. Fall detector system as a medium for a greater personalisation of medical care and one size fits all approach.

2.2 Fall Detection Involving Wearable Devices

Wearable technology plays a crucial role in today's healthcare transformation. It is being bought to the patient, whenever he or she is, rather that patient having to visit hospital or in home. During the innovation of wearable device, it is design to be small and portable. In this case, it is open a new path to traditional ways providers have direct interacted with patients, performed tests, collected data and deliver back to

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patients. The smaller the device is the easier for the patient to handle it. There are many forms of wearable device. For instance, waistbands, watches, shirts, shoes,shorts cap, headband, eyeglasses, necklaces and belt. However, in this project, the choosen wearable device is wrist band. The wearable device based approaches apply on accelerometer to detect the shock, motion and vibration. In the following, shows the summarization based on rearchers, article, journal and trusted sorces about accelerometer, gsm, arduino and smartphone. Based on Delahoz and Labrador (2014) clasify that wearable sensors are an alternative to external sensing. In fall detection, wearable device is attach to a subject of interest (SOI)'s body, and by removing the space limitation imposed by external sensing. According to authors, accelerometers are a suitable type of wearable sensors that are widely used in fall detection systems. Beside they are cheap, accelerometers also can be worn on different parts of the body. It has a benefits in fall prevention system. From the collected data, different motion characteristics are extracted, which used estimate the likehood of a fall and alert the user in real time.

2.2.1 Accelerometer

Technological evolutions have produced devices that able to measure human activities using accelerometers. The acceleration is measure in g- force. During rest, a device has 1 g of upward forced exerted on it in position of lying on surface. This is also indicates 1 g downwards force exerted by Earth's gravity. Meanwhile, it is register 0 g as in rest position since it is at zero acceleration. According to J. M. Broderick et al. (2014), accelerometer major in measuring the magnitude of body's acceleration. It is to provide data in terms of counts per unit time.

Accelerometer can be measured in one plane called uniaxial, two planes called biaxial or three (triaxial) planes. Accelerometers are usually placed as close as possible to the body's centre of mass or on the hip in the mid-axillary line. The newer accelerometer with a number of attachment options such as at the wrist, waist and ankle. In this project, accelerometer is attached at the wrist in order

to measure the acceleration of user. It is a large scale method implemented or measuring physical activities to observe the patients activity criteria.

L. Ren et al. (2012)   implement and designed a mobile fall detection prototype with significance on energy efficiency. The authors discuss and state that the system able to operate for approximately in one month using AA batteries (1500mAh). The author also discuss about the proposed portable system consists of a tri-axial accelerometer, a microcontroller and a ZigBee radio module. According to ZigBee protocol, the communication range is limited and in order to send the alarm signal to a remote detectoring center. It is because the wireless communication is used. Therefore, fall detection algorithm of author's project had reached the accuracy rate used was 96.25%.

The application of accelerometer device   is in mobile devices. It is installed and implement in mobile phone such as iPhone and Android devices. Therefore, it able to detect acceleration in terms of x,y and z axis. Figure 2.2 illustrates how the three axis orientation of an iPhone.

Figure 2.2: The orientation of x,y and z axis orientation based smartphone.

(Source:

https://books.google.com.my/books?id=tS7rZTpKOFYC&pg=PT250&dq=application+of+accelerometer&hl=en&sa=X&ved=0ahUKEwjswMT_vO7TAhWGwI8KHWdjDmoQ6AEIPDAE#v=onepage&q=application%20of%20accelerometer&f=false)