



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FALL DETECTION AND ALERT SYSTEM FOR HOME ALONE ELDERLY

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

by

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DECLARATION

I hereby, declared this report entitled “FALL DETECTION AND ALERT SYSTEM FOR HOME ALONE ELDERLY” is the result of my own research except as cited in references.

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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 the degree of Bachelor of Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Pada masa kini, terdapat banyak kes-kes warga emas yang hidup sendirian di rumah tercedera dan sebahagian daripada mereka mati di tempat kejadian kerana terjatuh dan tidak sedarkan diri tanpa pengetahuan sesiapa. Oleh kerana penuaan pesat penduduk, banyak penyelesaian untuk penjagaan warga emas yang sendirian di rumah sedang dibincangkan. Laporan ini membentangkan satu pendekatan untuk mengesan keadann jatuh dengan Arduino mikropengawal, Sistem Global untuk Komunikasi Mudah Alih (GSM) dan sensor pecutan. Dalam projek ini, pengguna memakai tali pinggang di mana semua sensor dan pengawal mikro melekat pada tali pinggang dan keadaan jatuh boleh dikesan dan dimaklumkan penjaga dengan menggunakan GSM. Ini mbolehkan ia untuk mengesan keadaan jatuh sebenar supaya tindakan segera boleh diambil oleh pengasuh. Beberapa keadaan jatuh telah diuji untuk menganalisis keadaan jatuh. Selain hanya mengesan keadaan jatuh, projek ini boleh memberitahu penjaga warga emas atas keadaan warga emas trsebut.

ABSTRACT

Nowadays, there are many cases of home alone elderly get injured and some of them died on the spot due to the unnoticeable condition of falling event. Due to the growing population of the elderly, many solutions to overcome this problem are being developed. This report presents an approach to fall detection with Arduino microcontroller, Global System for Mobile Communication (GSM) and accelerometer sensor. The developed device is designed as a belt. The system consists of the fall sensor and microcontroller attached to the belt and the falling events can be detected and notified the caregiver by using the GSM. This makes it possible to detect real falling event so that instant action can be taken by the caregiver. Few possible falling events were tested to analyze the condition of the falling events. Instead of only detecting falling events, this project manages to notify the caregiver of the home alone elderly of the elderly falling conditions.

DEDICATION

Special dedication:

To my beloved parents, Mr. Ismail Mohd Nasir and Mrs. Nik Norhayati Nik Hassan who always motivate me along the time period in finishing this project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

GSM	Global System for Mobile Communication
IDE	Integrated Development Environment
ADC	Analogue to Digital Converter
IC	Integrated Circuit
CPU	Central Processing Unit
LED	Light Emitting Diode
PWM	Pulse Width Modulation
USB	Universal Serial Bus
AC	Alternating Current
DC	Direct Current
Wi-Fi	Wireless Fidelity
AT	Attention
SMS	Short Message Service
MMS	Multimedia Message Service

CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, there many people with high education that leads to the development of modern technologies or devices. These developments are beneficial to the general public in their everyday life. These developments can be divided into many aspects and one of the most important aspects is communication. Technology in communications has been used widely all over the world to contact people, share information or any other actions that can connect people even in long distance.

The idea of this project is to use communication with the help of GSM (Global System for Mobile Communication), Arduino and accelerometer in improving home alone elderly monitoring. GSM was developed as a technology that improves quality, productivity, costs, environment protection and working conditions. The widespread availability of miniature wireless sensor devices that can sense their surrounding and wirelessly communicate with the rest of the world is generating tremendous interest in it.

Arduino is a Microcontrollers Development board where editing, developing and changing the program on the microcontroller can be done. There are many types of Arduino cards. The Arduino types such as Arduino Uno, Arduino Mega, Arduino Nano, Arduino Mini, Arduino Lilypad, Arduino Demulive and Boarduino. Each type differs in numbers of terminals on the control system, microcontroller type, and processing speed.

This project uses Arduino Uno as the microcontroller as it has an optimum specification. The processing speed is 16MHz, operating voltage of 5V, input voltage in the range between 7V to 12V and regular USB. Also, the price of Arduino Uno is no too excessive. Accelerometer can be used in many ways. For example, accelerometer had been used in vehicle where it is fitted in the vehicle in order to detect accidents and sends the accident location to a main server which maintains and searches the database of all nearby hospitals. The nearby hospitals can take action by sending ambulance to the accident spot and carries the patient to hospital.

Combining GSM, Arduino and accelerometer in this project can develop a new device that can detects falling event of home alone elderly and send information to the caregiver so that the caregiver can take action.

1.2 Problem Statement

This section explains on the problem statement relating with this project. Aging people face many problems especially when they are home alone. There are cases related with elderly injured or even died when they are home alone without anyone noticed them. When they are alone by themselves, if they fall due to specific factor, they might not able to get back on their feet. So, they are not able to get help.

In hospitals, there are nurse emergency buttons in each patient room that can help patient to notify the nurses when they need help. This is how the patient interacts with the nurse in hospital so that the nurse can monitor the patient well. Once the button is pressed, the light that indicates the patient's room will light up. So, the nurse can take action by going to the patient's room to check the patient. Besides the nurse emergency button, in certain hospitals there are also intercom system so the patient can talk directly to the nurse what they need or what is their problem.

But, the problem that leads to the idea of this project is that the nurse emergency button or intercom system in hospital only installed on the patients bed and beside the

toilet bowl in the restroom. The use of the button might be limited in some situation such as when the patient falls and cannot get back on their feet. In this situation, the emergency button might be too far to reach by the patient. When the button is not pressed, how come the nurse able to take action or check on the patient? If the same system installed at home to be used by home alone elderly, the consequence is the same. The problem can be solved by using a real time monitoring system. This system can notify the caregiver such as family members or neighbors as soon as the person falls to the ground. This type of system can improve home alone elderly monitoring. This project highly related with the real time monitoring system by using the accelerometer, GSM and Arduino.

1.3 Objective

The objectives of this project are:

1. To study available fall detection system.
2. To design a device for fall detection and alert system for home alone elderly.
3. To develop the system using Arduino, accelerometer and GSM.

1.4 Work Scope

This section explains about the scope of work for this project. In order to achieve the project's objective, GSM is used to send notification or SMS (Short Message Service) to the caregiver on the location where the patient falls. In order to receive the message, the accelerometer must detect the force applied with specific threshold. The threshold can be programmed by using Arduino which this project used Arduino Uno as the microcontroller card and also act as the medium to link the accelerometer to the GSM. Once the accelerometer detects the threshold of the falling event, the Arduino will program the signal detected and send information to the GSM so that the GSM can send short message to the caretaker on where the patient falls.

1.5 Report Organization

For Chapter 1 which is the introduction explains project background, problem statement, and objectives of project, project's scope and the importance of this project. For Chapter 2 which is the literature review covered the literature review and citation about any information that related to this project from any references. In this chapter, the citation about analysis of equipment also is included. For Chapter 3 which is the methodology, covered more detailed explanation of this project. Also, this chapter gives information of process flow in this project. For Chapter 4 which is the result expectation, explains about the result of this project accompanied by several analysis. For Chapter 5 which is the conclusion, covered the conclusion based on overall process that happened in this project from start until end of this project followed by future recommendations of this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Falls are serious problem these days especially for elderly that lives alone. It can be the major cause of death as they fall without any witness around them. Early detection is important in order to alert and protect the elderly from serious injury due to fall. In this chapter, the literature review related to elderly falling cases, existing fall detection system and the hardware that suitable to run the fall detection system.

2.2 Overview of Elderly Fall Risk Factor

There are several factors that leads to the falling event such as aging, mental impairment, neurological and orthopedic diseases, vision and balance disorder. In other aspects, the factor can also cause by slippery floors, poor lighting, loose carpets, handrails near bathtubs and toilets, electric or power chords and obstacle on the stairways. The impact from the fall might cause fracture on their bones and unconsciousness. At this point, the elderly might not able to get back on their feet to get help.

According to World Health Organization (2012), falls are the second leading cause of accidental or unintentional injury deaths worldwide. Each year an estimated

424000 individuals die from falls globally of which over 80% are in low and middle-income countries. Adults older than 65 suffer the greatest number of fatal falls which 37.3 million falls that are severe enough to require medical attention, occur each year. The risk factors includes occupations at elevated heights or other hazardous working conditions such as alcohol or substance use, socioeconomic factors including poverty, overcrowded housing, sole parenthood, young maternal age, underlying medical conditions, such as neurological, cardiac or other disabling conditions, side effects of medication, physical inactivity and loss of balance, particularly among older people, poor mobility, cognition, and vision, particularly among those living in an institution, such as a nursing home or chronic care facility and unsafe environments, particularly for those with poor balance and limited vision.

As technology improves nowadays, falls detection system is possible to be made, enabling detection of falling event of the elderly. This chapter discuss on the ideas in developing this project's system Elderly that might help overcome the problem of falling elderly that become major problem these days.

2.3 Overview of Fall Detection System

There are many existing research made on detecting falling event in the past few years. These systems are invented to solve the problem of falling elderly which become the main problem these days that cause injuries to the elderly and sometimes cause fatality. Each systems use different approach to detect the falling event which have its own advantages and disadvantages. Some also able to recognize whether the event is normal event such as walking, standing up, lying and sitting down. This section will explain on the past research that had been made which highly related with this project. Comparing all the past research gives idea on what need to improve.

2.3.1 Detecting Falls with Location Sensors and Accelerometer

. The system performs three main steps which are filtering noise, activity recognition on filtered data and fall detection based on recognized activities. In filtering steps, it eliminates large short-term changes in tag locations due to noise. Next, the filter will correct the error found in the signal obtained. In activity recognition step, this system uses a machine-learning module and a rule module. These modules recognize basic activities such as walking, standing, sitting, lying and fall. Next step is fall detection where the user's activity and the context are combined to detect falls. The system consider an event fall if the user falls and does not get up for 10 seconds.

Fall detection system is a system that detects the human event of fall in order to get real-time monitoring. There are several approaches in detecting the falling event. First approach is by using the UBISENSE, real-time location system for sensing. This system able to detect various changes in movement patterns of the user which may indicates the falling event. It employs ultra-wideband radio technology to determine the locations of up to four tags worn on the user's chest, waist and both ankles. The tags are installed with accelerometers that can detect the motion of the user. The system reports its findings as alarms and warnings to the user's caregiver (Luštrek et al. 2011).

2.3.2 Day or Night Activity Recognition from Video Using Fuzzy Clustering Techniques

This system is quite different with any other fall detection system as it uses the vision-based technique. The system detects images before it goes to preprocessing and silhouette extraction. After that it will go through fuzzy clustering process which analyzed the activity. After the activity had been analyzed, it will go to the next process which is matching. The matching process

will match the activity captured with the data that had been collected. The activities that nearest to the prototype in the data collection will be choose. This is where the activity state is identified.

Other type of system uses Kinect sensors that include an infrared projector and camera, thus this system functionally work as a vision-based sensor under all lighting condition. It is useful to gather activity data during all times of the day. Microsoft Kinect camera is enabling to gather information during night times. This system can recognize activities even with the degradation in silhouette quality. The data collection contains sitting, lying, standing up, activities with hand motion and walking. This system can also detects falling event by include the types of falling event in the data collections (Banerjee et al. 2013).

2.3.3 Detecting Falls with Wearable Sensors Using Machine Learning Techniques

This system uses the machine learning techniques which there are about 20 types of fall actions in the data set collection. The normal activities in daily life such as walking, standing, sitting, and lying also included. In the system high-impact events are also included because it may confuse with falling events.

The user fitted the six wireless sensor units tightly with special straps to the subjects' head, chest, waist, right wrist, right thigh, and right ankle. Each unit comprises three tri-axial devices (accelerometer, gyroscope, and magnetometer/compass). Unlike cabled systems, wireless data acquisition allows users to perform motions more naturally. Volunteers wore a helmet, wrist guards, knee and elbow pads, and performed the activities on a soft crash mat to prevent injuries, each trial lasting about 15 s on the average. Measurements were transmitted over ZigBee (Özdemir and Barshan 2014).

2.3.4 Fall Detection System Using Arduino Fio

In this system, it uses the timer to solve whenever there are false falling event. When the data is above threshold, the notification will not directly send to the caregiver. This system uses the timer function or in the Arduino software known as the delay function. When data is continuously above threshold and the duration is greater than 60 seconds vibrator is triggered. The user can reset the Arduino in case of a false falling event. If the vibrator continuously vibrates which the possibility of the user cannot stand up or unconscious, an email will be sent to the designated address.

This system consists of sensors along with microcontroller and Xbee elements to communicate with the computer and a battery which can sustain the operation of Arduino for 4 hours. Placed in elastic belt at the calf area of user, Arduino Fio can automatically detect the acceleration along x, y and z axis depending on the user's motion. To determine the threshold, the user wears the Arduino Fio and initiates certain actions which the elderly do in daily life. If the threshold is beyond normal events threshold, the system will send an email to a pre-designated address and notify the relatives of the user that the use user may have fallen down (Shuo 2015).

2.3.5 Accelerometer Sensor Based Fall Sensing for Elderly

This system use ADXL model Accelerometer that detect the motion of the user. If the specific threshold which indicates falling event detected, it will read by the Arduino Micro microcontroller and will trigger the function of Bluetooth module to send information to the relative of the user informing them that the elder might fall down. The falls are simulated during stand and sit, with protective mattress. There are 5 times of falls simulated and recorded. The average of peak value is calculated to determine the actions. Sensor placement is

fixed at left hip up to the waist of the user.

The approach of detection is varies depending on the sensor locations, sensor type or model, signal processing or algorithm and also overall system functional. The accelerometer is one of the sensors that have been proposed as a practical, inexpensive and reliable method for monitoring ambulatory motion in elderly for the detection and prediction of falls (Noor et al. 2015).

2.4 Hardware Overview

The hardware that is suitable for this project are microcontroller which is a need in order to run the system with specific function. Next, is sensor which to detects the motion of the elderly in order to differentiate between normal event and falling event. Lastly is wireless communication which can send or receive information in long distance. This section will discuss on the hardware that related with this fall detection system.

2.5 Microcontroller

Microcontrollers are often described as single chip computers. They contain a microprocessor core, some memory and various “peripheral” devices such as parallel I/O ports, serial i/o ports, timers, analogue to digital converters (ADC's) and various other special function sub-systems.