DESIGN ON FALL DETECTION SYSTEM USING

MICRO-ELECTRO-MECHANICAL SYSTEM (MEMS) ACCELEROMETER

AND GYROSCOPE

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Date : .... 14 / 6 / 2013 ....

Specially dedicated to

My beloved parents

Chong Su Lee & Khor Ah Lean

My supervisor

Dr. Kok Swee Leong

Co-supervisor

Dr. Low Yin Fen

and those people who have guided and inspired me throughout my journey of

education

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ABSTRACT

A fall detection monitoring system is commonly used for reducing set of cost of taking care of disable people and elderly citizen. This project presents a fall detection monitoring system using Micro-Electro-Mechanical System (MEMS) sensors. MEMS is the technology where the electronic components are integrated into small chip which normally involves mechanical moving parts. In this project, MEMS accelerometer and gyroscope sensors are used to detect fall. Accelerometer is a device that measure acceleration level and a gyroscope is a device for measuring the change of angle of rotation or orientation. The signal generated from these sensors will be fed into a microcontroller. A fall is identified when there is a sudden change of displacement which will be picked by both the sensors. The microcontroller is programmed to indicate the fall by activating a buzzer. The main objective of this project is to design the fall monitoring system which can be used for elderly patients and those who suffer from walking difficulties. It has been shown in the experiment that a fall is detected when angle of degree is not in the range of $-90°$ to $90°$. At the end of the project, a prototype of the fall detection is being developed.

ABSTRAK

A pengesanan sistem pemantauan jatuh biasanya digunakan untuk mengurangkan set kos menjaga golongan orang kurang upaya dan warga tua. Projek ini membentangkan pengesanan sistem pemantauan jatuh menggunakan Sistem Mikro-Elektro-Mekanikal (MEMS) sensor. MEMS ialah teknologi di mana komponen-komponen elektronik yang disepadukan ke dalam cip kecil yang biasanya melibatkan bahagian yang bergerak mekanikal. Dalam projek ini, MEMS accelerometer dan giroskop sensor digunakan untuk mengesan jatuh. Acceleromter ialah alat mengukur tahap pecutan dan giroskop adalah alat untuk mengukur perubahan sudut putaran atau orientasi. Isyarat yang dijana daripada sensor akan dimasukkan ke dalam mikropengawal. Suatu kejatuhan dikenalpasti apabila terdapat perubahan mendadak anjakan yang akan dipilih oleh kedua-dua sensor. Mikropengawal diprogramkan untuk menunjukkan kejatuhan dengan mengaktifkan buzzer. Objektif utama projek ini adalah untuk mereka bentuk sistem pemantauan jatuh yang boleh digunakan untuk pesakit tua dan mereka yang mengalami kesukaran berjalan. Ia telah ditunjukkan dalam eksperimen yang jatuh dikesan apabila sudut bukan dalam julat - 90 ° hingga 90 °. Pada akhir projek, satu prototaip pengesanan kejatuhan dicipta.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

MEMS   -   Micro-Electro-Mechanical System

ESC   -   Electronic Stability Control

LCD   -   Liquid Crystal Display

PIC   -   Peripheral Interface Controller

ADL   -   Activities of Daily Living

SMT   -   Surface Mount Technology

PCB   -   Printed Circuit Board

CHAPTER 1

INTRODUCTION

1.1 Introduction

MEMS or Micro-Electro-Mechanical Systems also refers to Micro Systems Technology is a technology of small electronic devices usually integrated with mechanical parts have found many applications in automobile industry, computer and audio-video technology. One of the examples of MEMS device is an accelerometer which is an electromechanical device that measures acceleration forces. These forces may be static, like the constant force of gravity pulling at our feet, or they could be dynamic- caused by, moving or vibrating the accelerometer.

Another example of MEMS device is gyroscope which is a device for measuring or maintaining orientation, based on the principles of angular momentum. Mechanically,

a gyroscope is a spinning wheel or disk in which the axle is free to assume any orientation. Although this orientation does not remain fixed, it changes in response to an external torque much less and in a different direction.

In this project, both of these MEMS devices will be used to develop a fall detection system. A fall detection system can be used in hospital for monitoring patients particularly for those whom had just undergone surgery. If there is any emergency happened to the patient for example fall to the ground, an alert system can help in bringing in attention immediately to reduce the risk of further injury to the patient. This alert system can also apply for monitoring senior citizen especially those who are having walking difficulties. The automatic alert system can reduce the cost of employing nurses or doctors to attend to the patient all the time.

Some hospital and doctor do not have this kind of technology to monitor patient who have just undergo surgery. If there is any emergency happen on patient, it will harm the patient due to do no provide treatment at the first time. For senior citizen especially those who are having walking difficulties, sometime they have fall down without any intention form anyone else. This is very dangerous if nobody have realize on it. It may cause severe injured or even death even though initially is a small matter.

Falling can be a frequent and dangerous event for the elderly population. It is estimated that over a third (33%) of adults age 65 years and older fall each year, making it the leading cause of nonfatal injury for that age group. Among older persons, 55 percent of fall injuries occur inside home. Meanwhile, 23 percent occur outside, but near home. (Jay Chen, *et al*, ,2005) Traditionally, placing seniors in nursing homes or other care centers has mitigated the dangers of the elderly falling. However, with the advent of ad-hoc networks and low-power mote technology, we can now approach the problem from a different perspective.

At the end of this project, a prototype of a fall detection system with the combination of MEMS accelerometer and gyroscope will be developed.

1.2 Project Objectives

1. To design a fall detection system using both MEMS accelerometer and gyroscope sensors.
2. To construct the monitoring circuit by combining MEMS accelerometer and gyroscope.
3. To analyze and evaluate the functionality of the system.

1.3 Problem Statement

1. All sensors have their limitation in detection for example accelerometer detects the change of velocity of movement. It may not be accurate to be used to detect fall. Therefore, a combination with MEMS gyroscope is a better way to detect a fall as inputs of movement changes. The major problem is the integration of both sensors in a system.
2. Data obtained from both sensors can be a major issues as to where the level of accuracy can be used to detect fall signals.

1.4 Project Scope

In this project, one accelerometer and one gyroscope sensor will be used. The accelerometer is being used in this project, ADXL335 has a sensitivity of 300 mV/g, while the gyroscope sensor, ITG-3200 has a sensitivity of. Both of the breakout board for theses sensor were obtained from Sparkfun Electronics

The detection of the fall will be determined and programmed into a microcontroller. PIC microcontroller, 16F877A will be used to programmed and determine the fall signal and the output will be indicated by a 5 V buzzer and display on a 4 bits LCD display.

1.5 The significance of project

1. To improve the facility at the hospital by providing the advance technology equipment in order to take care elderly patients.
2. To use as a convenient electronic applications for senior citizens and elderly patients to keep on monitoring their movement.
3. Combination of accelerometer and gyroscope signal for detecting fall to improve the accuracy.

1.6 Methodology

A study on the fall detection and functions of the MEMS accelerometer and principle operation is carried out in order to find out relevant information. It is really helpful on how the material is going to function and the precaution should be aware during the project in the progress.

After study the concepts and functions of the MEMS accelerometer and gyroscope, relevant information is acquired. Based on the information acquired, several methods and approaches are taken to find out the knowledge. The data acquired must be ample and sufficient to help, support and prove the whole progress. Before start the progress, information is collect and gather up from the findings of book, E-book, journal from various source such as Institute of Electrical and Electronics Engineers (IEEE) journal, or any other relevant materials pertinent to this project. To make a comparison between materials are going to be select, data sheets and information of the components are collected. These data sheets and information can be obtained via Internet.

After that, the project is designed based on the concepts of the project. In this project, MEMS accelerometer and gyroscope will be used as sensor to detect fall. The next step is to build up the project after design.

After build up the project with the construction of circuit board, testing the functionality will be done in order to check whether the project is working or not. In case there is any error arises during testing of this project, troubleshooting is carried out to find out the solution and maintenance could be applied if necessary.

Lastly, a fall detection system by using MEMS accelerometer and gyroscope is created successfully. The final step of this project is to write a proper report and prepare an appropriate thesis for this project.

1.7 Report structure

Chapter 1: Introduction

First of all, introduction will be discussed at the first part of project. At this part, part of the project will be introduced which consist of the introduction on the technology used in this project. Then, it followed by the explanation of the importance and the perspective of the previous findings.

Next, objectives of this project will be carried out as well as problem statement which cause this idea to be arise. After that, scope of this project is discussed followed by project importance. Lastly, methodology is mentioned in order to explain briefly the process of this project.

Chapter 2: Literature Review

In this chapter, literature review will be discussed. Literature review will discuss on numerous aspects such as explanations of method and perspectives when some researches is carry out during this project. Besides research, some concepts and theories which applied in this project during problem solving is also discussed in the literature review.

Chapter 3: Project Methodology

In this chapter, project methodology is discussed. Methodology is the way to show the methods and approaches during data collecting, data analyzing and data processing. When a problem occurs, which method suppose to use to tackle the problem and why the particular method should take and why not take another approach to overcome the problem. Analyzing the methods is very important when facing problem.

Chapter 4: Results and Discussions

In this chapter, the overall results throughout the project will be discussed. Analysis of data which acquired from this project also presented in this chapter. Some discussions

are performed in this chapter including the problem facing during this project, measures on how to overcome the problems and personal point of view of this project.

Chapter 5: Conclusion and Future Works

This will be the last chapter of this report. This chapter will be discuss all the acquired findings and conclude all the analysis as well as observations. Conclusion of the project findings will be included. Furthermore, some recommendations are added for better improvements in future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Fall detection system is not new, most of the systems found from literature are sophisticated and required very complex signal processing techniques. In this chapter, the background of the fall detection system will be discussed. The principle operation and the applications for MEMS based accelerometer and gyroscope sensors will also be discussed as they will be the essential units for detecting sudden change of movement in this project.

2.2 Fall detection system

Fall detection system can be developed by using location sensor and accelerometer. This fall detection system is used another system which know as confidence system to work together. The objective of using location sensor is to know whereabouts of the people who is falls down. By using location sensor and confidence system, the place of the people who falls down can be identified immediately.

One system, Buddy Guard, works with your smart phone to transmit your location to people who can help you if you fall. This system is unlike the others and does not have a call center that monitors activities. It seems more suitable for people who work on ladders or are in situations where they need to detect and make a record of work-related accidents such as falls.

When a fall is detected, the system automatically initiates a call to its call center which determines what kind of help is needed. With most systems, the call center associate will try to communicate with the senior who called for help often using a two-way speakerphone. If he or she does not respond, the center will contact someone from the person's emergency response list (family members, neighbors or friends), or will call for an ambulance.