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Fall Detection on Humans Using Threshold Method Based On Smartphone Accelerometer Data

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Abstract – Many fall detection systems are developed using accelerometer and gyroscope on smartphone. In existing fall detection systems, smartphone location placement is generally selected from the beginning and cannot be repositioned. The movement of smartphone decreases the accuracy of the system. This research provides fall detection model using accelerometer on smartphone and the placement of the smartphone could vary as of six predetermined positions. The method used for fall detection is threshold method applying only one parameter, the value of resultant acceleration. There are two thresholds used in this research, upper threshold and lower threshold. The testing of fall detection model is conducted by eight volunteers (four males and four females), and resulted in 98.1% of accuracy, 96.9% of sensitivity, and 100 specificity.

Keywords: acceleration resultant; unfixed position; upper threshold; lower threshold

I. INTRODUCTION

Falling can be interpreted as an event of quick or sudden change from a standing position or sitting to a lying position or sitting on a floor or a lower place [1]. Falling can result in injury effects such as sprains, fractures and concussions. It can even lead to someone's death.

Human efforts to keep an eye on the fallen fellows continue to be improved. The current advanced technology allows supervisors to immediately know when humans experience a falling event. Some fall detection researches use certain sensor such as a camera, accelerometer, gyroscope, microphone, ultrasonic, vibration or a combination of thow or more sensors [2]. These sensors are grouped into 3 categories, namely camera-based, environment-based and body-mounted sensor [3]. Among these three categories, the most well-studied and practical detection system is body-mounted sensor [4].

There are two models of fall detection sensors, i.e. sensors combined with microcontrollers and sensors converged in the smartphone. Recent studies have shown that falling detection trends are shifting to smartphone usage [5].

The existing fall detection researches have mainly determined the location of sensor placement from the beginning e.g. in the pockets of the shirt [6], [7], in the chest [8], at the waist [9]–[14] and in the pants pocket [15]–[18]. Unfortunately, this specified sensor location can not be moved elsewhere. Switching the sensor location allows for the appearance of false alarms and the performance is not as expected [19]

Fall detection by Chen [19] shows that are the location of the smartphone can be moved in accordance with a predetermined location, i.e. the top left pocket, front pocket / back pocket, jacket pocket or inside the bag. This detection process requires three parameters, the resultant acceleration, the standard deviation of the acceleration resultant and the average value from the slope angle obtained from the acceleration resultant. When all three values of this parameter exceed the threshold value that has been determined, then a falling event has occurred. Examination of all three parameters to determine the occurrence of a fall event takes six seconds. Chen's research yielded a specificity value of 97.5% and a sensitivity of 91.3%.

In this paper, we designed a fall detection model using an accelerometer on a smartphone with a threshold method that uses 1 parameter only. The data used to detect falls in this study is only the resultant acceleration value (R) obtained from the accelerometer. Determining whether a fall event required a threshold value, there are two threshold values