Energy Saving in Forward Fall Detection using Mobile Accelerometer

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ABSTRACT

Fall injury is one of the biggest risks to health and well-being of the elderly especially in independent living because falling accidents may cause instant death. There are many research interests aimed to detect fall incidents. Fall detection is envisioned critical on ICT-assisted healthcare future. In addition, mobile battery is currently another serious problem in which performance feasibility is considered as a standard to verify an effective method. In this paper, the authors study forward fall detection method from mobile phone perspective using accelerometer only without sacrificing accuracy to save energy. Using peak threshold algorithm in axes of mobile accelerometer, transition from activity of daily living (ADL) to forward fall event is recognized. In collected templates, Dynamic Time Warping (DTW) was applied to compute difference among them with new unlabeled samples. Results implemented on mobile phone easily show the feasibility of the method hence contribute significantly to fall detection in healthcare.

Keywords: Activity of Daily Living (ADL), Dynamic Time Warping, Dynamic Time Warping (DTW), Fall Detection, Mobile Accelerometer, Peak Detection

INTRODUCTION

Human activity recognition is an important subject because it provides accurate information about the behavior of the observed people. Therefore, it is researched widely with different approaches (Biswas, 2011; Thang, 2012). In various ADLs, the fall is the most risky factor in the elderly people’s daily living since it often causes serious physical injury such as bleeding, and centre nervous system damages. A rate of 1/3 people aged over 65 have been reported to occur at least once per year (Luo, 2004). Fall accident requires immediate response from medical aid
especially in serious cases as late response in those situations increase higher possibility to death. Addressing the issue importantly, many researches have been conducted varying from using single to multi sensor which is either acting as dedicated device or embedded one in many types of devices. However, mass usage is still infeasible due to the inconvenience when wearing unusual devices on the body frequently. Since current sensing capabilities on mobile phone including GPS, Wi-Fi, accelerometer, and orientation sensor are expanded widely, mobile phone could definitely bring enhanced services to the persons in this fall activity (Ruiz, 2009). One problem of using smart phone to detect falling event is serious energy consumption of mobile phone. In this paper, we propose a forward fall algorithm using accelerometer only for saving energy purpose which does not sacrifice accuracy. Fall detection could be applied for everyone in everywhere. Greatest impact is expected to help many elderly, especially in the independent living.

STATE OF THE ART

The current fall detection methods can be basically categorized as following:

- **Video data:** The video-based system captures the images of human movement. A fall event is detected based variations of images (Toreyin, 2006);
- **Acoustic data:** Detecting a fall via audio signals analysis;
- **Wearable sensor data:** Embedding some micro sensors into clothes, or girdle, shoes, plugged on foot, etc. to monitor the human activities in real-time, and finding the occurrence of a fall based on the changes of some movement parameters (Winters, 2002).

However, these approaches have some weak points. For example, the narrow scope of video system, notably inaccurate of acoustic data, the inconvenience of wearable sensors system, and the limited range of application where they can be deployed at this moment. Accelerometer has been basically used in research (Williams, 1998). Since then, many studies have been presented about various methods using heuristic classifier (Bussman, 2001), while others used multiple sensors such as accelerometer and sound data (Charalampos, 2008). The common and simple methodology for fall detection is using threshold algorithm based on decision whether an event crosses predefined thresholds (AlertOne, 2008). Fall detector is also implemented on waist-worn accelerometer fixed on human body (Zhang, 2006) using SVM classifier. Mobile devices have some limitations on computational resources unlike full-fledged processing devices with wearable sensors as detection engine. Directly adopting wearable sensors research to mobile phone is not suitable as they are different in daily usage context (Korpipää, 2008). Proposing a fall detection algorithm that enables application to be lightweight for guaranteeing mobile phone resource’s consumption and also maintaining excellent accuracy is considered as a necessity at the moment.

Recently, researchers (Raymon, 2011) in Roehampton University, made an experiment using motion signals while participants were equipped G1 phone to observe acceleration changes in different falling directions and propose corresponding thresholds to distinguish the falls from some specific activities (walking, picking, getting up). The fall is suspected when acceleration’s amplitude crosses fixed thresholds. In other ADLs, their accelerations can exceed the falling thresholds. Therefore, improving the accuracy of fall detection needs further investigation. From our previous study,
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