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Mems and IOT Based Automatic Fall Monitoring : A Review

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ABSTRACT

Falls and fall-related injuries are major incidents, especially for elderly people, which often mark the onset of major deterioration of health. More than one-third of home-dwelling people aged 65 or above and two-thirds of those in residential care fall once or more each year. Reliable fall detection, as well as prevention, is an important research topic for monitoring elderly living alone in residential or hospital units. The aim of this study is to review the existing fall detection systems and some of the key research challenges faced by the research community in this field. We categorize the existing platforms into two groups: wearable and ambient devices; the classification methods are divided into rule-based and machine learning techniques. The relative merit and potential drawbacks are discussed, and we also outline some of the outstanding research challenges that emerging new platforms need to address.

Keywords : Short-Time Fall Monitoring, Fall Detection, Fall Prevention, Wireless Sensors, Wearable Sensors

I. INTRODUCTION

Adults 65 years of age or older experience higher rates of falling and are generally at a higher risk for falls. 1–4 One in every 3 persons over the age of 65 years are estimated to fall 1 or more times each year. 5–7 Falls and fall related injuries represent a significant threat to the health and independence of adults 65 years of age and older. Falls can have severe consequences such as injury or death; in 2010 in the United States, 21,649 older adults died from fall related injuries. 8 Even if a fall does not result in a physical injury, it can often produce fear of falling resulting in a decrease in mobility, participation in activities, and independence. 9, 10 Fear of falling can be amplified in the presence of the "long lie", which is identified as involuntarily remaining on the ground for an hour or more following a fall. 1 Such an event can results in substantial damage to the individual's body and morale. Lying on the floor for an extended period of time often results in several medical complications such as dehydration, internal bleeding, pressure sores, rhabdomyolosis or even death. Half of those who experience the "long lie" die within 6 months of the fall. 11 A recent cohort study reported a "long lie" was seen in 30% of fallers; 12 therefore it represents a great threat to the long term health of older adults.

Evidence-based methods to prevent falls include regular exercise, vitamin D supplementation and having regular fall risk assessments. 2, 13–15 However, despite prevention efforts falls are still likely to occur as one ages, and they need to be quickly identified to prevent further injury to the fallen individual. Personal emergency response systems or PERS represent one commercial solution to addressing this issue. These clinical alarm systems provide a way for individuals who fall to contact an emergency center by pressing a button. 16 While appropriate in many situations, the PERS system is rendered useless in the event that the person is unconscious or unable to reach the button. Even

when the system is available, a recent cohort study found that around 80% of older adults wearing a PERS did not use their alarm system to call for help after experiencing a fall.

In this project, a surveillance system based on Arduino, fall detection is proposed. Raw data of three-dimensional accelerometer are provided by Arduino with ADXL345., analyzing, storing and acquiring any time from any place as long as they have access to the Internet. The system architecture is shown is Fig. 1 as follows.

Figure 1. System Architecture

II. LITERATURE REVIEW

Falls represent one of the leading causes of deaths and injuries in the elderly population. According to Lord et al. [1], more than one-third of home-dwelling people aged 65 or above and two-thirds of those in residential care fall one or more times each year. More than two-thirds of people who have experienced a fall are prone to falling again [2]. Vellas et al. [3] reported that 219 out of 487 elderly subjects had experienced a fall during a two-year study period and one-third of which developed a fear of falling after the incident. The psychological consequences often lead to decreased mobility and independence among elderly population [4]. Falls can occur on level surfaces, mostly in living rooms, bedrooms, kitchens, bathrooms, or hallways [5]. The rate of fall-related injuries is generally higher among women [6] and the medical costs increase rapidly with age [7]. Damages caused by falls include tissue injuries, lacerations, joint dislocations, bone fractures and head trauma. Carroll et al. [8] reported that the total direct medical costs of fall injuries among elderly people in the U.S. in 1997 were $6.2 billion. The costs increased to $19 billion in 2000 [7] and $30 billion in 2010 [9]. Fall-related injury is considered one of the 20 most expensive medical conditions among community-dwelling elderly population [7]. Most elderly people are unable to get up by themselves after a fall and it was reported that, even without direct injures, half of those who experienced an extended period of lying on the floor (>1 h) died within six months after the incident [10].

Fall is defined as “an event which results in a person coming to rest inadvertently on the ground or other lower level”. This definition has been used as a baseline in many fall prevention and fall-risk assessment studies [11–14], and covers most types of falls targeted by fall detection research. Variations of fall definitions from different perspectives of seniors, health care providers and research communities can be found in [15]. Thus far, there are several review papers on fall detection and prevention. Noury et al. [16,17] reported a short review on fall detection methods and proposed a set of protocols to evaluate fall detection algorithms. In the study, a fall is divided into four phases, i.e., prefall, critical (impact), postfall and recovery phases, and fall detection algorithms are categorized based on whether they focus on “direct”

detection of the critical phase or postfall phase. The critical phase, which consists of a sudden body movement towards the ground, lasts for approximately 300–500 ms.

III. DESIGN COMPONENTS

Fall detection sensor system uses a sensor device, a hardware that detects the body position and motion, which then communicates with the system (thesoftware part) to send out an emergency to the contact person if falling is detected. The system would only send the signal after the alarm is triggered by the sensor for 15 seconds. The hardware needed is presented in Sections 4.1 and 4.2 while the software languages used in provided in Section 4.3.

3.1 Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (Figure 3). It has 14 digitalinput/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with AC-to-DC adapter or battery to get started [8, 9, 10, 11, 12].

Figure2: Arduino UNO board

In most fall situations, the body leans to the side and touches the ground with high acceleration. So, an algorithm must detect a fall in these situations when there is a rapid change of position in a very short amount of time.

Commonly, fall detection systems use a gyroscope and an accelerometer. A gyroscope is used to determine an orientation and an accelerometer provides the information about the angular parameter as three-axis data. But we also need to decide a threshold so that the system can differentiate between a fall and normal activity.

The circuit we discuss in this tutorial is built around an Arduino UNO and an MPU6050 accelerometer and gyroscope breakout module. We will also try to send the SOS message via a Wi-Fi module. First of all, we need to decide on an algorithm

3.2 Arduino Programming Language

Arduino programs can be divided in three main parts: structure, values (variables and constants), and functions. The Arduino language is based on C/C++ and supports all standard C constructs and some C++ features. In Arduino, the standard program entry point
(main) is defined in the core and calls into two functions in a sketch. The function setup() is called once, then loop() is called repeatedly until the board is reset. Besides, Arduino development environment, SPI Arduino Library and SoftwareSerial Arduino Library are also needed [13].peaker in a voice signal by analyzing it.
Our long term goal is to implement a gender classifier that can automatically predict the gender of the speaker based on the above investigation.

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