

## Chapter 24

# Fall Detection Systems to be Used by Elderly People

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### ABSTRACT

*Statistics show that, each year, falls affect tens of millions of elderly people throughout the world. Falls are the leading cause of injury deaths and injury-related hospitalization among people over 65 years old. A system able to automatically detect falls could be an important tool from a social point of view, as it would contribute to the prompt assistance of these emergency cases. Currently, many researchers are interested in the development of fall detection systems. This chapter presents several approaches suggested so far, with special attention to the different strategies and technologies applied. Other sensor technologies that could be applied to this field are also referred. Additionally, a new fall detection system based on a machine learning paradigm, using neural networks, is suggested. The system was trained using fall and non-fall examples. Although the test set has included some particular examples, problematic for detection of the correspondent motion, the obtained results present good specificity (88.9%) and sensitivity (93.9%) rates.*

### INTRODUCTION

The advances in medicine and improved access of populations to health care systems, has increased life expectancy over the last decades. As a consequence, the number of elderly people in the

global population is increasing and it is expected to become higher in the next years, especially in the developed countries. In 2008, the United Nations Statistics Division registered a total of 16.1% of population with 65 or more years old in Europe and 12.7% in the North America countries

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(UNSD, 2009). According to the Portuguese National Institute of Statistics, in 2006 the Portuguese average life expectancy was 78.5 years (75.2 for the men and 81.8 for the women) and between 1990 and 2006, the Portuguese population over 80 years old increased 35% (INE, 2007). Data from 2009 showed that elderly people (over 65 years old) already represent 17.9% of the Portuguese population. These numbers present an ageing tendency of the developed countries population and a new challenge to create balanced health and social policies.

Due to several factors, such as muscle strength impairment, decreased balance, vision difficulties, neurodegenerative diseases, among others, the elderly people frequently have less mobility, less autonomy and increased difficulties to perform normal daily activities, making them a particular group prone to suffer fall events. Falls can lead to moderate to severe injuries, such as hip fractures and head traumas, which remarkably deteriorate the health status of elderly people and can even increase the risk of early death (CDC, 2011). Each year, one in every three adults over 65 years older falls and this ratio increases to one in every two adults aging 80 years or older (Hausdorff *et al.*, 2001; Hornbrook *et al.*, 1994). In 2007, 81% of fall deaths were among people over 65 years old (CDC, 2011). Falls are considered to be the leading cause of injury death among elderly and they are also the most common cause of nonfatal injuries and hospital admissions for trauma. In 2009, 2.2 million nonfatal fall injuries among older adults were treated in emergency departments and more than 581,000 of these patients were hospitalized (CDC, 2011). Data from 2000 indicates that direct medical costs of falls in the United States corresponded to approximately \$19 billion (\$179 million for fatal falls and \$19 billion for nonfatal fall injuries) (Stevens *et al.*, 2006). In Ireland, it was reported that for just one Irish hospital, costs related to falls of older adults were estimated to be 10.8 million € per year (Cotter *et al.*, 2006). Thus, besides its social impact, fall related events

in older adults represent a significant financial burden to the health services worldwide.

Due to a fall event, the individual can lose consciousness or become unable to raise or ask for help, which can delay medical intervention. It is well documented that a relationship exists between the delay in providing for medical assistance and the increased morbidity-mortality rate (Noury *et al.*, 2008). In fact, it has been reported that half of the elderly population that suffers a long-lie (involuntarily remaining on the floor for an hour or more) after a fall, dies within six months, even if no severe injuries result from the fall (Noury *et al.*, 2008). Thus, it is very important to provide for help as soon as possible when a fall event takes place. Nevertheless, nowadays a considerable number of senior citizens live alone on their homes. In Portugal, data from 2006 showed that 44.2% of the old population lived only with their wife's or husband's, and that 20.7% lived completely alone. This situation could present a risk for medical assistance because in case of accident, most of the times there is no one to call the emergency services. Considering that it has been reported that almost 75% of the accidents with old people occur at home and 30% of these accidents result from falls (50% with people over 80 years old), the development of intelligent systems able to distinguish a fall from other daily activities and send an alert signal when needed would contribute for a higher quality of life and independent living of elderly people.

Moreover, a smart system able to detect fall events and subsequently send an alert (*e.g.* an SMS or an Internet alert) to care holders, represents an important and valuable technology to improve the speed and responsiveness of the health services rendered. Such a system would contribute for the diminution of long-lie situations. Considering that long-lies can aggravate the negative health impact of a fall (due to dehydration phenomena, hypothermia, bleeding, ulcers, etc.), and consequently increase the treatment costs, these automatic systems could also contribute to economical savings for the healthcare services. Additionally, providing

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