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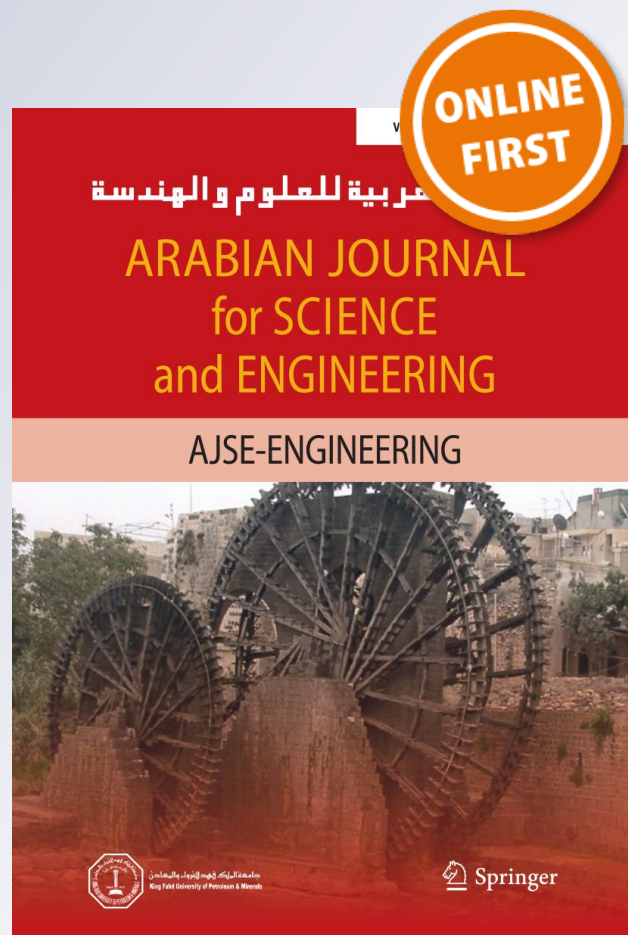
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Development of a Real-Time, Simple and High-Accuracy Fall Detection System for Elderly Using 3-DOF Accelerometers

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Abstract
Falls represent a major problem for the elderly people aged 60 or above. There are many monitoring systems which are currently available to detect the fall. However, there is a great need to propose a system which is of optimal effectiveness. In this paper, we propose to develop a low-cost fall detection system to precisely detect an event when an elderly person accidentally falls. The fall detection algorithm compares the acceleration with lower fall threshold and upper fall threshold values to accurately detect a fall event. The post-fall recognition module is the combination of posture recognition and vertical velocity estimation that has been added to our proposed method to enhance the performance and accuracy. In case of a fall, our device will transmit the location information to the contacts instantly via SMS and voice call. A smartphone application will ensure that the notifications are delivered to the elderly person's relatives so that medical attention can be provided with minimal delay. The system was tested by volunteers and achieved 100% sensitivity and accuracy. This was confirmed by testing with public datasets and it also achieved the same percentage in sensitivity and accuracy as in our recorded datasets.

1 Introduction

Population aging is the trend in modern society [1] and the number of the elderly's falls because of old age, mental and physical diseases such as stress, high/low blood pressure, heart diseases, knee pains is on the increase. Figure 1 shows an example of fall event with the elderly which will lead to many dangerous problems, even death if they do not receive immediate attention.

In order to solve the problem, the authors proposed to develop an effective fall detection system to support the elderly, especially for those living alone. There have been a lot of published methods about fall detection in recent years such as image processing [3–11], location sensors [12], smartphones [13], accelerometers [14] or wristband and smartwatches. However, these methods have certain limitations, for instance, the systems are inconvenient, costly and inaesthetic.

Firstly, for the image processing approach [3–11,15], the authors employed different types of cameras to distinguish between activities of daily living (ADLs activities) and fall risk detection in home environments such as depth Kinect

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