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Multimodal System for Fall Detection and Location of person in an Intelligent Habitat

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Abstract

The risk of falling is designed much more to the aging population. Due to this risk, many researchers have focused their work to the fall detection to improve the daily life of this category of population. The objective of this paper is to propose a multimodal system for fall detection in an Intelligent Habitat. Our system is based on two Ambient Assistance services (Fall Detection service and Location service) and an Emergency service. The ambient assistance services use sensors installed in the home (Photoelectric sensors) and on the persons (accelerometer), to collect information at any time about location and state of the person. The Emergency service result from the fusion of data collected by these services and sends a code number to the doctor. Depending to this code number, he can know the situation of followed person. This multimodal system is modeled by Colored Timed and Stochastic Petri nets (CTSPN) simulated in CPNTools.

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1. Introduction

A fall event is one of the main factors that influence the physical and psychological health of a person. According to the website Federal Office of Statistics 1, 15% of elderly suffer from a fall at least one time per year. This last can produce serious injuries such as fractures, conscience loss ... etc.

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To avoid these results and at the same time let the person lives in his own house; several studies have been developed in the field of fall detection. Among these works, the division of the fall detection according to the sensors in 3 methods: Ambience device method, Camera-based method and Wearable device method.

Ambience device method based on sensors placed in the environment such as the "Smart Floor" to detect the trajectory and follow the person in internal environment, or an audio systems (microphones) to detect the fall.

The second method (Camera-based) used one or more cameras installed in Habitat to follow the person. We can detect the fall from the analysis of human body shape deformation.

The Wearable device method is based on sensors worn by the individual for detecting posture or body movement of patient to detect fall. The sensor used in this case is the three-dimensional accelerometer placed on the belt or on a vest worn by the individual. Or directly use the accelerometer integrate in the Smartphone, and send a message or email in case of fall detection.

Vision sensors (camera) have a very high cost and very limited coverage area, In addition, privacy and life style of individuals is hindered. The smart floor is a good fall detector, against it does not make the difference between the monitored person and others in Habitat. On the other hand, accelerometer is an accessible tool to people and it is not expensive; we can use even the accelerometer integrated in smartphone.

In our work, we will develop a multimodal system of fall detection from a standing or walking. This system is dedicated to elderly people living alone in their homes. It is based on a three-dimensional accelerometer placed on a belt worn by the followed person in an intelligent habitat; and at the same time locates it in the Habitat based on the photoelectric sensors installed on the doors.

Our system ensures two services of ambient assistances and an Emergency service. The ambient assistances services are: Fall detection Service and Location Service. In case of fall detection, our system send message code to the doctor and according to code number, he can know the detailed status of the followed person.

2. Functional architecture

Like presented in fig. 1, the representation of our system architecture approach is a multimodal system of fall detection based on two modalities:

- Absolute acceleration tacked by a three-dimensional accelerometer placed on a belt worn by the followed person.
- Room location of person using photoelectric sensors.

![Functional architecture of the proposed system](image)

The first modality ensures the fall detection service and the second ensures the location service. After the fusion and the treatment of results made by these two ambient assistance services (body position and room location), an emergency service will be triggered depending on the result of the fusion. This emergency service sends a message code to the doctor. According to the number of this code; he can know the detailed status of the followed person.

To validate this architecture, we used the simulation tool CPNTools (Computer Tool for Colored Petri Nets). The tool offers two modes of simulations: the step-by-step simulation and automatic simulation. In each mode, the graphical interface assists the user in the comprehension of behavior specified by an activation system by coloring components. Our simulation is performed with the version of CPNTools v4.0.0.
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