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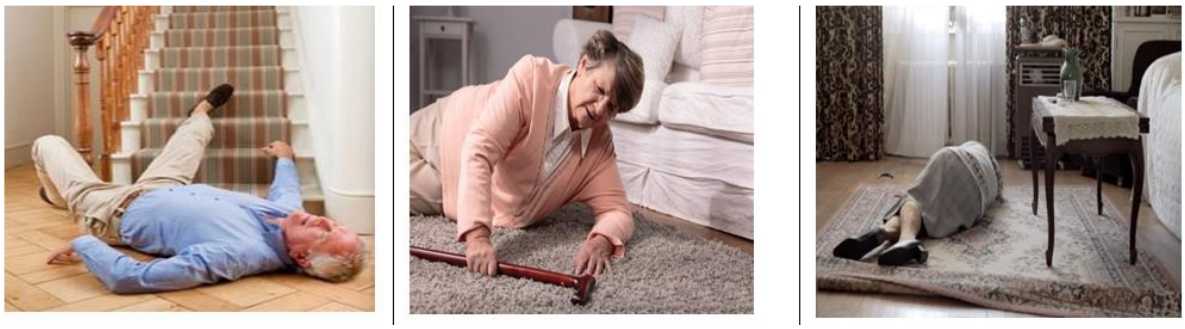
Falls detection and prediction of an elderly person in an indoor environment using a vision system

Fairouz MERROUCHE. PhD Sutdent, USTHB, **Supervisor**: Prof. Nadia BAHA, USTHB

Introduction

The world's population is aging, living independently and without risks for the elderly is a major challenge for a system of human activity recognition. The fall of an elderly person can be fatal or can lead to health problems and a loss of their autonomy.

The main objective of this work is to propose a monitoring system based on the computer vision and human activity recognition to detect the fall, or even predict it in the future to improve performance and assistance time to the person, which can avoid staying on the ground hours before help arrives. This solution is based on a single Kinect sensor to monitor the elderly person.



Example of an elderly person fall

The method and Results

Two fall detection methods are proposed: the first method is based on the human form and the movement of the center of gravity. The first step consists in the detection of the person in the image using background subtraction methods, then his head is tracked using the particle filter. Three scenarios were tested. For the first and second scenarios, head position is used to detect postures that are close to the ground. The movement of the center of gravity is analyzed to validate the falls. Regarding the third scenario, the person's tilt angle is calculated to detect abnormal postures. To validate the fall, we used the center of gravity movement as for the other two scenarios.

In the second method, the HOG descriptor and Hu moments were used to describe human posture by incorporating center of gravity motion to describe human activity. We also proposed a new descriptor that we called HDO. This descriptor is based on the orientation of each contour point of the silhouette as well as the distances of these points from the center of gravity. Several classification methods have been used to differentiate a fall from normal activity.

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The third part was devoted to fall prediction, we used Transfer Learning based on CNN architecture to detect imbalance of the human body. To discriminate falls from normal activities, we analyzed the center of gravity velocity for k frames where k is less than the duration of a fall. Very good results have been obtained for the detection and prediction of falls on the tests conducted on the SDU and URFall databases.

Example examples of Fall Detection with the SDU Fall Dataset

Example examples of Fall Detection with the URFall *Dataset*