Overview of UP-Fall Detection Project

Anonymous Author(s)
Affiliation
Address
email

Abstract

In this paper, we present an overview of our project of UP-Fall Detection. The aim of this project is to configure a simple, comfortable and fast fall detection and human activity recognition system. This system must be accurate in fall detection and easy to implement and adopt. We briefly describe the achievements and advances obtained in two years.

1 Introduction

Fall prevalence has increased in recent years due to the world phenomenon of population aging [1]. Falls are actually considered a major health problem in the world [2] given that falls often cause severe injuries and death manly among elderly persons. Reliable and robust fall detection systems are needed in order to reduce the time in which a person receives medical attention when a fall occurs and diminish its negative consequences. Main approaches of human activity recognition, fall classification and fall detection systems use wearable devices, ambient sensors and/or vision devices[3]. There are important challenges and issues reported by most authors like privacy concerns, obtrusiveness and operative device limitations, and difficulty of comparison among techniques caused by the lack of public databases. Other frequent design challenges when developing a fall detection system are selecting which modality of sensor to use for data acquisition; determine the best placement and orientation of the information sources; and selecting the most suitable fall detection technique.

In this paper, we present an overview of our project of UP-Fall Detection. The aim of this project is to configure a simple, comfortable and fast fall detection and human activity recognition system. This system must be accurate in fall detection and easy to implement and adopt. We briefly describe the achievements and advances obtained in these two years in which the aforementioned challenges were addressed.

This project is an initiative of Computer Intelligence and Vision (INVICO) research group at Universidad Panamericana to build an ambient assisted living monitoring system for elder people. The aforementioned system's goals are:

1) The creation of a monitoring system that allows the independence of older adults to be maintained and improves their well-being and safety conditions. This system will focus on using using different combinations of vision, wearables and ambient sensors to gain more precision and robustness as well as machine learning techniques to provide assistance, in a first stage, when there are falls.

2) Identify the severity of the damage caused by the fall by monitoring your breathing without intrusive contact sensors, using a vision system.

2 UP-Fall Detection Project Overview

The project is divided into two phases: (1) database creation, (2) data analysis and system simplification. We describe each part of the project in this section.

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Table 1: Ranking (top-bottom) of the best IMU sensor per classifier, based on F-score

	IMU type			
	RF	SVM	MLP	KNN
1	(98.36) Waist	(83.30) Right Pocket	(57.67) Right Pocket	(73.19) Right Pocket
2	(95.77) Neck	(83.22) Waist	(44.93) Neck	(68.73) Waist
3	(95.35) Right Pocket	(83.11) Neck	(39.54) Waist	(65.06) Neck
4	(95.06) Ankle	(82.96) Ankle	(39.06) Left Wrist	(58.26) Ankle
5	(94.66) Left Wrist	(82.82) Left Wrist	(37.56) Ankle	(51.63) Left Wrist

2.1 Database creation: UP-Fall Detection Dataset

In previous work, [4] we present a publicly available multimodal dataset for fall detection in order to address the problem of lack of available datasets for comparison among fall detection systems and machine learning techniques. UP-Fall Detection dataset was collected over 17 healthy young subjects using multiple modalities. The volunteers performed three attempts each of six daily living activities, and simulated five different types of fall. We use five wearable sensors to collect accelerometer,gyroscope and ambient light data. These sensors were positioned in the left wrist, in the neck, at right pocket of pants, in the belt, and left ankle. In addition,we acquired data from one electroencephalograph (EEG) headset, six infrared sensors, and two cameras. This dataset comprises raw and feature sets summarizing information from wearable sensors, ambient sensors and vision devices. The aim of our dataset is to leverage fair comparisons of fall detection solutions. It also provides many experimental possibilities for the signal and human activity recognition, vision, and machine learning community.The consolidated dataset (812 GB), as well as, the feature dataset (171 GB) are publicly available in http://sites.google.com/up.edu.mx/har-up/.

2.2 A Comparison Analysis for Best Multimodal Combination Devices in a Fall Detection System

There are different approaches of fall detection system and their success depend on the types of devices selected for data acquisition, the location in which these devices are placed, and how fall detection is done. We designed experiments in order to determine the best suited placement and multimodal combination and simplify the system improving fall detection efficiency and precision. We mainly focus on the best choice of a wearable sensor and a camera viewpoint. In the analysis over the UP-Fall Detection data set, we built an independent classifier model (random forest (RF), multilayer perceptron (MLP) and k-nearest neighbors (KNN), support vector machines (SVM)) for each window-length feature data set for each IMU sensor.

We summarized the ranking of the IMU sensors per performance classifier, based on the F-score, obtained from the previous results in table 1. The best performance is obtained using the following isolated IMU sensors: waist, neck and right pocket (i.e. the IMU types in the shadowed region). Also, ankle and left wrist IMU sensors performed the worst. In addition, the combination of the IMU sensors and the cameras was also important in this task.

2.3 Publicly available resources

Another contribution is a public repository with many Python programs for feature selection, training and validation. Features were calculated using three different time-windows with overlap. Available in https://github.com/jpnm561/HAR-UP.

3 Conclusions

We presented the achievements obtained in UP-Fall detection project. We are now working towards an assisted daily life monitoring system using mobile technologies, less intrusive and low cost. The social contribution is to relieve the burden of caregivers and family members who care for older adults and increase their safety.

Acknowledgments

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