REVIEW OF VISION-BASED FALL DETECTION SYSTEMS

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SCOPE

The scope of the project is to detect human fall using machine learning algorithm. Falls are an important healthcare problem for vulnerable persons like seniors. This project addresses the detection of human falls using relevant pixel-based features reflecting variations in body shape.

ABSTRACT: Vision-based fall detection systems have experienced fast development over the last years. To determine the course of its evolution and help new researchers, the main audience of this paper, a comprehensive revision of all published articles in the main scientific databases regarding this area during the last five years has been made. After a selection process, detailed in the Materials and Methods Section, eighty-one systems were thoroughly reviewed. Their characterization and classification techniques were analyzed and categorized. Their performance data were also studied, and comparisons were made to determine which classifying methods best work in this field. The evolution of artificial vision technology, very positively influenced by the incorporation of artificial neural networks, has allowed fall characterization to become more resistant to noise resultant from illumination phenomena or occlusion. The classification has also taken advantage of these networks, and the field starts using robots to make these systems mobile. However, datasets used to train them lack real-world data, raising doubts about their performances facing real elderly falls. In addition, there is no evidence of strong connections between the elderly and the communities of researchers

INTRODUCTION In accordance with the UN report on the aging population [1], the global population aged over 60 doubled its number in 2017 compared to 1980. It is expected to double again by 2050 when they exceed the 2 billion mark. By this time, their number will be greater than the number of teenagers and youngsters aged 10 to 24. The phenomenon of population aging is a global one, more advanced in the developed countries, but also present in the developing ones, where two-thirds of the worlds older people live, a number which is rising fast. With this perspective, the amount of resources devoted to elderly health care is increasingly high and could, in the non-distant future, become one of the most relevant world economic sectors. Because of this, all elderly health-related areas have attracted great research attention over the last decades. One of the areas immersed in this body of research has been human fall detection, as, for this community, over 30% of falls cause important injuries, ranging from hip fracture to brain concussion, and a good number of them end up causing death [2]. The number of technologies used to detect falls is wide, and a huge number of systems able to work with them have been developed by researchers. These systems, in broad terms, can be classified as wearable, ambient and camera-based ones [3]. The first block, the wearable systems, incorporate sensors carried by the surveilled individual. The technologies used by this group of systems are numerous, ranging from accelerometers to pressure sensors, including inclinometers, gyroscopes or microphones, among other sensors. R. Rucco et al. [4] thoroughly review these systems and study them in-depth. In this article, systems are classified in accordance with the number and type of sensors, their placement and the characteristics of the study made during the system evaluation phase concluding that most systems incorporate one or two accelerometric sensors attached to the trunk. The

second block includes systems whose sensors are placed around the monitored person and include pressure, acoustic, infra-red, and radio-frequency sensors. The last block, the object of this review, groups systems able to identify falls through artificial vision. In parallel, over the last years, artificial vision has experienced fast development, mainly due to the use of artificial neural networks and their ability to recognize objects and actions. This artificial vision development applied to human activity recognition in general, and human fall detection in particular, has given very fruitful outcomes in the last decade. However, up to where we know, no systematic reviews on the specific area of visionbased detection systems have been made, as all references to this field have been included in generic fall detection system reviews. This review intends to shed some light on the process of development followed by vision-based fall detection systems, so researchers get a clear image of what has been done in this field during the last five years that help them in their investigation process. In this study, authors intend to show the main advantages and disadvantages of all processes and algorithms used in the reviewed systems so new developers get a clear picture of the state of the art in the field of human fall detection through artificial vision, an area that could significantly improve living standards for the dependent community and have a high impact on their day-to-day lives.

EXISTING SYSTEM

•Recently, several works have focused on shape information to detect and classify falls

•One can cite the body's center of gravity, the bounding box and approximated ellipse of the silhouette

•However, most of the proposed features cannot always distinguish among various body postures, especially when there is a high degree of similarity between activities (e g dimensions and orientations of the bounding boxes and approximated ellipses are nearly the same for both bending and sitting postures

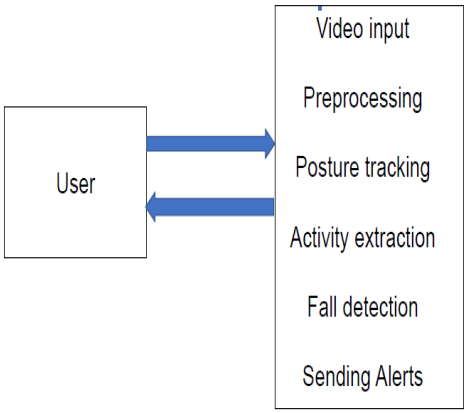
PROPOSED SYSTEM

- The proposed system presents a comparative study among several supervised classification techniques while using the video sequences during different daily and fall activities
- The classification algorithms tested in this project are The K Nearest Neighbors method (KNN), the Naïve Bayes(NB)Neural Network (NN) and the Support Vector Machine (SVM)

ADVANTAGES OF PROPOSED SYSTEM

- Falls were viewed at different angles, both from standing position and sitting position
- The proposed system provides accuracy and alerts the user

ARCHITECTURE



Other researchers use information learned from images and videos in detecting falls [12]. These mechanisms were introduced based on a single

camera, multiple cameras [13], and omnidirectional ones [14] and stereo-pair cameras [15]. This approach presents some benefits over a sensor-based approach, in particular, no human intervention is needed and no wearing of sensors is required. In comparison to wearable sensors, the camera provides more complete and detailed information about the supervised person (e.g., posture, positioning, and location), as well as their environment. Thus, growing demand for vision-based fall detection systems has been recorded from health centers, hospitals, and retirement homes [16], [17]. Furthermore, many research in related fields has shown that vision-based remote health monitoring is essential to monitor non-critical patients at home rather than in hospital whilst reducing strain on hospital resources. Since video surveillance systems enable efficient analysis of the behavior of the supervised person (even in the normal state), such as taking medication and sleep schedules, it facilitates to elderly people to live independently at home for longer [17], [18]. In the last past few years, several international projects such as BIOTELEKINESY are implemented using camera-based fall detection mechanisms [19]. To mitigate the problem of stakeholder' privacy, image acquisition, and data treatment should be consistent with ethical concerns. To do so, only the processed images are used for fall detection and the videos of the supervised senior are not recorded [19]. In [20], Ozcan et al. introduced a systematic fall detection procedure via wearable cameras using relative entropy metric. Rougier et al. [21] designed a fall detection technique by merging the variation of human shape and motion history. However, this approach uses a threshold manually fixed to discriminate non-fall from fall activities. Also, a high false alarm rate resulted due to miss-classification of several non-fall activities such as fast sitting activities. Miaou et al. [14], [22] proposed a fall detection algorithm using a MapCam (omnidirectional camera). Specifically, this approach uses the rule-based algorithm. This approach achieved 91% successful fall detection rate. In [23] a reconstructed 3-dimensional human silhouette was used to determine whether a person fell. The decision in this mechanism is based on the volume distribution along the vertical axis, an alarm is reported if the majority of this distribution was abruptly close to the floor. The method in [23] requires multiple cameras and a graphics processing unit for processing. The method in [24] used an approximated ellipses that closely encapsulate the contours of the human body and temporal changes of head position to detect human fall; falls were classified by neural network algorithm. Other works used a depth camera and sensor data to detect potential falls by support vector machine (SVM) algorithm [25], [26]. In [27], an image-based fall detection approach has been introduced to detect falls in the elderly based on videos from surveillance systems or webcams. This approach is performed into two steps: after identifying people in a video frame using an object detection algorithm, then a posture recognition method is applied to track the status of the supervised person by verifying the relative positions of the chair and the people [27]. An alarm is given when a potential fall is detected. However, this approach focuses only on detecting falls that occur while sitting down and standing up from a chair. Others fall scenarios, such as falling while picking something up from the ground and falling while getting out of bed, are not considered in this work. In this work, an efficient computer vision approach is proposed to address the fall detection and classification problem.

This paper introduces an effective and efficient human fall detection mechanism based on the generalized likelihood ratio (GLR) approach, which is an efficient anomaly detection technique [28]. The GLR detector is suitable to achieve automated detection of falls due to its capability to small changes [28], [29]. However, the principal shortcoming of the GLR detector is its incapability to separate real falls from behaviors similar to a fall like stretching out. Then, to mitigate this limitation, the greater discrimination capacity of SVM is exploited. Notably, the SVM classifier is frequently used for tackling the classification of linear and nonlinear features by employing nonlinear kernels. The main benefit of SVMs consists in their capacity to suitably uncover important patterns in the data by transforming problems into higher dimensions using kernel functions, enabling a non-linear relationship to appear approximately linear [30]. Here, the desirable properties of the GLR chart and the SVM classification system are exploited for enabling efficient human fall detection in a home environment In this work, the classification stage is performed only when a potential fall is identified by the GLR approach. Therefore, the SVM classification is fed with a reduced number of sequences, which enhance accuracy. Accordingly, by merging the GLR fall detection procedure with the SVM classifier, GLR-SVM, fall detection accuracy is significantly improved compared to that obtained via the conventional approaches. Tests on two publicly available datasets show that the proposed GLR-SVM has a good capacity for enabling efficient fall detection. Compared with the conventional machine learning techniques namely neural network, k-nearest neighbor, decision tree, and naïve Bayes procedures, the GLR-SVM mechanism achieves better detection results.

CONCLUSION In this study, a statistical strategy for efficient fall detection and classification using a GLR chart and SVM classifier is presented. First, the human body is divided into five portions corresponding to five partial occupancy areas. Then, for each frame, the area ratios (extracted features) have been computed and utilized as input data. The feasibility of the designed mechanism was tested on two publicly available datasets. The results demonstrated that the combined GLR detection scheme with the SVM classification was not only able to separate between daily activities and falls but it was also able to distinguish true false from false fall events (like intentional lying or missing step). Data were also collected to evaluate the combined GLR-SVM fall detection strategy in comparison to other classifiers including neural network, K-nearest neighbor, decision tree, and naïve Bayes classifiers. The major finding was that the combination of GLR and SVM techniques provided a method with fewer false-positive falls than other approaches, making it a more accurate fall detection technique.

As future work, we plan to incorporate information from Kinect camera (instead of RGB camera), which operates on depth imagery and preserves privacy for people being monitored. Hence, in this case, the proposed fall detection strategy can be used in a similar manner as in the case of RGB cameras.

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