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Real-Time Fall Detection Using Vision-Based Monitoring

K.Arulselvan[1], R.Reshma[2], A.Rihana Banu[3], M.Noorul Marwa[4]

[1]Department of Instrumentation & Control Engineering, A.V.C. College of Engineering
[2]Department of Instrumentation & Control Engineering, A.V.C. College of Engineering
[3]Department of Instrumentation & Control Engineering, A.V.C. College of Engineering
[4]Department of Instrumentation & Control Engineering, A.V.C. College of Engineering

[1*]**Corresponding Author E-mail:** aselvan02@gmail.com

ABSTRACT: Video Surveillance is an omnipresent topic when it comes to enhancing security and safety in the intelligent home environment. Artificial vision provides a remarkable good sensor. Cameras are passive sensors that supply a great amount of information.In this project we develop an application for elderly care that detects falls or faints and automatically triggers the health alarm. In this work, we propose a human-shape-based falling detection algorithm and implement this algorithm in a multi-camera video surveillance system. This algorithm uses multiple cameras to fetch the images from different regions required to monitor. It then uses a falling-pattern recognition approach to determine if an accidental falling has ccurred. If yes, the system will trigger the health alarm. It should not reset within few seconds system automatically sends short messages to someone needs to alert. Furthermore, we use the speed of fall to differentiate real fall incident and an event where the person is simply lying without falling.

Keywords: Passive Sensors, Video Surveillance, Pattern Recognition, Speed Of Fall

1. Introduction

Frequency of falls amongst elderly people is high. About 30% of independent living elderly persons (>65yr) make at least one fall a year. Half of those over 80 fall at least once a year. About 10% to 15% of all falls in older people will result in some serious physical injury, e.g. fractures (in 5% of all falls). Fall-related injuries are reported to be the fifth most common cause of death in the elderly population and the most likely cause of accidental death.

According to the Public Health Agency, one person out of eight was older than 65 years old in 2001. In 2026, this proportion will be one out of five. Moreover, a majority of seniors, 93%, reside in private house, and among them, 29% live alone. Falls are one of the major risks for old people living alone, causing severe injuries.The gravity of the situation can increase if the person cannot call for help, being unconscious or immobilized. Nowadays, the usual solution to detect falls is to use some wearable sensors like accelerometers or help buttons. However, older people often forget to wear them, and in the case of a help button, it is useless if the person is unconscious after the fall.

Moreover, batteries are needed for these devices and must be replaced or recharged regularly for adequate functioning.

2. Objective of the Project

The objective of this project is to detect the accidental falls of elderly people using video monitoring. A computer with dual web camera is going to monitor the elderly people.

The frames are analyzed using the prescribed algorithm, if any fall is detected the system will raise alarm. The alarm will produce sounds for few minutes to indicate fall is happened. If it is not reset manually within a preset time, it resets automatically and fall information is transferred to the care taker via short message through mobile phone.

3. Related Works

Recently some research has been done to detect falls using image processing techniques. A simple method was used in [1] based on analyzing aspect ratio of the moving object's bounding box. This method could be inaccurate, depending on the relative position of the person, camera, and perhaps occluding objects. The works in [2] used the normalized vertical and horizontal projection of segmented object as feature vectors. To overcome occluding objects problem, some researchers have mounted the camera on the ceiling: Lee [3] detected a fall by analyzing the shape and 2D velocity of the person. Nait-Charif [4] tracked the person using an ellipse and inferring falling incident when target person is detected as inactive outside normal zones of inactivity like chairs or sofas.

Despite the considerable achievements that has accomplished on this field in the recent years, there are still some clear challenges to overcome:

• Visual fall detection is inherently prone to high levels of false positive as what appears to be a fall or not be a fall. In other words, most of current systems are unable to discriminate between real fall incident and an event when person is lying or sitting down abruptly.

• Existent fall detection systems tend to deal with restricted movement patterns and fall incidents are usually detected in contrast with limited normal scenarios like walking; however in real home environments various normal /abnormal motions occur.

4. Proposed System Overview

In this paper, we consider indoor environment setting with dual camera. We assume camera point of view is easily recognising human postures without ambiguities.

The first step in our method is to obtain the segmentation of the foreground human object. We achieve this by adapting background subtraction algorithm developed by Mohamed sigari [5].

The next step is to skeletonise the human object in order to maintain their privacy. From the silhouette of the foreground human object thinning algorithm is applied. Using the skeleton fall is detected by projection histogram Àpar method [6]. With the help of the height and width of the skeleton, projection histogram is plotted. Using the plot of the projection histogram fall is identified.

Finally we use the adjacent frame difference method to identify the falling speed and to infer the real falling events. These algorithm steps are portrayed in figure.1.

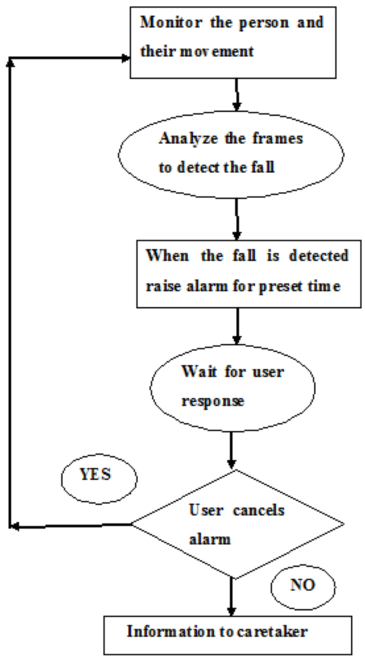

Figure 1: *Process flow diagram*

We will now discuss the various algorithms used in the proposed system.

4.1 Foreground Segmentation

Identifying moving objects from a video sequence is a fundamental and critical task in many computer-vision applications. A common approach is to perform background subtraction, which identifies moving objects from the portion of a video frame that differs significantly from a background model. There are many challenges in developing a good background subtraction algorithm.

First, it must be robust against changes in illumination. Second, it should avoid detecting non-stationary background objects such as moving leaves, rain, snow, and shadows cast by moving objects. Finally, its internal background model should react quickly to changes in background such as starting and stopping of vehicles.

Figure 2 (a): *Background image*

Background subtraction is particularly popular method for motion segmentation. The traditional background extraction methods such as average method, histogram method, GMM commonly could not precisely extract background when moving objects have high density or appear too frequently. In order to solve this problem, popular method for motion segmentation is used and attempts to detect moving regions in an image by differencing between current image and a reference background image in a pixel-by pixel fashion .This method extracts the foreground object shown in figure 2a, b.c which is fairly robust and gives appropriate results on image sequences with shadows, highlights.

Figure 2 (b): *Background image with foreground object*

Figure 2 (c): *Background subtracted image*

4.2 Silhouette Formation and Skeletonaisation

Complex models and scenes are rendered as simple line drawings by rendering silhouette edges. This definition includes internal silhouettes as well as the object’s outline, or halo. It is important to note that the silhouette set of an object is view dependent, that is the edges of a model that are silhouettes change based on the point from which the object is viewed. Here silhouette of the foreground image is obtained with the help of the method developed by Bruce grooch [7] and is shown in figure 3.

Figure 3:*Human silhouette of the Foreground image*

Next from the silhouette, skeleton of the human being is formed. It should be obtained by using Thinning algorithm. It reduces all black components in a binary image to single pixel wide branches shown in figure 4 and preserves the following properties: 1) Does not remove end points, 2) does not break connectedness, and 3) does not cause excessive erosion of the region. The algorithm is described in detail in Gonzales and Woods [8].

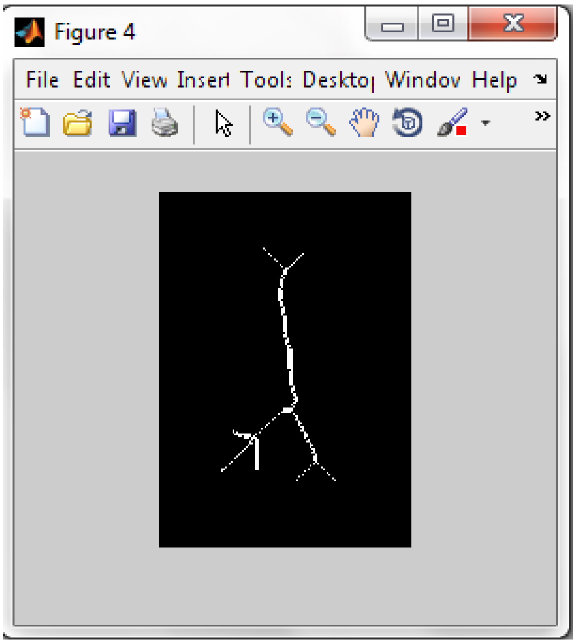

Figure 4:*Skeleton of the human silhouette*

4.3 Projection Histogram

Since the videos were acquired by a fixed camera, each frame I(x, y) is processed to extract the foreground mask (F) by means of a background subtraction step.

For this contest, we directly used the foreground images. The feature vectors are then obtained from the projection histograms of the foreground mask i.e. projections of the person's silhouette onto the principal axes x and y. Examples of projection histograms are depicted in Figure 5.

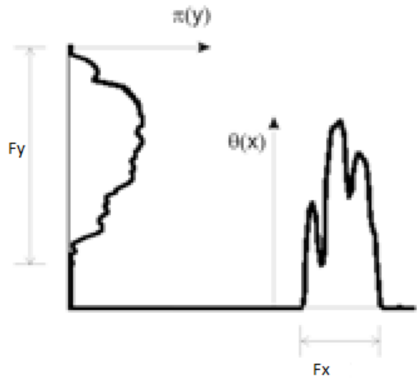

Figure 5: *Projection histogram of human silhouette*

Given the foreground mask F(x, y), the projection histograms ϴ and π can be mathematically defined as:

$$\theta(x) = \sum_{y=0}^{Fy} \emptyset(F(x,y));$$

$$\pi(x,y) = \sum_{x=0}^{Fx} \emptyset(F(x,y))$$

where the function Ø is equal to 1 if F(x, y) is true, 0 otherwise, while Fx and Fy are the width and the height of the foreground mask F respectively.

In practice, Ο and . can be considered as two feature vectors used to describe the current frame.

5. Results and Discussions

In order to evaluate the overall system performance, we apply the proposed approach to a set of videos recorded in our lab. Here we consider indoor environment settings with dual camera monitoring scenes. Distance of person to the camera is approximately 2 meters. We could expect two different kinds of behaviour: Normal, Unusual.

a) Normal Daily Activity

Five different normal daily activities are considered: Walking, Running, Bending and rising up, Sitting down on the floor and standing up and Lying down.

b) Unusual -fall

As most falls occur during intentional movements initiated by the person, they happen mainly in forward or backward: stumbling on an obstacle during walking, backward slip on wet ground.

6. Conclusions and Future Work

In this paper we developed a novel real-time video surveillance system principally dedicated to fall detection. We claim that the proposed system is not just an ordinary human fall detection system; it has many applicable properties and can be employed in different surveillance systems. Moreover while existing fall detection systems are only able to detect occurrence of fall behaviour, the proposed system is able to detect type of fall incident (forward, backward or sideway). We used combination of Horizontal and vertical projection histograms to detect the falls. Finally A software program is developed to inform fall through mobile phone to care takers.

Future works will include the incorporation of multiple elderly monitoring which is able to monitor more than one person in the scene and also be able to handle occlusion. Detecting additional behaviour is also a subject to be explored in the future work.

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