Vision-based Fall Detection and Alert System Suitable for the Elderly and Disabled Peoples

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1. Introduction

Automatic monitoring of the activities of daily living (ADL) for elderly and disabled people from image sequences is an important issue for homecare or care centre. Falls amongst the elderly are particularly serious and often lead to injury or death [1]. This paper proposes a fall detection algorithm with alert system based on video analysis techniques. In the first part, the fall detection algorithm is described: the mixture motion-texture model for human detection and tracking is firstly explored, and then the human's body characteristics are extracted and defined as robust features. The Spatial-Temporal Features is specially constructed in order to detect the fall events. Our detection algorithm is build based on this representation.

The second part emphasizes on the alert system. A central system for fall analysis framework is designed to deal with the heavy processing for large amount of video data from multiple cameras that needs to be executed in real-time with supported multi-cores multi-processors architecture and resource management capacity such as CPU, memory, and network bandwidth. In the alert process, the detected events obtained by framework may be sent to the map-based alert service that can be remotely monitored by the experts or the correspondent online call center.

2. Fall Detection Algorithm

Our algorithm is divided into 3 steps: motion detection and tracking based on motion-texture technique; human features extraction: width, height, y-axis angle and speed; fall detection: extracted features are used for fall detection analysis.

2.1 Motion Detection and Tracking

Moving object is separated from background by using background subtraction technique that small noises are removed by morphological opening and closing filters. Frequently, an object might be detected as several fragmented parts. In this case, a region-fusion operation is needed. Two regions are considered to be the same object if they are overlapped or their distance less than a specific threshold. With these constraints, the method is again very sensible to light condition such as shadow, contrast changing and sudden changes of light.

Intuitionally, introducing some special characteristics of object such as texture properties will probably improve better results. Thus, in this fusion process, the color probability density of object's texture is additionally applied as a similarity measurement between regions. Mean-shift algorithm is used as an optimization method. This mixture motion-texture model can reduce noises and increases significantly the effectiveness of algorithm.

Figure 1: Motion detection and segmentation

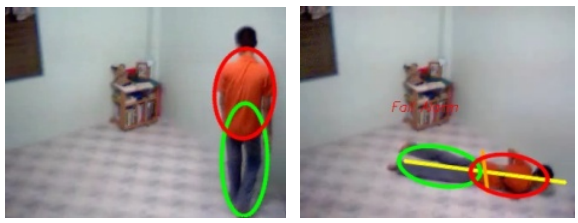

Figure 2: Humain tracking

In the tracking process, a simple human model is defined. The upper and lower body parts are considered as two separated regions with difference texture properties, but geometrically coupled together as one body. The color probability density of these textures is the key concept of our tracking method which defines the similarity between groups of pixels (moving object) from a frame to another.

2.2 Features Extraction

During the tracking processing, in each frame the human characteristics are determined. The following parameters are extracted: width and height of object region, angle between y-axis (axis is calculated from region moment) and horizontal line, and speed of the extremity points of y-axis which are computed as the ratio of moving distance between frames and time. Generally, these five features are disturbed by noises during non-perfect tracking process. Consequently, it needs to be smoothed by a low-pass filter that Butterworth is used. By considering the fall characteristic factors the filter parameters is $\frac{1}{4.22}x\left\{\frac{1}{6},\frac{1}{2},\frac{1}{1.06},1,\frac{1}{1.06},\frac{1}{2},\frac{1}{6}\right\}$.

2.3 Fall Detection

Observationally, fall event is occurring in 0.4-0.8 second [2]. To detect the event, we then inspect how these features change during that moment. Experimentally, we found that the width increases when height decreases. The angle between y-axis and horizontal line decreases close to zero. The speed acceleration of points is high and became zero rapidly. So, fall event is detected simply if one of these situations occurs.

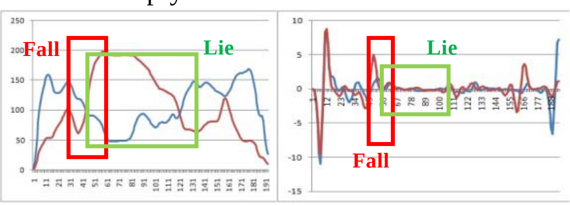

Figure 3: (left) width/height (right) control point speed.

We note that these characteristics are correct when only if camera angle is positioned perpendicularly (or likely) to the fall direction. If not, multi-cameras model is necessary.

3. Alert System

Fall detection algorithm is implemented and integrated with the video analysis framework proposed in [3] as its processing component. This framework allows our algorithm to analyze the image sequences from multi-IP-cameras in real-time. The algorithm execution supports the multi-cores and multi-processors architecture with resource management capacity such as CPU, memory, and network bandwidth. The framework architecture is divided into five important components: video acquisition, video analysis, video encoding, event alert, playback, and event statistic analysis. Details are described in [3].

4. Experimental Results

Fall datasets in indoor situation was done in a room using volunteers. We can't apply directly to elderly people because of the risk of injury.

T-Shirt Color	*Pants Color*	*Sequ-ences*	*Detect falls*	*False positives*
Orange	Blue	5	80%	1
White	Blue	5	60%	2
Green	White	5	80%	1

Table 1: Fall detection results

5. Conclusion

The performance of our system is tested for the fall detection algorithm and overall alert system. The robustness of algorithm is evaluated by using testing Datasets which the detection rate is acceptable (up to 80%). The integrated system for fall alerting shows encouraging results, in term of efficiency and reliability, which could be used in the real application.

6. References

[1]. R. Cucchiara, A. Prati and R. Vezzani "A Multi-Camera Vision system for Fall Detection and Alarm Generation", *Expert Systems Journal*, vol. 5, 2007.

[2]. L.Chia-Wen and all,"Automatic Fall Incident Detection in Compressed Video for Intelligent Homecare", Journal on Computer Communications and Networks 2007, pp.1172 – 1177.

[3]. N. Suvonvorn, A Video Analysis Framework for Surveillance System, IEEE 10th Multimedia Signal Processing, 2008, Cairns, Australia, p.867-871.