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Fall Detection Depth-Based Using Tilt Angle and Shape Deformation

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ABSTRACT

The population of elderly people is in growth. Falls risk their life, to disabilities, and to fears. Automatic fall detection systems provide them secure living; helping them to be independent at home. Computer vision offers efficient systems over many developed systems. In this article, the authors propose a new vision-based fall detection using depth camera. It combines human shape analysis, centroid detection and motion where it exploits the 3D information provided by a Kinect to compute the tilt angle to discriminate falls. Experimental tests were done with SDUFall dataset that contains 20 subjects performing five daily activities and falls, demonstrate the efficiency of the proposed system, and show that our method is promising achieving satisfactory results up to 84.66%.

KEYWORDS

Action Recognition, Depth Images, Fall Detection, Video Surveillance Vision System

INTRODUCTION

In recent years, the increase of life expectancy has led to the growth of aging population. Independent living and not needing help can lead to severe consequences. Falling are risky event that can occur in an elder person life and repeated falling are the major danger ("Health Organization Department," 2008), hospitalization and traumatic injury-related deaths (Stevens and Rudd, 2010) for person aged 65 or elder. Furthermore, fall can have physiological consequences such depress, avoidance of activities, a fear of falling that increase from suffering (Friedman et al., 2002).

There have been various researches, in order to overcome elderly fall risks and prevent these incidents. Some of these technologies are based on wearable sensors such as accelerometers, gyroscope (Cheng et al., 2013). Nevertheless, these sensors are ineffective when the user forgets to wear them or forgets to recharge or to replace the battery.

Vision-based technologies that use commodity cameras have proven to offer better solutions. Cameras have a low price, and not required to be worn by the user (Rougier et al., 2011).

Recently, Kinecth has received much attention of lot of researches due to its low-cost price and many other advantages against regular RGB camera like the privacy of person's life. In this paper, we will present a new vision-based method for fall detection in an indoor environment. The main contribution of this work lies on detecting falls differently in simple way by using the tilt angle based on head tracking and centroid movement.

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In this paper, we outline a new vision-based approach using depth camera Kinect to detect falls and exploiting person shape based on tilt angle and motion.

The remainder of this paper is organized as follow section 2 presents the related work in the field of fall detection systems. Section 3 presents the stages followed to fall detection. In section 4, experimental results are presented and discussed. Finally, section 5 concludes the paper with some remarks.

RELATED WORK

In the last few years, various approaches have been put forward by many researches to improve fall detection solutions. Fall detection methods are subdivided into two classes: computer vision-based methods and non-computer vision method.

In this section, we will review some works proposed for fall detection starting by non-vision category. Many sensors have been exploited. In the work of (Cheng et al., 2013) the authors have attached two accelerometers to chest and thigh of 10 persons. Decision tree was applied to recognize posture transitions with threshold to detect falls. The main disadvantage of this method is to wear the sensor.

Another work was proposed in (Sannino et al. 2015) where a wearable accelerometer and a mobile device were used to monitor the patients in real time, the data recorded by the accelerometer is sent to the mobile device to analyze them. This approach has three phases. First, gather data and make a set of simulated falls with the corresponding class "fall" or "non-fall". Second, knowledge extraction as a set of IF-THEN rules and the last phase consists in patients monitoring in the decisional layer in real time but this approach still preliminary, the tests were done for just three people.

In the work of (Alwan et al., 2006), a special piezoelectric sensor coupled to the floor is used, a binary fall signal can be generated in case of fall, and however, the main drawbacks can be false alarms.

In (Yazar et al., 2014) fall was detected based on three sensors consisting of a vibration sensor and two PIR sensors. The vibrations were converted into electrical signals and then Feature vectors from the vibration waveforms are extracted using the complex wavelet transform (CWT) and they are classified using support vector machine (SVM). PIR sensors were used as additional sensors to detect the infrared radiation emitted by moving objects in the room and that to eliminate falls alarms generated when the vibration sensor signal energy is concentrated in low-frequency bands such as vibration from door slams and other similar events.

In recent work in (Jokanovic et al., 2016) a new method was proposed based on radar technologies to detect falls, the authors proposed to use time-frequency (TF) which is able to reveal higher order velocity for different part of human body and based on deep learning which learns and captures the properties of the TF signatures without human intervention then it is fed to a classifier achieving 87% success rate.

These solutions are promising but cannot be effective due to noise they generate and cannot satisfy the elder user due to the inconvenience they provide why the computer vision-based solution has been adopted by many researches. There are some methods that used shape analysis to detect fall. Generally, the first step is to detect the person in each video frame using separation of people from the background. In 2D sensors, the bounding box aspect ratio was used to distinguish if the person is in an upright position or not (Liu et al., 2010).

In (Foroughi et al., 2008), an ellipse approximated the shape of the person. Despite their performance, these approaches are not feasible for fall into the direction of the camera, therefore a multi camera system was proposed to overcome this problem which benefits from the 3D features to detect fall.

(Worrakulpanit and samanpiboon, 2014) also proposed a fall detection method based the orientation standard deviation of the Ellipse, so the silhouette s approximated by an ellipse and then the motion is quantified by calculating pixel value of Motion History Image. Fall is discriminated

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