Received: 29 June 2020 | Revised: 29 December 2020 | Accepted: 25 January 2021

IET Image Processing

DOI: 10.1049/ipr2.12208

The Institution of Engineering and Technology WILEY

ORIGINAL RESEARCH

Falling motion detection algorithm based on deep learning

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Funding information
National Aerospace Science Foundation of China, Grant/Award Number: 61871021

Abstract

Falling is a significant cause of injuries and even death in the elderly. The timely detection of the fall action helps to rescue people who may have physical health problems due to the fall, so fall detection is necessary. The traditional fall detection methods are mostly based on wearable devices, which need to be worn all the time, and the cost of the device is high. In recent years, the fall detection method based on computer vision has become a research hot spot. This paper proposes a framework for falling motion detection based on deep learning. To quickly and accurately classify human movements, a method using bone key points as the feature descriptors of human movements is proposed. The OpenPose algorithm is used to extract the human skeleton point information as the primary human body feature, and then use the deep learning method to classify further and recognise our action features. In this paper, four types of daily actions, such as falling and walking, are classified and recognised. The results show that the algorithm achieves an accuracy of 99.4% on our dataset. Simultaneously, 86.1% accuracy is reached in the public dataset fall detection dataset.

1 | INTRODUCTION

Unexpected fall movements have a high probability of causing injuries and death to the elderly and patients with poor health. According to a report published by the World Health Organization in 2008 about preventing the elderly from falling [1], it is estimated that 646,000 people fall to death worldwide each year and the largest proportion of people over 65 years old. There were 3730 hospitalisations due to falls each year. In recent years, the aging of the population in various countries has deepened, and these data have increased year by year.

When a fall event occurs, timely and accurate detection of dangerous actions and alarms can reduce panic in the heart of the fallen people and allow patients to get timely help from family members or doctors. Therefore, the detection of falling motion has great practical significance.

Falling motion recognition methods are divided into sensor-based methods, environmental sensor-based methods, and vision-based methods. Sensor-based methods [2–4] use external sensors such as accelerometers, three-axis magnetometers, and gyroscopes to collect human posture and posture changes. Monitor changes in acceleration or Euler angles by setting a threshold to determine whether the wearer is falling. The accuracy and sensitivity of this method generally depend on the type of sensor selected and the location where the device is installed. As a limitation of the external device, the monitoring object is required to wear the device at all times. These sensors will fail if the user forgets to wear them or fails to charge them in time. Environmental sensor-based methods generally use infrared sensors or other sensors to detect the fall of the elderly environment. Feng et al. [5] detected fall events by placing pressure-sensitive fibre optic sensors on the floor. Taramasco et al. [6] installed infrared sensors at the height of 10 cm and 1 m above the ground to monitor the human body heat change at different heights to determine whether a fall event occurred. This method of installing special sensors in an indoor environment is complicated in equipment installation and expensive, difficult to promote.

According to the different types of data collected by cameras and the number of cameras, the fall detection method based on the vision can be divided into a depth camera-based method, a multi-camera method and a single camera method. Depth camera usually refers to the Kinect camera, which can collect depth information and image information simultaneously, and its data