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The detecting of abnormal crowd activities based on motion vector

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ABSTRACT

Aiming at the crowd in high-definition video motion state of sudden changes in rapid detection of abnormal crowd behavior problem, this paper proposes a kind of abnormal behavior crowd detection method based on motion vector. This algorithm is established upon the Social Force Model, first, extracts the motion vector in the code stream of the high-definition compressed videos, computes the interaction force in the social force model and rapidly draws the characteristics of the moving crowd; then according to the algorithm, we perform the bag of words approach and histogram statistics on the intensity and angle of the interaction force flow; finally we analyze two histograms to distinguish the moving state of the crowd and fulfill the detection of the abnormal crowd movement. The simulation experiment shows the method compared with the traditional social force model, in the 1024×768HD video frame processing speed on the average increase of 30% in average, the discrimination of abnormal frame advance 35 frames, the recall to an average increase of 22%.

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1. Introduction

The detection of crowd behaviors in the crowded scenes has drawn more and more attention from the research institutes. It is highly applicable to the identification of events, estimation of traffic flow and simulation of predicted behaviors. An evident question concerning these issues is how to simulate and learn the detection of the pedestrian's dynamic behaviors in the crowded scenes.

In recent years, breakthroughs have been made in the aspect of the crowd behavior analysis due to the swift development of the machine visual technology. At present, there are two major methods of crowd density research. One is the method of pixel statistics proposed by Davies [1], and the other is the method of texture features proposed by Marana [2]. Chow [3] adopt the method of neural network to analyze the crowd density, which requires the neural network to be trained in advance. It was applied to the Hong Kong subway system in 2009, and the following adoption of the vector machine help to enhance the accuracy of identification. In 2001, Lin [4] detect the individual characteristics with the personal features and fulfilled the statistics of crowd population and the estimation of crowd density. This method is quite effective in dealing with the circumstance of low density crowd, while in the circumstance of high density crowd where the crowd may be occluded, it is not very effective. In 2008 Chan [8] propose the dynamic texture system of the Gaussian mixture model by introducing the Gaussian model into the traditional texture method. It could fulfill the general classification of various circumstances in

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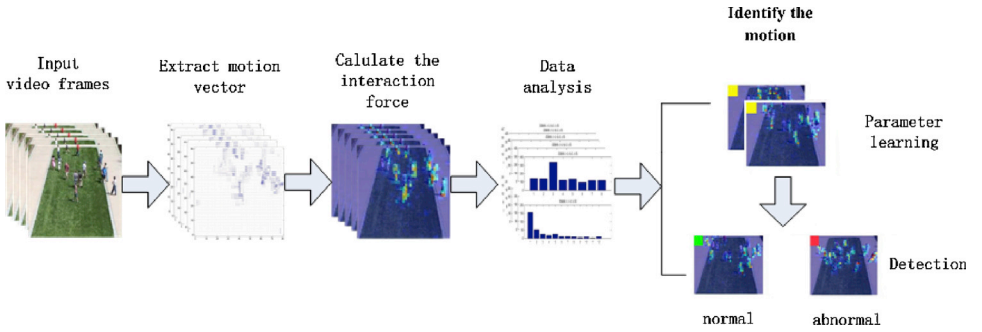

Fig. 1. Framework of our algorithm.

the crowded outdoor scenes. Le Bon [12] describe the collective crowd behaviors as the study of the popular minds. As the group is a gathering of crowds, it demonstrates very different traits from the individuals. When people are grouped together, their emotions and thoughts would become similar and their own wills tend to disappear. Therefore, the crowd has its own intrinsic and collective features. Though people of a crowd do not know each other, they still share their behaviors and targets, which guide them to adjust together according to the routes of others.

In the normal crowded scenes, the pedestrians would produce an interactive effect as they are influenced by cooperativeness and exclusiveness. Therefore, they need to change the direction or speed of their movement in order to avoid collision. When it is hugely crowded, the pedestrians would try to avoid touching each other by keeping a certain distance away from others, and would pay more attention to the minimization of the contact areas. Thus, Helbing and Molnar [5,6] proposed the social force model to simulate crowd movement. This model could describe well the particular phenomena of crowding, blocking and so on of the scenes of evacuating.

As is shown by Fig. 1, based on the social force model, this paper firstly collects the information of the motion vector in the code stream of the high-definition compressed videos. Then it extracts the traits of the crowd movement and simulates the particle movement of the crowds by using the macro-blocks. Secondly, it computes the motion vector of the macro-blocks and the average motion vector of the neighboring macro-blocks, and fits the social force model with the motion vector to get the interaction force of the particles of the macro-blocks. Finally it uses the bag of words approach to classify the interaction force and conducts the histogram statistics on the strength and direction angles of the force flow to identify the motion of the crowds. This method replaces the optical flow field with the motion vector, which largely improves the speed of detection.

2. Social force model

The social force model is a classical model in the individual microscopic models. Helbing [7] propose that the motion behaviors of the pedestrians are co-determined by the individual willingness to move, the effect of the interaction with the environment, and the random interruption during the movement. He also established the mathematical expression to depict the individual motion behaviors, which could simulate the dispersion of crowds vividly.

The social force model [11] holds that an interactive effect would be produced between the pedestrians, and the pedestrians and the obstacles around in the normal scenes. There is cooperativeness and exclusiveness in the effect, as people tend to change their directions or speed of movement to avoid collision. Thus, it can be decided that the individuals in motion are influenced by two kinds of force. One is F_p, the applied force of individual motive which comes from the individual that moves at his desired velocity; the other is F_{int}, the interactive force which is produced by the mutual effect between the environment and the crowd around when the individual is moving. The mutual effect of the individual motive force F_p and the interactive force F_{int} becomes the actual applied force F_a, under which the individual makes his movement.

Suppose there is the moving individual i. The mass is m_i, and the moving speed is v_i, then the actual applied force F_a is:

$$F_a = m_i \frac{dv_i}{dt} = F_p + F_{\text{int}} \tag{1}$$

The applied force of individual motive F_p refers to the driving force that the moving individual i applies to himself in order to realize his goal. It is also the intrinsic motion force that enables the individual to adjust his moving direction and speed timely to move rapidly towards his destination. However, as the crowdedness would influence people's actual movement, v_i of the actual motion will be different from the desired velocity v_i^p, then the intrinsic force applied by the pedestrian, when the actual speed v_i is changing into the desired speed v_i^p, is the applied force of individual motive F_p, τ is the relaxation parametric which represents the time that the pedestrian spends to change his actual moving speed into the desired moving speed.

$$F_p = m_i \frac{1}{\tau}(v_i^p - v_i) \tag{2}$$

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