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An Intelligent Detection Approach for Smoking Behavior

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ABSTRACT

Smoking in public places not only causes potential harm to the health of oneself and others, but also causes hidden dangers such as fires. Therefore, for health and safety considerations, a detection model is designed based on deep learning for places where smoking is prohibited, such as airports, gas stations, and chemical warehouses, that can quickly detect and warn smoking behavior. In the model, a convolutional neural network is used to process the input frames of the video stream which are captured by the camera. After image feature extraction, feature fusion, target classification and target positioning, the position of the cigarette butt is located, and smoking behavior is determined. Common target detection algorithms are not ideal for small target objects, and the detection speed needs to be improved. A series of designed convolutional neural network modules not only reduce the amount of model calculations, speed up the deduction, and meet real-time requirements, but also improve the detection accuracy of small target objects (cigarette butts).

KEYWORDS

Computer vision, Real-time, Robustness, Small object detection, Smoking detection

INTRODUCTION

With the continuous advancement of technology, smoking detection methods have also been continuously improved. Traditional smoking detection methods are usually detected by physical means such as smoke sensors and wearable devices. Mobile health technologies are being developed for personal lifestyle and medical healthcare support, of which a growing number are designed to assist smokers to quit (Ortis et al., 2020). However, these methods have many limitations: one is that the concentration of smoke in outdoor scenes is greatly diluted and cannot be sensed by the smoke sensor; the other is that wearable devices are expensive to perform detection and need to be owned by everyone. In addition, the movement trajectory and speed of multiple parts of the limbs are judged in this method, the pattern is match with the smoking behavior, and then the matching degree is judged through machine learning classification methods such as support vector machine (SVM). The detection accuracy and efficiency of this type method are relatively low (Senyurek et al.,2019).

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In addition to using physical equipment to detect smoking, some scholars detect smoking by using traditional graphics object detection methods. This type of method is divided into three steps (Wu et al., 2010): First, different sizes and step length sliding windows are set, and then all the windows are slided in each position on the image. For each window, the feature of the object to be measured is extracted through the histogram of oriented gradient (HOG) or scale-invariant feature transform (SIFT) method, and finally the classification algorithm is used for each sliding window to perform classification, such as SVM, Adaboost, etc., and the sliding window with the highest score is selected as the detection result. However, this type of method has the following disadvantages: firstly, the detection effect is not ideal, it is easy to be interfered by other objects, and the positioning is not accurate, relying on the preset sliding window size and sliding step length; secondly, there is a large amount of calculation in this method, and it needs to perform feature processing and classification judgment for each sliding window; finally, the method and process of manually extracting features are more complicated and do not have generalization.

With the rapid development of computer and video processing technology, the intelligent off-site law enforcement of taxis has become possible. However, there is still a lack of intelligent analysis technology for illegal taxis. An automatic detection algorithm is proposed for smoking behavior (Huang, Jia, Liu, 2020). First, the proposed brightness screening rules are used to reduce the processing time of the image enhancement part; secondly, Haar-Adaboost and the proposed segmented histogram matching algorithm are combined to realize the recognition of the taxi window area; a set of representative features are designed to identify smoking smoke and smoke shaking actions, including the movement trajectory of the center of mass of the smoke, the area growth rate, the ratio of the smoke convex hull to the contour circumference, the area ratio of the circumscribed rectangle within the contour, and the frequency and time interval of the smoke shaking, and the support vector machine is finally used for feature classification. In order to detect smoking behavior in time and make accurate state judgments, a smoking behavior detection algorithm is proposed based on multi-task classification (Cheng et al., 202). This algorithm combines multi-task convolutional neural networks, cascaded regression and residual networks, multi-task convolutional neural network algorithm and the regression tree method based on gradient enhancement learning (RET cascade regression) are used to quickly locate the region of interest (ROI) in the mouth; on this basis, the residual network is used to detect the target and identify the state in the ROI. In view of the slow speed, false detection rate and high hardware occupancy of the classic convolutional neural network smoking detection algorithm, a fast smoking detection is proposed based on faster region with convolution neural networks (Faster R-CNN) (Han & Li, 2020). The face is detected and the detected face image is used as the cigarette detection area to reduce the target detection area and filter out targets similar to cigarettes. The image segmentation method is used to conduct a preliminary cigarette inspection on the face area and to determine whether there is a cigarette. The Faster R-CNN algorithm is used to detect the cigarette target on the image, that initially judges that there may be cigarettes and determine whether there is smoking behavior.

The AlexNet network model was born in 2012 and won the ImageNet image classification competition in that year (Krizhevsky, Sutskever, & Hinton, 2012). As a result, both academia and industry have paid extensive attention to the application of deep learning in the field of computer vision. Such as face recognition, vehicle detection, etc. In this paper, the smoking detection problem is classified as a target detection problem, that is, the position relationship between pedestrians and cigarette butts is located to determine whether there is smoking. In this paper, a lightweight smoking detection network model is designed by drawing on the high-performance detection algorithm of YOLO (you only look once) (Redmon et al., 2016). Multi-level and different feature map vectors are combined in the model, the attention mechanism module and the disabled difference module and SPP (spatial pyramid pooling) module are increased, the original network structure is improved, and the detection accuracy of small targets is improved. At the same time, it reduces the convolution kernel parameters of the model, thereby reducing the amount of model calculations and speeding up the final