Research on pedestrian detection system based on intelligent terminal with limited computing ability

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Abstract. Pedestrian detection technology is the use of computer vision technology to determine whether there are pedestrians in static images or video images, and accurately mark pedestrians. Intelligent vehicles, intelligent monitoring, human behaviour analysis and other aspects are related to pedestrian detection technology, so pedestrian detection technology has been widely concerned by all walks of life. However, in some application environments, the network setting is flexible and the location of the device can be changed at any time, so it is difficult to establish a pedestrian detection system by wired way, and the pedestrian detection system can only be established through WSN. It is necessary to consider how to complete pedestrian detection through intelligent terminal under the condition of limited computing power. Many researchers have put forward a lot of algorithms, which are constantly optimized, but there are still many problems to be solved in practical application. In this paper, aiming at the intelligent terminal in WSN environment with limited computing power, a pedestrian detection system based on HOG+SVM is designed, which can detect moving pedestrians in video in real time. The detection system is mainly composed of detection algorithm and video acquisition module. After the test of INRIA and CVC data set, the accuracy of the detection algorithm in this paper is 89.06%. This method is tested under the intelligent terminal with limited computing power, with a good detection effect.

1. Introduction

With the development of society and economy, more and more temporary outdoor activities, such as marathons and concerts, have attracted more and more attention. At present, UAV monitoring is mainly used to monitor security. However, there is a lack of complete and comprehensive coverage of the monitoring site. Therefore, the pedestrian detection system based on intelligent terminal combined with Wireless Sensor Network (WSN) network appears.

The main problem of pedestrian detection is to detect pedestrians in pictures or videos, and then the position and size of pedestrians are represented by rectangular boxes. Face detection is also a kind of target detection and analysis. Pedestrian detection technology is very practical, which is involved in autopilot system, intelligent robot, intelligent video surveillance, human behaviour analysis, pedestrian tracking, pedestrian identification, passenger flow statistics, transportation and other fields. However, in some application environments, the network structure is flexible and the location of the device can be changed at any time, so it is difficult to establish a pedestrian detection system by wired way, and the pedestrian detection system can only be established through WSN. In this way, it is necessary to consider how to complete pedestrian detection through intelligent terminal under the condition of limited computing power. All these factors make pedestrian detection a very challenging topic in the field of computer vision [1,2].

At the beginning of the development of pedestrian detection, the detection method based on sliding

window is the most widely used. This method was proposed by Papageorgiou and Poggio [3]. They also proposed Haar wavelet features and trained pedestrians with SVM to test samples including the front and back of pedestrians. After that, Viola and Jones [4,5] used cascade AdaBoost and Haar-like feature learning algorithm to detect pedestrians, and applied this technology to identify pedestrians in video surveillance, which was considered to be the basis of modern video detection. In 2005, Dalal and Triggs and others proposed that the gradient direction histogram feature (HOG), HOG feature depends on the gradient information detection of the image, and allows the image information to overlap, which makes it insensitive to the change of light and transition. And it can effectively characterize the edge characteristics of the human body. In recent years, pedestrian detection algorithm based on deep learning has achieved a great success. Deep learning model training requires a large number of pedestrian sample data, and the more complex the network layer, the greater the amount of computation required, so it is urgent to improve the optimization technology [6,7].

The detection method based on sliding window and the pedestrian detection algorithm based on deep learning require the intelligent terminal to have strong computing power, but this is precisely what the intelligent terminal lacks [8-10]. Therefore, aiming at the intelligent terminal in WSN environment with limited computing power, this paper designs a pedestrian detection system based on HOG + SVM, which can detect moving pedestrians in video in real time. The detection system is mainly composed of detection algorithm and video acquisition module. After the test of INRIA and CVC data set, the accuracy of the detection algorithm in this paper is 89.06%. This method is tested under the intelligent terminal with limited computing power, with a good detection effect.

2. Related algorithm

2.1. HOG feature

When calculating HOG features, the entire image is divided into small junction regions called cells, creating a directional gradient histogram in each unit. When describing the detected object, the combination of these histograms can be used.

2.2. Support vector machine

Support vector machine [11,12] is a binary classification model to find the hyperplane used to separate samples. The principle is to maximize the interval and turn the problem into a convex quadratic programming problem to find the best answer.

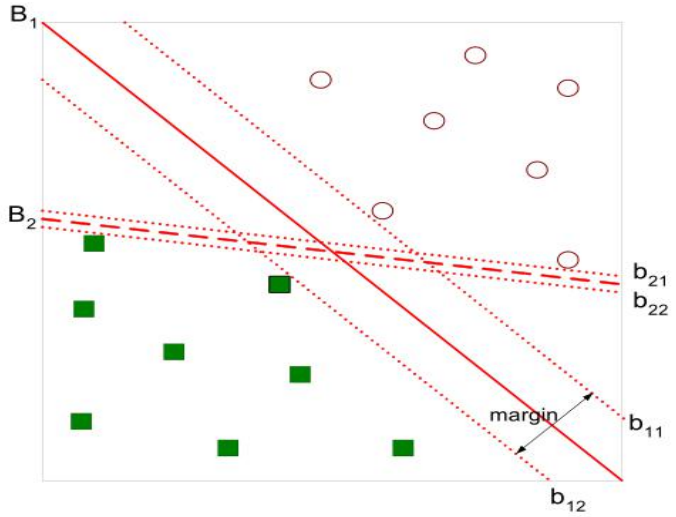

Figure 1. Hyperplane.

In the binary classification problem, there is data set $T = \{(x_1, y_1), (x_2, y_2), ... (xn, yn)\}$, $y_i \in (0, 1)$. We can find a hyperplane $w * x + b = 0$. The corresponding decision function $f(x) = sign (w * x +$

b) separates the data as shown in Figure 1.

From the above figure, it is obvious that B1 has a better classification effect. The distance between the two points closest to the optimal hyperplane is called margin. From the graph, we can see that the larger the range of margin, the higher the accuracy of classification. The calculation of margin is formula (1):

$$margin = \frac{2}{\|\omega\|} \tag{1}$$

3. Pedestrian detection algorithm based on intelligent terminal with limited computing power

This is the core part, using HOG+SVM to achieve pedestrian detection algorithm. The implementation is divided into the following processes: (1) Dataset reprocessing includes negative sample cutting and positive sample scaling; (2) HOG feature extraction; (3) Classifier training (Figure 2); (4) Algorithm detection, including detecting pedestrians in still images and image sequences.

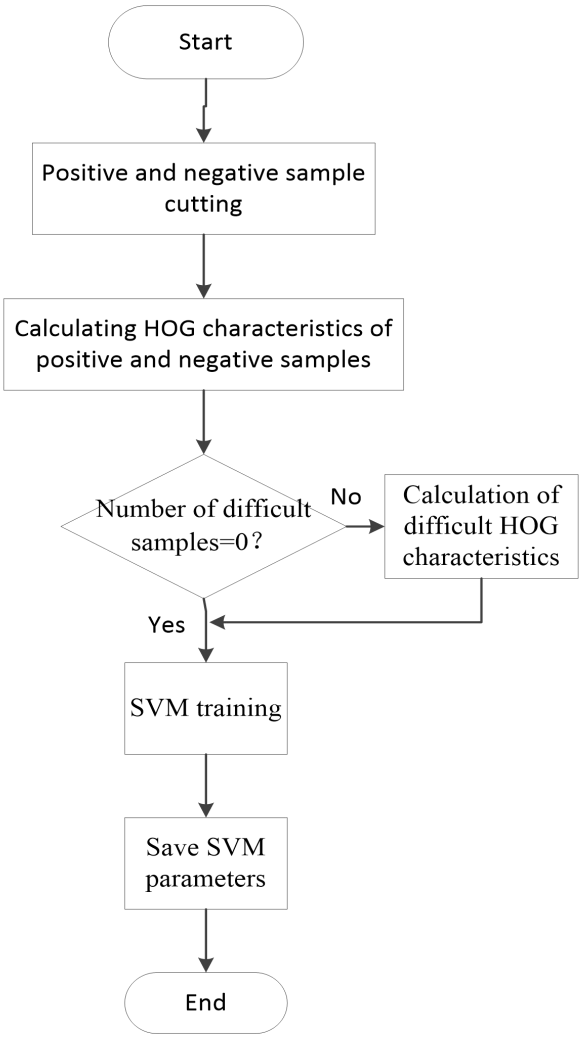

Figure 2. Training process.

4. Experiment

As a mature and convenient classifier, SVM is used by many researchers. There are many software packaging libraries implemented by SVM, among which LIBSVM is familiar to everyone. OpenCV collates the functions of LIBSVM, on the basis of which the SVM algorithm is implemented.

Therefore, we use OpenCV to develop a HOG+SVM pedestrian detection program for intelligent terminals with limited computing power, and use INRIA and CVC data sets to test. INRIA is a static image database and CVC is an image sequence database. The training set in INRIA database is used to train SVM classifiers, and the test set is used to test the accuracy of classifiers. The database is the most commonly used static pedestrian database, providing the image and the corresponding tag file. Positive and negative samples were included, of which 2416 pedestrians were included in the positive sample. 2441 positive samples were randomly cut from 2416 images for training, and some difficult images were selected for repeated training. The program interface is shown in Figure 3:

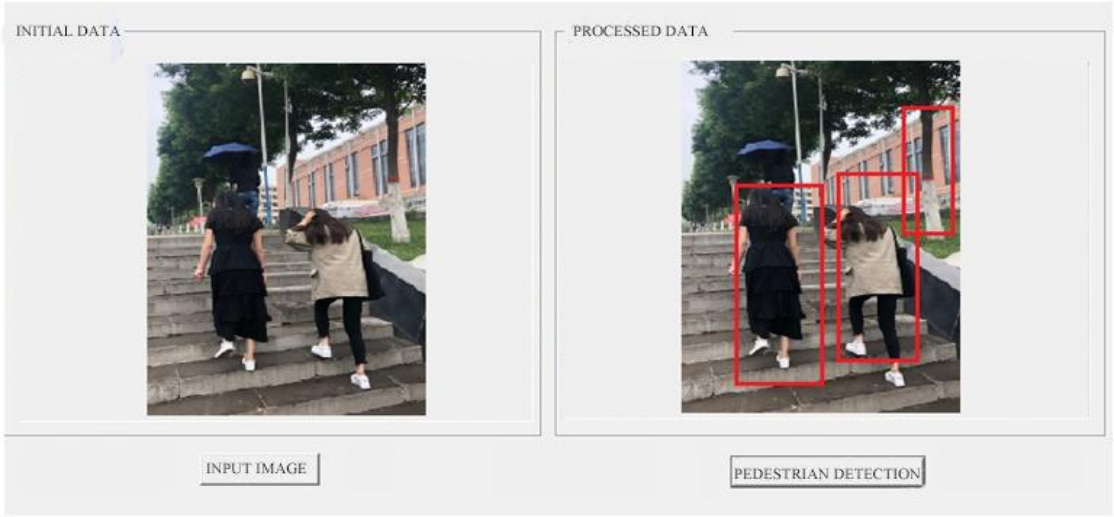

Figure 3. Our pedestrian detection program.

The experimental results are as follows in Table 1 and Table 2:

Table 1. Experimental results.

Sample set			Total
Positive sample (1082)	TP = 825	FP = 10	835
Negative sample (1359)	FN = 257	TN = 1349	1606

Table 2. Statistics of experimental results.

	Result
TPR (True Positive Rate)	76.26%
FPR (False Positive Rate)	0.74%
ACC (ACCuracy)	89.06%

From the experimental data, it can be concluded that the SVM classifier trained in this paper is better than the positive samples in dealing with negative samples.

5. Summary and prospect

In this paper, OpenCV, is used to complete the HOG+SVM pedestrian detection algorithm on the intelligent terminal with limited computing power. After testing, a good detection effect has been achieved. But there are still some problems:

- The training set in the prototype system is small, and the selection of parameters is not further optimized. In the future, it will be gradually improved in the product stage.
- In the case of complex background conditions and a large number of people, TPR is not high; there will be error detection, missed detection and so on. With the development of intelligent

terminal technology and the continuous improvement of computing power, higher complexity algorithms can be used to improve the accuracy [13].

- Combining HOG operator with other operators, an improved directional gradient histogram algorithm has been proposed by researches. The characteristics dimension of the deep model extracted by Res Net is reduced by principal component analysis algorithm (PCA), which greatly improves the accuracy.

This paper first introduces the development of pedestrian detection technology at home and abroad. Secondly, it describes the HOG+SVM pedestrian detection scheme used by intelligent terminals with limited computing power, as well as the implementation of the algorithm and the test of the detection system, which verifies the feasibility and effectiveness of the system. Intelligent terminal technology and pedestrian detection technology are still developing. The arrival of big data and artificial intelligence era has put forward higher requirements for pedestrian detection algorithm, in order to make the detection technology better applied in various fields, further research is needed.

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