Research on Pedestrian Detection Technology Based on AdaBoost-RBFSVM Algorithm Intelligent Monitor

Ling-Hua Kong

Abstract:
Make a cascade classification by AdaBoost and RBFSVM algorithm, the HOG features are extracted using HOGDescriptor of OpenCV. From the pedestrian detection experiment with the specified samples, the result shows that the AdaBoost-RBFSVM cascade classification is superior in Positive rate and False Positive rate of classification, the training time is greatly reduced.

Keywords: AdaBoost; RBFSVM; HOG; OpenCV
Middle map classification number: TP391  document identification code: A

1. Introduction
Pedestrian detection is a hot topic in the field of image recognition. The goal is to obtain each pedestrian's space position in each frame in the video image. Pedestrian detection is a very complex intelligent behavior recognition technology. At present, the mainstream pedestrian detection method is based on the detection method of the apparent eigenvector. In the aspect of target feature extraction, HOG features, LBP features and Haar-like features have different applications in the image detection in different fields, especially in the pedestrian detection with the HOG feature. In terms of machine learning algorithm selection, AdaBoost and SVM algorithm has been successful, but there are still shortcomings such as over fitting and long training time. In this paper, in view of the problems in pedestrian detection, the real-time detection of pedestrians in video surveillance is realized by using the HOG feature and the AdaBoost and SVM cascading machine learning algorithm.

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2. Statistical learning algorithm
   2.1 AdaBoost algorithm

   AdaBoost is a classification iteration algorithm based on cascade model. The algorithm is described as follows:

   Input: training set: \((x_1, y_1), \ldots, (x_n, y_n)\), where \(x_i\) is the sample description, \(y_i\) is a sample mark,

   \[ y_i \in \{0, 1\} \quad 0 \text{ of them, 1 are positive samples and negative samples, respectively.} \]

   In pedestrian detection, 0 is defined as pedestrians and 1 is non-pedestrians .

   **Initialization:** the same weight is set in the initial sample \(w_{i0} = \frac{1}{n}\)

   T=1 for the following steps, 2,.. T sub cycle:

   ① Normalize Weights
   \[
   u_{it} = \frac{w_{it}}{\sum_{j=1}^{n} w_{ij}}
   \]

   ② Training a weak classifier for each feature \(f, h(x_i, f)\)

   The weighted error rate of all weak classifiers is calculated

   \[
   e_t = \sum_{i=1}^{n} u_{it}|h(x_i, f) - y_i|
   \]

   ③ Select the best weak classifier according to the minimum error rate \(h_t(x_i)\)

   \[
   e_t = \text{min}_t \sum_{i=1}^{n} u_{it}|h(x_i, f_t) - y_i| = \sum_{i=1}^{n} u_{it}|h_t(x_i, f_t) - y_i|
   \]

   \[
   h_t(x_i) = h_t(x_i, f_t)
   \]

   Weight adjustment based on the best weak classifier

   \[
   w_{t+1} = w_{t} \beta_t^{1-e_t} \quad \beta_t = \frac{e_t}{e_t}
   \]

   among \(e_t = 0\) Express \(x_i\) is correctly classified \(e_t = 1\) Express \(x_i\) is wrongly classified

   ⑤ Finally, a strong classifier is obtained
\[ C(x) = \begin{cases} 1 & \sum_{i=1}^{N} \alpha_i y_i (x) \geq \frac{1}{2} \sum_{i=1}^{N} \alpha_i \\
 0 & \text{Other} \end{cases} \]

among \( \alpha_i = \log \frac{1}{p_i} \)

2.2 Support vector machine SVM

Support Vector Machine, SVM \(^{[3]}\) It's a machine learning algorithm based on the VC dimension theory and the structural risk minimization principle. Group training sample set

\[ T = \{ (x_i, y_i) \mid x_i \in \mathbb{R}_n, y_i \in \{ 1, -1 \}, i = 1, 2, \ldots, n \} \]

SVM The problem of solving the solution is transformed into a solution

\[
\begin{align*}
\text{Min} & \quad g(w, \varepsilon) = \frac{1}{2} ||w||^2 + C \sum_{i=1}^{N} \varepsilon_i \\
\text{Subject to:} & \quad y_i (\langle w, \varphi(x_i) \rangle + b) \geq 1 - \varepsilon_i, \quad i = 1, 2, \ldots, n
\end{align*}
\]

among \( \varepsilon_i \) Relaxation variable \( C \) As a penalty factor according to WolfeDual form

1 2 The problem of minimization can be expressed as

\[
\begin{align*}
\text{Min:} & \quad W(\alpha) = \frac{1}{2} \sum_{i=1}^{N} \sum_{j=1}^{N} y_i y_j \alpha_i \alpha_j \langle \varphi(x_i), \varphi(x_j) \rangle - \sum_{i=1}^{N} \alpha_i \\
\text{Subject to:} & \quad \sum_{i=1}^{N} y_i \alpha_i = 0, \forall \theta 0 \leq \alpha_i \leq C \\
& \quad \langle \varphi(x_i), \varphi(x_j) \rangle = \langle \varphi(x_i), \varphi(x_j) \rangle
\end{align*}
\]

SVM Discriminant of classifier is

\[ g(x) = \text{sign}(w^T x + b) \]

Nonlinear mapping \( x \rightarrow \varphi(x) \) Substitution type SVM discriminant of classifier is changed to

\[ g(x) = \text{sign} [\sum_{i=1}^{N} w_i \varphi_i(x) + b] \]

among
1 B is the classification threshold, it can be obtained by any support vector, or the median value can be obtained from any pair of support vectors in the two class.

2 Among them, \( k(x_p, x_i) \) Kernel function, A common kernel function

\[ K(x, y) = \langle x \cdot y \rangle \] Use of linear classification

b Polynomial kernel, Poly \( K(x, x) = (\langle x \cdot y \rangle + 1)^d \), D is a natural number

c Radial basis nucleus, Radial Basis Fuction(RBF) nucleus

\[ K(x, x) = \exp \left(-\frac{\|x-y\|^2}{2\sigma^2}\right), \quad \sigma \geq 0 \] 8

d sigmoid nucleus \( K(x, x) = \tanh (kx^Ty - \delta) \) among k, \( \delta \) The constant is constant

3 The radial basis kernel function (RBF) has shown good results in the classification detection. In the improved SVM algorithm, the radial basis kernel function (RBF) is used as the core function of the SVM classifier.

2.3 AdaBoost-RBFSVM cascade algorithm

In the process of pedestrian detection, the traditional AdaBoost cascade classifier is easy to cause the over fitting of the classifier, which leads to the classification efficiency of the classifier and the deterioration of the stability.

In view of the shortcomings of the AdaBoost algorithm, SVM algorithm has the unique advantages in solving small sample, nonlinear and high dimensional pattern recognition. In this paper, the traditional AdaBoost cascade classifier is improved, and the SVM algorithm and AdaBoost algorithm are combined to realize the cascade classifiers of AdaBoost and SVM.

Algorithm design

Initialization: set the minimum classification accuracy d for each level of the classifier, the maximum false alarm rate \( \alpha \) and the overall false alarm rate \( F_\alpha \) of the cascade classifier, and the maximum number of \( n_H \) for each level of weak classifier.

Construct two-layer cycle: the outer loop trains the classifier in the overall false alarm rate \( <f_\alpha \) and="" the="" adaboost="" cascade="" classifier="" is="" trained="" inner="" circle.<="" span="" /></f_\alpha >

The AdaBoost cascade classifier was trained by the inner circle training, and the AdaBoost cascade classifier was evaluated by increasing the number of weak classifiers in the training to determine whether the classification target was achieved. If achieved, the classifier training is completed; Otherwise, it will continue to increase the number of weak classifiers, and when the number of weak classifiers reaches \( n_H \), and the false alarm rate is still not up to standard, the SVM algorithm will replace the AdaBoost algorithm classifier for training.
When the overall false alarm rate reaches $F_t$, the algorithm ends.

3 The system design

In the pedestrian detection process, the Histogram of Oriented Gradients (HOG) gradient Histogram is compared with other feature descriptors to maintain the invariance of geometry and optical transformation. Therefore, the HOG feature descriptor is particularly suitable for pedestrian detection and has a high detection success rate in pedestrian detection. Its core idea is to use the distribution of light intensity gradient or the edge direction to treat the appearance of target is described, through the whole image segmentation into small connection area (cells), each connection area generated on a direction of gradient direction histogram or edge of the area of the connection, the combination of the histogram to represent the targets to be detected feature descriptor.

HOG feature extraction process is as follows:

① Grayscale (image as a three-dimensional image of x,y,z (grayscale));

② It is divided into small cells (2*2);

③ Calculate the gradient of each pixel in each cell;

④ The gradient histogram of each cell can be calculated to form the characteristic descriptor of each cell.

In this paper, we use the HOGDescriptor class in OpenCV to implement HOG feature extraction of pedestrian detection process, which mainly uses the following interface. HOGDescriptor constructor.

\[
\text{CV\_WRAP HOGDescriptor()}: \text{winSize}(64, 128), \text{blockSize}(16, 16), \text{blockStride}(8, 8), \\
\text{cellSize}(8, 8), \text{nbins}(9), \text{derivAperture}(1), \text{winSigma}(-1), \\
\text{histogramNormType}(\text{HOGDescriptor}::L2Hys), \\
\text{L2HysThreshold}(0.2), \text{gammaCorrection}(\text{true}), \\
\text{nlevels}(\text{HOGDescriptor}::\text{DEFAULT\_NLEVELS})
\]

Main parameters:

winSize The window size

nbins Gradient direction

NBins represents the number of statistical gradients in a cell. For example, when nbins=9, the gradient histogram of 9 directions is counted in one cell, and each direction is 180.

After determining the above parameters, you can calculate the dimension of a HOG descriptor.

The parameter diagram is shown in figure 1.
Figure 1. Parametric schematic diagram.
4. Experimental results and analysis.

According to the algorithm thought, the test sample set of the design was trained and tested, and the minimum classification accuracy \(d=0.999\) for each level classifier was set, and the maximum false alarm rate of each classifier was \(f=0.4\). Tested AdaBoost classifier according to the following Settings, the optimal classification effect, namely: the AdaBoost cascade classifier is set to level 7, each level of the maximum number of weak classifier \(n_0 (H)\), respectively 1,6,8,11,12,16 class USES the magnitude 7, each level of the number of weak classifier respectively 1, 6, 8, 11, 12, 16 and 29, and set in the AdaBoost cascade SVM classifier - each level of the largest number of weak classifier \(n_0 (H) = 10\), so in the first 3 level using AdaBoost cascade classifier, then 4 using SVM classifier.

<table>
<thead>
<tr>
<th>classifier</th>
<th>Accuracy of detection (PR)</th>
<th>The rate of false positives (FPR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AdaBoostCascade classifier</td>
<td>99.00</td>
<td>0.44</td>
</tr>
<tr>
<td>AdaBoost-RBFSV MCascade classifier</td>
<td>99.56</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Experimental results show that the designed by AdaBoost - RBFSVM cascade classifier in pedestrian detection has better detection accuracy and low false alarm rate, especially in the image complex, AdaBoost - RBFSVM cascade classifier to detect the effect will be more obvious.

In order to test the efficiency of the proposed algorithm in this paper, the operation time of the traditional AdaBoost cascade classifier and adaboost-rbfsvm cascade classifier was compared under the same test environment. The experimental

<table>
<thead>
<tr>
<th>classifier</th>
<th>Average detection time (\text{s})</th>
</tr>
</thead>
<tbody>
<tr>
<td>AdaBoostcascade classifier</td>
<td>0.4</td>
</tr>
<tr>
<td>AdaBoost-RBFSV cascade classifier</td>
<td>0.14</td>
</tr>
</tbody>
</table>

It can be seen from the experimental results that the adaboost-rbfsvm cascade classifier can greatly reduce the detection time compared to the traditional AdaBoost cascade classifier. This is because in AdaBoost - RBFSVM cascade classifier, a large number of training samples has been in previous level of AdaBoost cascade classifier, leading to the SVM training sample greatly reduced, so the number of support vectors of the SVM and the training time will be greatly reduced. The adaboost-rbfsvm cascade classifier has better real-time performance.

5. conclusion

The final analysis, through the experiment results show that this design of AdaBoost - RBFSVM cascade classifier in the classification of classification accuracy and the rate of
false positives are superior to the traditional AdaBoost cascade classifier, at the same time also can ensure the training of the classifier speed and test speed.

REFERENCES