International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 05 – Issue 08 || August 2020 || PP. 19-25

Multi - target tracking method based on Harr feature

[1]liao Zhang, [2*]Shuping Li

[1,2]School of Mechanical and Power Engineering,
Henan Polytechnic University, Jiaozuo, China

Abstract: Aiming at the problem that Camshift can only track a single target vehicle, this paper proposes a multi-target tracking algorithm based on Harr features and Camshift. This paper calculated the Harr eigen value of the relationship between the tilt characteristic of 45 degrees and the difference of the sum of pixels. The signal classifier was used to detect the input video signals, and the shape features of the output vehicles were taken as the initial test window of Camshift. The experimental results show that compared with other underlying visual features, the method of feature combination is adopted, the proposed method is more significant and stable, with better rotation, scale invariance and higher robustness. This is of great significance to the development of intelligent transportation.

Keywords: Camshift；Harr feature；45 degree ;Feature combination

1. Introduction

The current traffic system is highly dependent on real-time traffic information obtained by video surveillance equipment. Based on video surveillance, it can automatically detect vehicle moving targets, extract vehicle target speed, moving trajectory, vehicle characteristics, traffic density, license plate number and other information. When acquiring traffic signals, it is inseparable from the most basic underlying technology, which is to track vehicles on the road. It is the most important basic method for analyzing vehicle behavior and the most effective method for maintaining and guaranteeing the traffic system. This is of great significance for improving work efficiency and the development of intelligent transportation.

There are generally four methods for vehicle tracking. The first three are an overview of area-based vehicle target tracking methods, an overview of contour-based vehicle target tracking methods, and a feature-based vehicle target tracking method. The fourth is later developed Vehicle detection method based on machine learning. In the study of vehicle tracking on the road, the method based on regional target tracking has once become a research hotspot. Shi et al. [1] proposed a vehicle video tracking system based on region method, and proved the feasibility of the system; Ge et al. [2] used the background clipping method to extract the motion area of the target, and track the area through the motion changes between two adjacent frames, According to the relationship between the area and the vehicle, the possibility of vehicle occlusion is judged, Cai et al. [3] proposed a Gaussian background model of the disturbed area to reduce noise and eliminate the error of tracking results when the background is small. The contour-based tracking of vehicle targets is the most common problem in machine vision, and it is also the most widely used algorithm. Zhang [4] first proposed the GVF-Snake model, which is a gradient vector active contour obtained by the inter-frame difference method, Ji et al. [5] segmentation target based on contour feature point information. The tracking model combined with Kalman filtering realizes the tracking of moving vehicles.

Gao[6] proposed a fine tracking algorithm based on contour. The initial contour is tracked by mean shift window, which can track the target at an accurate level. The third feature-based vehicle target tracking algorithm, the biggest feature is that it can detect the moving target in the shortest time, Literature [7] avoids the establishment of real-time models, which are based on the tracking method of Haar features. This method is particularly important for tracking the real-time details of the target. Xie et al. [8]Based on the angular feature point information of vehicles, Kalman filter was added, and the height information of feature points to be matched was recovered by projection equation. The last vehicle tracking algorithm based on machine learning is the main object of this paper, Target detection and tracking based on machine learning theory [9-10] has developed rapidly in recent years. It makes the target tracking have the ability of self-learning and judgment, so that the target tracking can change with the change of target and background, and keep stable tracking for a long time. One of the biggest advantages of this method is that it has good robustness and is not affected by external factors, including illumination, background changes, and vehicle speed changes.

Freund et al. [11] proposed a new boosting method, which combined weighted voting with online allocation algorithm to form the famous AdaBoost algorithm. AdaBoost algorithm[12] could not need any prior knowledge, so it has been widely used. Grabner [13] applied the Haar-lick feature to the Boosting algorithm, and proposed the online Adobe Adaboost method, which further expanded the application scope of online learning and applied it to the target tracking field.

This article introduces the commonly used Harr-like extended feature representation method, using the most basic principle of the gray difference of Harr features, After introducing the extended features in the most basic 4 of the Harr feature, the relationship between the 45-degree tilt feature and the difference of the pixel sum is calculated to characterize the Harr feature value. In the calculation process, the double integral is used to represent the sum of the pixels in the area before and within the transformation. The difference between the two is calculated, and finally the Harr characteristic value of the 45-degree characteristic and the pixel difference is calculated. Using the signal classifier to output the detection result of the vehicle signal, Camshiftis used to take the circumscribed rectangle of vehicle as the initial window of tracking algorithm.

2. Improved Haar-like features:

We know that we can classify only after we have features. We mainly extract the Harr features of the vehicle, and use the Harr features to first train the classifier for identifying the vehicle.

Haar-like classifier is used to detect targets by comparing the features of known training samples with those of unknown images. The classic application of this method is face detection. Generally, two rectangular features are used. The detection requirements can be met by summing the pixels in the white and black areas, and then making the difference.

There are 3 types of traditional Haar-like eigen values, namely horizontal, vertical, and diagonal. For targets with randomness, large gray image difference and small background gray difference, such as vehicles, the weak classifier has poor detection performance due to the difference method, so the strong classifier needs a large number of weak classifiers in cascade. Therefore, it is proposed to use the extended 45° feature, calculate the sum of pixels in the black and white area, and their respective values are subtracted. Using this feature to detect, the detection performance of weak classifier is enhanced. The extended feature is shown in Figure 1.

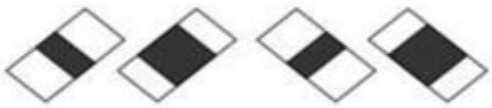

Figure1: Using 45-degree edge feature detection to identify vehicles

2.1 Calculate the eigenvalue of Harr

Integral graph method:

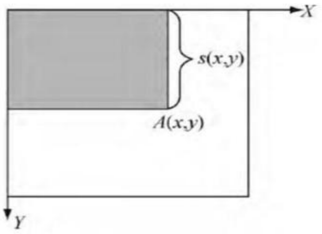

Figure 2: Integral diagram of point coordinates

Now how to determine the integral map of the pixel point represents the point. When calculating the integral map, the double integral of advanced mathematics is used. Assuming the third quadrant of the pixel point on the coordinate, it can be obtained:

$$s(x,y)=\int_{-y}^{0}\int_{0}^{x}dxdy \quad (1)$$

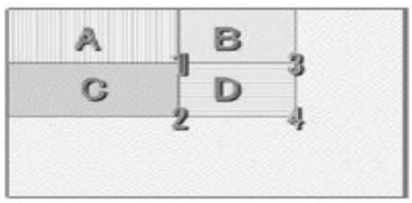

Figure 3: Integral image of rectangle D

As shown in Figure. 3, the grayscale integration of all pixels in rectangle D can be calculated from the integral image value of each point:

$$Sat3 = A + B \quad (2)$$

$$Sat4 = A + B + C + D \quad (3)$$

There are:

$$D = Sat1 - Sat2 - Sat3 + Sat4 \quad (4)$$

Therefore, no matter the size of the rectangle, the sum of the pixel values in any rectangle can be obtained by searching the integral image for 4 times. Moreover, in the process of multi-scale detection, the search is still carried out at any scale. In the implementation, the integral graph of the image can be obtained by traversing the whole image once according to the row or column, which avoids the time-consuming problem of the algorithm.

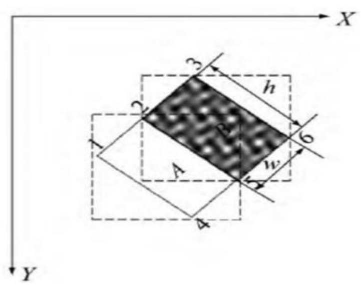

Figure 4: Edge feature at 45 degrees

The 45 degree feature extended by Harr feature is used, as shown in the figure 4 above, the rectangle with length w and width h will turn into a square with side length $w+h$ after rotating 45 degree angle to the right. Suppose the position of the rotation is in the third quadrant of the coordinates, In order to find the edge feature of Harr feature vehicle, The sum of pixels in the changed square area and that in the rectangle before transformation are used，After subtracting them, the feature of the image signal of the vehicle tilting 45 degrees is obtained.

The sum of pixels in the rectangular area before transformation:

$$A = \int_{-(\mathrm{h+w})}^{0} \int_{0}^{h+w} dxdy \quad (5)$$

The sum of pixels in the square area after the change:

$$B = \int_{-(h+w)}^{0} \int_{-y-\frac{w}{\sqrt{2}}}^{\frac{w}{\sqrt{2}}-y} dxdy \quad (6)$$

For any rotation matrix B (x, y, h, w, 45°), assuming that the edge length of the region is w and the width is h , then the sum of the pixel values in B , and subtract the above two formulas to obtain the vehicle , The edge feature after rotating 45 degrees can be expressed as:

$$A - B = \int_{-(\mathrm{h+w})}^{0} \int_{0}^{h+w} dxdy - \int_{-(h+w)}^{0} \int_{-y-\frac{w}{\sqrt{2}}}^{\frac{w}{\sqrt{2}}-y} dxdy \quad (7)$$

2.2 The formula for calculating the number of Haar features

Rainer Lienhart's formula for calculating the number of Harr features：$X = \left[\frac{W}{\mathrm{w}}\right]$ and $Y = \left[\frac{H}{h}\right]$ represent the maximum scale coefficient that can be enlarged in the horizontal and vertical directions of the rectangle features. For the rectangle 45 degrees to the right, the number of Harrr features is calculated as follows:

$$XY(W+1-W\frac{X+1}{2})(H+1-h\frac{Y+1}{2}) \quad (8)$$

Among them:

$$X = \left[\frac{W}{w+h}\right]; \ Y = \left[\frac{H}{w+h}\right];$$

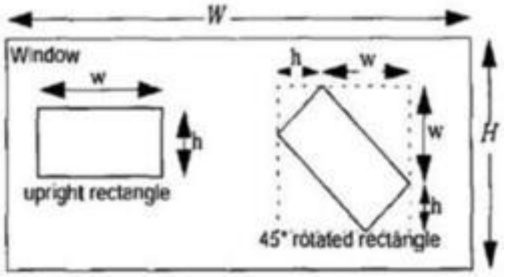

Figure 5: Comparison of edge length after rotation before and after rotation

The number of features after the transformation：

$$XY(w+1-z\frac{X+1}{2})(H+1-Z\frac{Y+1}{2}) \quad (9)$$

Among them:

$$Z=w+h\;;\; X=\left[\frac{W}{w+h}\right];\quad Y=\left[\frac{H}{w+h}\right];$$

2.3 Principle of signal classification algorithm

The Adaboost algorithm allows the designer to continually add new "weak classifiers" until a predetermined low enough error rate is reached. In the AdaBoost method, each training sample is assigned a weight indicating its probability of being selected into the training set by a component classifier. If a sample point has been correctly classified, its probability of being selected will be reduced in constructing the next training set. Conversely, if a sample point is not properly classified, its weight is increased，In this way, the AdaBoost method can focus on such a difficult (and richer) sample，For the kth iteration operation, we select sample points based on these weights, and then train the classifier ck. Then, according to this classifier, the weight of the sample points that are misclassified by it is increased, and the weight of the samples that can be correctly classified is reduced. Finally, the sample set with updated weights is used to train the next classifier ck +1.

$$h(x)=\begin{cases}1 & \frac{1}{2}\sum_{i=1}^{T}\alpha T \le \sum_{i=1}^{T}\log\frac{1}{\beta}ht \\ 0 & else\end{cases} \quad (10)$$

The specific flow of signal classifier:

1. begin initialize D , $K_{\max}, W_1(i) \leftarrow 1/n, i=1,\ldots,n$;

2. $k \leftarrow 0$;

3. *do* $k \leftarrow k+1$

4. Training using a weak classifier that samples D according to $W_k(i)$;

5. The training error of C_k is measured with the sample set of $W_k(i)$ and D ;

6. $a_k \leftarrow \frac{1}{2}\ln\left[(1-E_k)\right]/E_k$;

7. $W_{k+1}(i) \leftarrow \frac{W_k(i)}{Z_k} * \begin{cases} e^{-ak}, & if\ classied\quad cprrectly \\ e^{\alpha_k}, & otherwise \end{cases}$

8. *Until* $k = k_{\max}$;

9. *end* .

3. Experimental results

Based on the above theory and method, Camshift algorithm is used to combine with the above classifier，The vehicle signal detected by the classifier is taken as the initial window of Camshift algorithm, and then the subsequent image window is tracked. Camshift independently selects the window, and the effect diagram of the result is shown in the figure 6below:

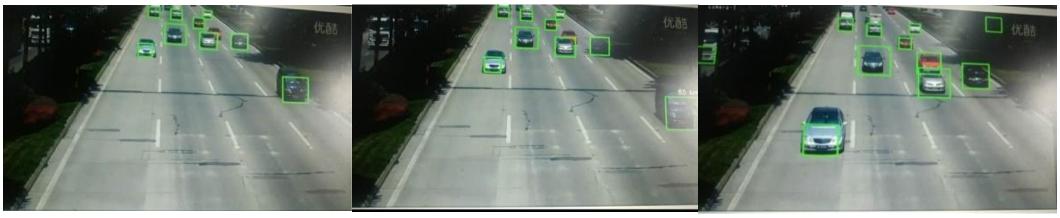

Figure 6: Experimental results

From the detection effect shown in the figure 6above, the advantage of Harr feature overcomes the shortcoming of Camshift tracking a single vehicle target. From the experimental results, the improved algorithm proposed in this paper can basically track all vehicles in the video sequence frame of the image, and the tracking rate can reach 100% in the first two frames. In the last frame of the video sequence, a mistake was made and the background was wrongly classified as a vehicle, which was mainly caused by the wrong sample classification in one of the links in the process of using the Harr classifier. On the whole, Camshift algorithm combined with Harr features can better realize the tracking of vehicles. Moreover, the tracking efficiency of the vehicle has been greatly improved, which lays the foundation for judging vehicle behavior.

4. Conclusion

In this paper, a method is proposed to characterize the Harr eigenvalues by calculating the relationship between the 45 degree tilt feature and the difference of the sum of pixels. When the Harr feature is used to obtain the edge features of the vehicle, the sum of pixels in the changed square area and the rectangle before the transformation is used to subtract them, and finally the image signal features of the vehicle tilt of 45 degrees are obtained. By combining Camshift and Harr features of the tracking algorithm, compared with other underlying visual features, the multi-target tracking algorithm proposed in this paper is more significant and stable, with better rotation, scale invariance and higher robustness.

References:

[1] Shi Shixu, Zheng Qilun, Cao Bo. Vehicle Video Tracking System Based on Region[J].Computer Engineering, 034(17):196-199.

[2] Ge Jiaqi, Li Bo, Chen Qimei. Vehicle occlusion tracking algorithm based on image motion region [J]. Journal of Nanjing University, 2007，43（1）：66-72.

[3] Caixun, Meng Xiangxu, Liu Qiang. A Region-based Multi-vehicle Tracking Scheme for Expressway [J]. Photoelectric engineering. 2006,33(6): 20-23.

[4] Zhang Hui, Dong Yvning, Xiang Yang. A vehicle tracking algorithm based on an improved GVF model [J]. Model recognition and human intelligence，2007,20 (3):388-393.

[5] Ji Peng, Wei Zhiqiang,. Research on Vehicle Tracking Method based on Contour Feature and Extended Kalman Filter [J]. Chinese Journal of Image and Graphics，2011,16(2):267-272.

[6] Gao Tao, Liu Guangzheng, ZhangJun, etl; Research and Application of Traffic Vehicle Contour Tracking Algorithm [J]. Journal of Application Foundation and Engineering,2010，18（2）: 343-351.

[7] Reyes Rios Cabrera，Tinne Tuytellaars，Luc Van Gool. Efficient Multi-Camera Vehicle Detection、Tracking and Identification in a Tunnel Surveillance Application [53].Computer Vision and Image

Understanding，2012（10）：111-115.

[8] Xie lei, Zhu Guangxi, Zhang Zhenming. Traffic Vehicle Detection and Tracking Algorithm based on Sub features [J]. Microelectronics and Computer,2007, 24（7）: 91-93.

[9] QiuJ , Wu Q , Ding G , et al. A survey of machine learning for big data processing [J]. Eurasip Journal on Advances in Signal Processing, 2016, 2016(1):67.

[10] You-Biao Y, Yuan-Yan C. A Survey on Machine Learning and Its Main Strategy [J]. Application Research of Computers, 2004, 21(7):4-649.

[11] Freund Y ,Schapire R E . A Decision-Theoretic Generalization of On-Line Learning and an Application to Boosting[C]// Proceedings of the Second European Conference on Computational Learning Theory. Springer-Verlag, 1995.

[12] Cao Y, Miao Q G , Liu J C , et al. Advance and Prospects of AdaBoost Algorithm[J]. Acta Automatica Sinica, 2013, 39(6):745-758.

[13] GrabnerH, Grabner M , Bischof H . Real-Time Tracking via On-line Boosting[C]// Proc of British Machine Vision Conference. 2006.

Author Profile

Zhang Liao (1994-), male, from Xuchang, Henan province. Master degree candidate. He engaged in robot vision research (2213120658@qq.com).