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Target Tracking Feature Selection Algorithm Based on Adaboost

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Abstract

With the development of image processing technology and popularization of computer technology, intelligent machine vision technology has a wide range of application in the medical, military, industrial and other fields. Target tracking feature selection algorithm is one of research focuses in the machine intelligent vision technology. Therefore, to design the target tracking feature selection algorithm with high accuracy and good stability is extremely necessary. This paper presents a target tracking feature selection algorithm based on Adaboost. It includes Adaboost algorithm's principle and Adaboost algorithm's application in video object tracking. Experimental results show that the proposed algorithm has the characteristics of real-time, accuracy and stability.

***Keywords**: intelligent machine vision, target tracking, algorithm, Adaboost*

1. Introduction

Vision is the most important way for human to percept the foreign objects to get information. Giving machine vision functions can make life and production more convenient. The human visual system can quickly capture an image, object recognition, and take the corresponding actions in accordance with the information obtained [1]. The machine vision makes use of input devices such as cameras instead of eyes to get images. Use a computer instead of the human brain for image processing in order to accomplish a similar function of the human visual system [2]. In recent years, with the improvement of computer performance and the falling price of cameras, intelligent machine vision technology is more widely used in military, medical, industrial and electronics manufacturing industries. That intelligent machine vision technology replaces the human eye to distinguish has become a trend of the development of production, and target tracking algorithms is an important part in machine vision technology. The traditional target tracking algorithm mainly includes continuous frame difference method and background removal method [3]. The motion region detected by successive frame difference method relates to velocity of the target. When the target speed is very slow, it may not be able to detect the target motion; background removal method is sensitive to changes in illumination and background, and in the case of interference, it may fail to detect the target [4-5].

This paper presents a target tracking feature selection algorithm based on Adaboost to extract the characteristics of the target and in the next frame to find a picture that matches the characteristics of the target in order to determine the target location, and ultimately achieve target tracking.

2. The Overall Design

The target tracking selection algorithm framework proposed based on Adaboost can be divided into the following three parts:

(1) Indicates the target object using Harr features, uses and Integral map method to accelerate the speed of operation;

(2) Using Adaboost algorithm to select the most representative of the target object rectangle features (weak classifiers), based on the detection rate of the weight given to the corresponding value of the weak classifiers are constructed as a strong classifier;

(3) The number of series to form a strong classifier cascade structure cascade classifier cascade structure can effectively improve the detection rate of classification.

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Adaboost algorithm is divided into the following parts. First, calculate the target characteristic parameters, and then calculate each classifier threshold parameter according to the parameters, and convert the target feature into the corresponding weak classifiers, train sample set to elect the best weak classifier and calculate its weight. After T times to generate a strong classifier cascade to achieve the purpose of tracking. Cascade mentioned above is to detect the image window iteration step by step through a weak classifier, decide target area, filter the target area to test the weak target image as the target, then the output is 1; if it is determined to be non-target, the output is 0. The overall design of the algorithm flow chart is shown in Figure 1.

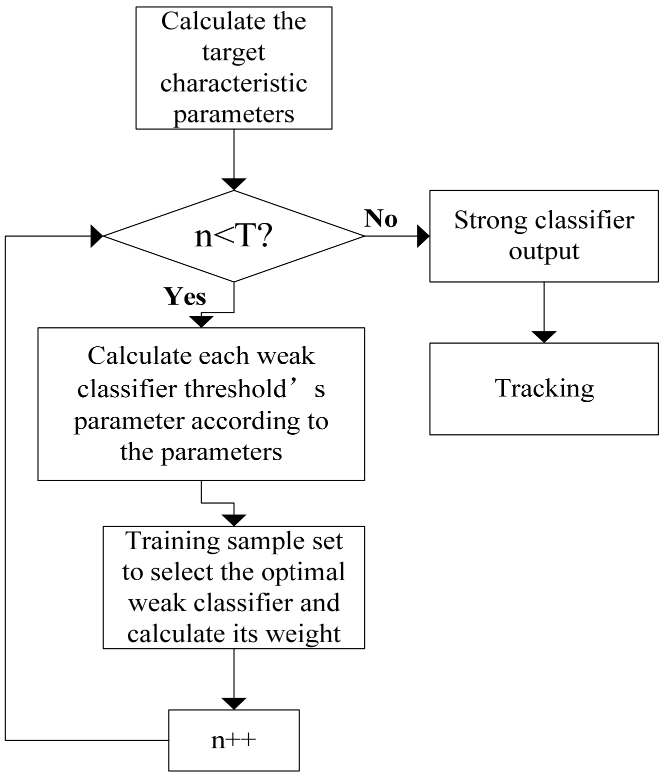


Figure 1. Overall Design

3. Target Tracking Feature Selection Algorithm Based on Adaboost

3.1. Adaboost Algorithm Principle

Adaboost algorithm's basic principle is that integrate a weak learning algorithm in the collection by several iterations into a strong learning algorithm. Adaboost algorithm is against a set to train weak classifiers, and classify the resulting cascade of weak together to form a strong classifier. Initial weights of the samples are the same. In this sample distribution, train a basic classifier h1 (x), increasing h1 (x) misclassified sample weights; reduce the correct classification of the sample weights, so it can highlight the error samples and get a new sample distribution. Then according to the principles that the less the error of the weight is, the greater the weight is and the more the error is, the less the weight is, entitle h1 (x) to a new weight. Under the new sample distribution, basic classifier is trained to basic classifier h2 (x) and its weight, and so on, through the T cycles, it gets a basic classification of T and its weight [2]. Finally add up these T basic classifier at a certain weight to obtain the final strong classifier.

AdaBoost algorithm is described as follows:

Assume that X is the sample of space, Y represents a collection of sample categories identified. Here set $Y = \{-1, +1\}$ so that $S = \{(x_j, y_j) \mid j = 1,2, ..., m\}$ is the sample training set, where $x_j \in X$, $y_j \in Y$.

A. initializes the weights of n samples to make Dt uniformly distribute: $D_t(j) = \frac{1}{n}$. represents the weight of the sample (xj, yj) assigned in t iteration;

B. Let T represent the number of iterations. For each t = 1 ... T, based on the sample distribution Dt, generate sample to form the collection St. Train the classifier ht on the set St. Use the classifier ht to classify all samples of the set S. Get classifier in this round and minimum error rate Ej [3];

$$E_j = \sum_{j=1}^{n} | h_t(x_j) - y_j |$$

C. Calculate the weights: $\beta_j = E_j/(1 - E_j); a = \log(1/\beta_j)$

D. Update the weights: $H(x) = sign(\sum_{t=1}^{T} \alpha_t h_t(x))$

Adaboost algorithm flow chart is shown in Figure 2.

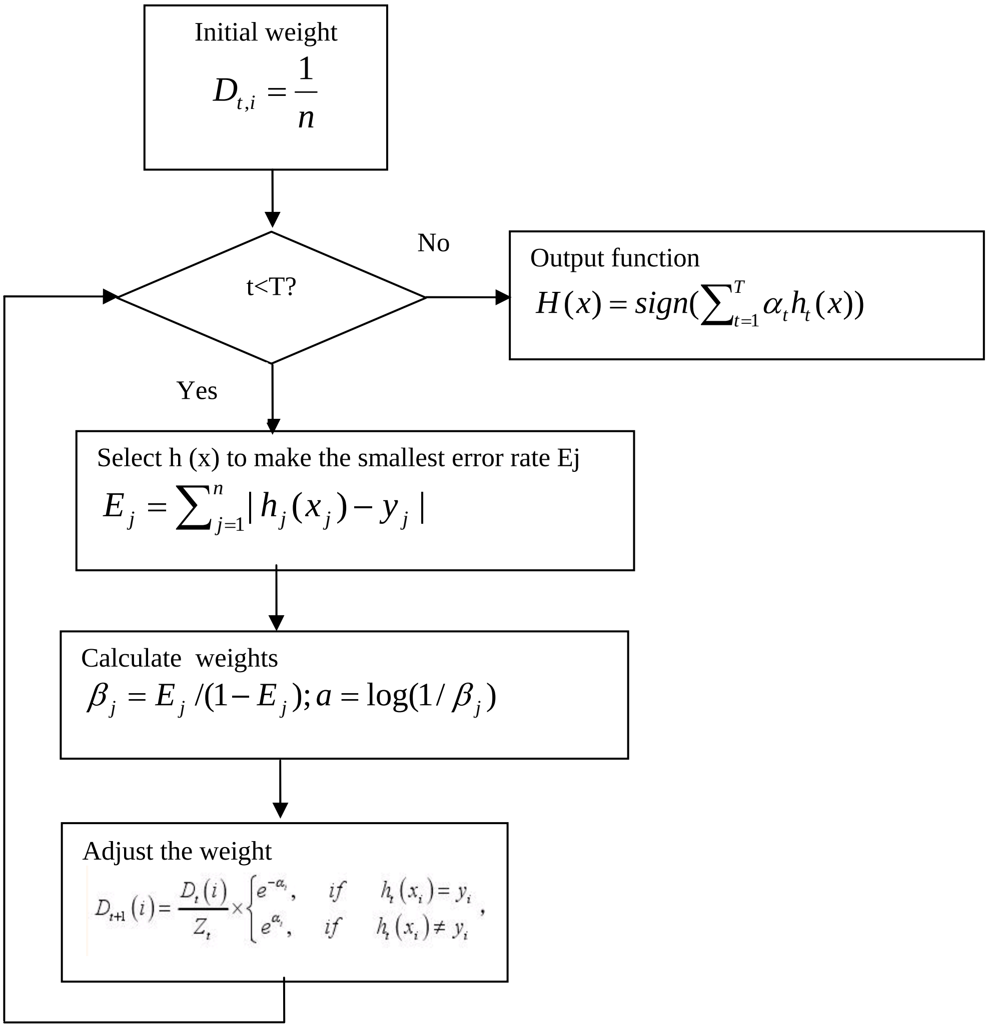


Figure 2. Adaboost Agorithm Flowchart

3.2. Target Feature Extraction

The target tracking selection algorithm based on Adaboost proposed in the paper is in the light of gray distribution characteristics of the target object to detect and track. Here we use Harr features as selection feature. Harr feature is based on the integral image features. Compared with the traditional pixel-based computing eigenvalues, because gray-scale images possess the characteristic og a single color, small computation, it is easier to use integral image characteristic to extract parameter [6]. Target tracking selection algorithm based on Adaboost is adopted to detect and track the target object, whose high degree of classification results impact target detection and tracking significantly. Harr features is able to accurately distinguish objects and non-objects. For example, Haar featured as the face edge features. Face Haar features are divided into three categories: linear features, edge features and center surround features. Linear characteristic can be accurately represent the linear direction of the image information; edge feature can accurately show the edges of the image information; center surround feature can accurately show the central portion of the image information [4]. Feature template consists of black and white rectangles. According to the characteristics of the image obtained, these features can be expressed as:

$$feature = \sum_{j}^{T} w_j * \mathrm{Re}\, ctSum(r_j)$$

Here T is the number of the rectangular featurej, wj is the weight of the rectangle, RectSum (rj) is the sum of the pixel values surrounded by a rectangle rj. However, use the above algorithm based on pixel rectangle feature too much will greatly reduce the training speed. This paper uses the integral image method, whose main idea is to avoid calculated prior to the pixel region before double counting and save pixels in the rectangular region starting from the image point to the current j as elements of the array. When a region of pixels is to calculate, it can search directly elements stored in the array to speed up the computation. Specific formula is as follows:

$$ii(x, y) = \sum_{x' \le x, y' \le y} i(x', y')$$

Here i is the original image, (x, y) is the image pixel, ii (x, y) i is the sum of all the pixels in the upper left point.

3.3. Design of the Weak Classifiers

According to Adaboost algorithm the above mentioned, against the original weights with the same sample, it trains a series of weak classifiers through changing its sample weights. Weak classifier is initially proposed when in 1984 Valian learned theory in PAC. Detection accuracy is better than random guessing, but not obvious weak is called weak learning [7]. If detection accuracy was significantly better than random guessing, we call it strong learning. If the data is sufficient, weak classifier cascade forms a strong classifier through training and learning. Because of the diversity of target detection characteristics, we can detect categories to determine the required basic classifier h (x). Here is calculated as follows:

$$h_j(x) = \begin{cases} 1 & f_j(x) \le \theta_j \\ 0 & otherwise \end{cases}$$

Here hj represents the characteristic value of classifier. The output is 1 if the target detection is correct, otherwise, the output 0; j is the threshold value of the characteristic value and fj (x) indicates eigenvalue function.

3.4. Final Strong Classifier Constructor

The most important part of target tracking feature algorithm is the target detection accuracy and detection speed should be fast to make it real-time in order to achieve tracking results. The weak classifier design mentioned above does not meet the requirements of accuracy, false alarm and false detection's rate is still very high. Adaboost algorithm is used to cascade up and optimize the weak classifiers to form a strong classifier. This strong classifier can quickly detect the object to be tested. In Adaboost learning process, usually every positive detection threshold rate is 98.5% [8]. We can appropriately increase the positive examples' threshold, thereby false detection of non-target will also increase, but do not worry. The strong classifier classifier formed after the combination of weak classifiers through study can be used as the first few hierarchical levels, then more precisely filter non-target by means of the strong classifier. As the first few levels filter the majority of non-target, the non-target past the final level of strong classifier will be greatly reduced. As a result, the detection accuracy and detection speed is greatly increased. Specific strong classifier algorithm is as follows:

Given the training samples (x1, y1) ... (xt, yt), where xj denotes the sample j. When yj = 1, it is the positive sample (target). If yj = 0, it indicates a negative sample (non-target).

a. Initialize the weights: $w_j(x_j) = \frac{1}{T}, j = 1...T$;

b. train a weak classifier hj (x) for each feature;

c. Select hj (x) to make the smallest error rate Ej; $E_j = \sum_{j=1}^{T} w_j \,|\, h_j(x_i) - y_i \,|$

d. update the sample distribution and ej = 0 means that the sample is correctly classified and ej = 1 means that classification is incorrect, $\beta = E_j / (1 - E_j)$, $D_{t+1}(x_j) = D_t(x_j)\beta_j^{1-e_j} / Z_t$, where Zt is used to meet the $\sum_{j=1}^{T} D_{t+1}(x_i) = 1$;

f. Strong classifier constructor [5]; $H(x) = sign(\sum_{j=1}^{T} a_j h_j(x))$

3.5. Strong Classifier Cascade Structure

Cascade in classifiers refers that the final strong classifiers are combined by several weak classifiers and optimized components. In the target feature detection, target feature waiting for detecting pass sequentially through each classifier, so that the first few levels of weak classifiers can filter most of the non-target characteristics [10]. Ultimately, the detection area which can pass all and export is the target area zone. Strong classifier cascade schematic diagram is shown in Figure 3.

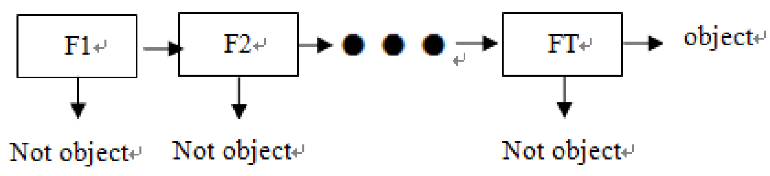
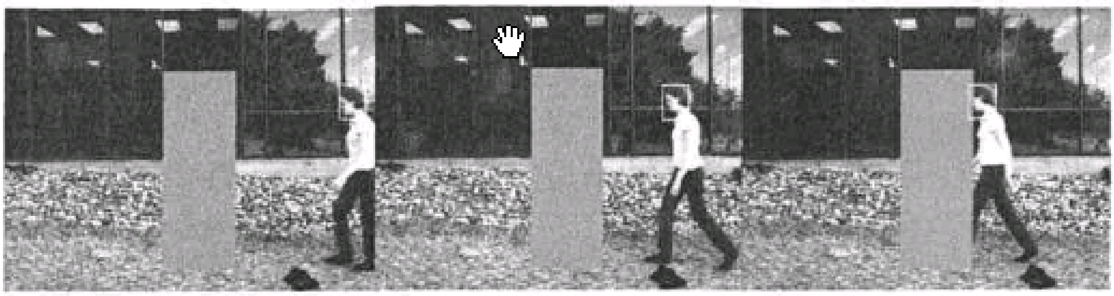


Figure 3. Schematic Strong Classifier Cascade

Through this algorithm, each weak classifier can eventually generate a strong classifier through T iterations. Calculate the image xj through the operation of hj (x) to obtain a high accuracy and stability. The bigger the T training times is, the more parameters and judgment involved in. The accuracy and stability of h (x)will be improved [9].

4. The Experimental Results

In order to test the effect of target tracking algorithm, use visual C + +6.0 simulation in Windows XP operating system. Obtain the following results, shown in Figure 4: observe the video section 15, section 25 and section 40 pictures , the target for the image of the human face, and we can detect the position of human faces in the tracking video to achieve a target tracking. This shows that the proposed algorithm has real-time, accuracy and stability.



section 15 section 25 section 40

Figure 4. Simulation Results

5. Conclusion

In summary, the paper proposes a target tracking feature recognition algorithms based on Adaboost. By extracting the target feature, the integral gray value of the resulting feature image is given the appropriate weigh based on its being the case of ant detection rate to form a weak classifier. After T times' association and sub-optimal level, it ultimately generates a strong classifier to achieve the target tracking results. Overall this algorithm can be divided into the following steps:

(1) Input samples, according to the specific properties of the target object to draw rectangle features and calculate and get a rectangular prototype feature set;

(2) Enter the feature to determine the threshold value and correspond features to weak classifiers to obtain set of weak classifiers;

(3) Enter weak classifiers. In the training rate limit, select the optimal weak algorithm classifiers as a strong classifier input by means of Adaboost;

(4) Enter the strong classifier and optimize it cascade to constitute strong classifier of the final stage.

In addition, through the update of the new weak classifiers integrated online and the existing weak classifiers' weights, it improves the ability that algorithm adapts to characteristic change of illumination and other factors. In a large number of experiments on real image, it compares with the original algorithms. And the result shows that this algorithm can not only respond better to the change of the target feature in the presence of interfering background to stably track targets, but also it describes the target size more accurately and significantly improve the tracking accuracy of the algorithm.

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