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Research on Background Extraction of Dynamic Video

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Abstract

As for heavy traffic, road congestion and the hard extraction of vehicles in dynamic video, an improved method of dynamic video background updating is proposed. By using frame-to-frame differences and mask technology, the hole of difference image is eliminated, then extracts the reliably initial background. The image is segmented by using double threshold based on the combination of Bacterial Foraging Optimization Algorithm and Otsu Algorithm to improve the effect and reliability of background updating. Experiments shows that it is an effective way that is good in speed and effective in background extraction, and provides a good foundation for further study of the vehicle tracking.

Keywords: *finite difference method, background update, background extraction, mask, double threshold image segmentation, Bacterial Foraging Optimization Algorithm (BFOA)*

1. Introduction

Separating moving objects from dynamic video is the basis for target feature analysis, target recognition and target behavior analysis. It plays an important role in engineering applications. Currently, there are three main methods for separating moving objects from dynamic video. They are optical flow method, inter-frame difference method and background subtraction method. In the case of optical flow method, it is able to get the information of moving target by solving the velocity vector field, by doing this we can get the single moving object, but the solving process is complex, and the poor performance limits its practical application [1-3]. In the case of Frame different method, we can get the moving object by computing the difference between adjacent frames. The method is simple, fast and has good adaptability in moving image, however, the internal situation of moving target and its velocity is uncertain, “hole” is very easy to appear[4]. Those will affect the complete extraction of moving objects. In the case of Background subtraction method, by constructing a stable background and updating background in real time, it is able to compute the difference between the current frame and background and get better moving target detection. Ahmed Elgammal, *et al.*, proposed a new non-parametric background model and background subtraction method. This method has good adaptability in the case of light movement such as shaking of branch [5]. Alan M. McIvor analyzed 3 important attributes of background subtraction method: foreground detection, background update and post processing. It will be a good guidance to future optimization of background subtraction method [6]. Traiwit Intachak and Watcharin Kaewapichai proposed a solution about real-time adaptive traffic video in case of the "Lighting mutation”. It has achieved good results in the real-time nature and effectiveness [7]. Amit Pal, Gerald Schaefer et al proposed an improved codebook background model and subtraction technique, which uses a pixel-based codebook pseudo background layer to filter and so prevent erroneous segmentation. They also proposed a method about updating background under two conditions of "Illumination mutation" and "illumination

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gradient" [8]. However, those treatment effects with the above methods are poor in some cases, such as some vehicles speed is too slow, traffic is bigger and vehicles' short stay.

This paper presents a dynamic background updating method based on dual-threshold and inter-frame difference, the method of updating the background under the larger traffic situation is studied. The main contents include: (1) the generation of stable background; (2) The generation of mask of moving object based on dual-threshold and inter-frame difference; (3) updating the background in case of the sudden stationary of moving target; (4) updating the background under the condition of static target sudden movement.

2. The Generation of Initial Stable Background

2.1 The Selection of Initial Background Video

The generation of initial stable background is the prerequisite and basis of later dynamic background updating, so how to get a complete initial background is the first thing to be solved.

Assuming that a moving object go through a single pixel in N frames, and then take N/6 frames as interval. A point in the center of screen can be taken as the detective target to figure out the time how long the vehicle needs to go through. Assuming that a moving object goes through the whole screen in T frames then set the initial background generated frames TB to T. Using the method in 2.2 to determine the background and moving target and to examine whether the probability of the appearance of the background of every pixels in the screen of TB frames is more than 50%, if not, then double the initial background generated frames, set TB to 2T. And so on, until the probability is more than 50% and the initial stable background is generated.

2.2 Improved Method for Background Extraction

Usually we select the continuous frames or the first frame as the initial background, in literature [9] presents an initial background generation method based on statistics; it can get good initial background under the condition of strong noise. But if vehicles go through a pixel point continuously, the background appear time is less than the target appear time, then there will be misjudgment. Based on it, this paper introduces the concept of undetermined background group, which is adding background mask to statistical frequency backgrounds, by removing the moving target and figuring out the part of the non-moving object, to get accurate background pixels, thereby obtain the complete stable initial background.

Through statistical analysis, moving target takes an average of 12 frames to go through a pixel, so get one image after every 2 frames, and convert it to grey-scale map. Then, subtract adjacent two frames, and get difference image, such as the formula (1).

In Equation (1), Fn is the current frame image, Fn-1is previous frame image. Using the double threshold segmentation method mentioned in section 2.2 to convert the difference image into binary image FB, as shown in formula (2).

In the formula, T1 is the larger of the two threshold threshold, T2 is the smaller of the two threshold threshold.

Mask processing the required binary image FB, removing the internal hole and getting connected target mask. This paper uses the mask method from literature [10] including connecting process and deletion process: connecting process is when the distance of the black spots which between the adjacent white points is less than the threshold TC then connect the two white points into a white line with white spots; deletion process is when the length of white line is less than a threshold then remove the white line. Connecting process and deletion process should be executed in the horizontal and vertical directions. A large number of experiments indicate that after a connecting operation some black area may be wrapped in white line. In this case, some edge information may lose after a deletion process. So in this paper, the above method is improved. By executing the connecting process two times then executing the deletion process, we can get a more complete mask image.

As shown in Figure 1, graph (a) is the background image, graph (b) is the target image, graph (c) is the difference image, graph (d) is a mask image. It is clear that the mask image is internal connected which provide a basis for subsequent operations.

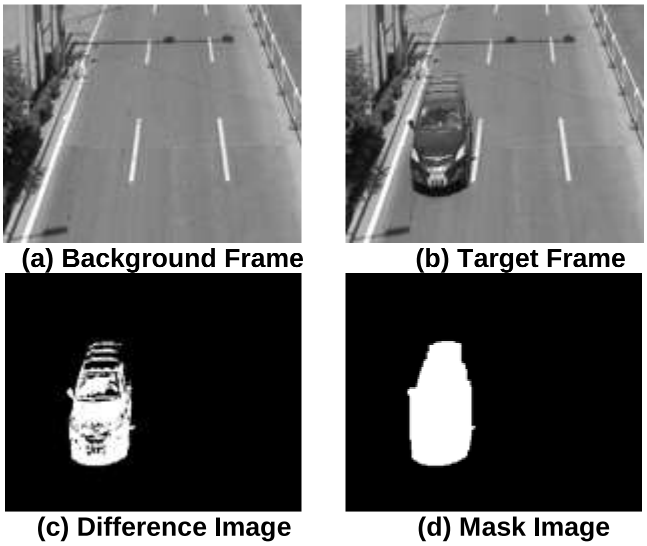


Figure 1. Chart Masked

2.3 The Initial Background Generation Algorithm

The initial background algorithm flow chart shown in Figure 2.

The TS is single threshold segmentation result. It is used to judge whether the current frame contains moving objects. TD take the value of 4, if TS is less than TD, it means there are no moving objects in the background, then put the whole map into the background group directly.

Adding the background portion into the pending background group after each frame process. Counting the frequency of each pixel when the process of TB frames are done. Taking the pixel that is repeated most often as the final pixel of initial stable background.

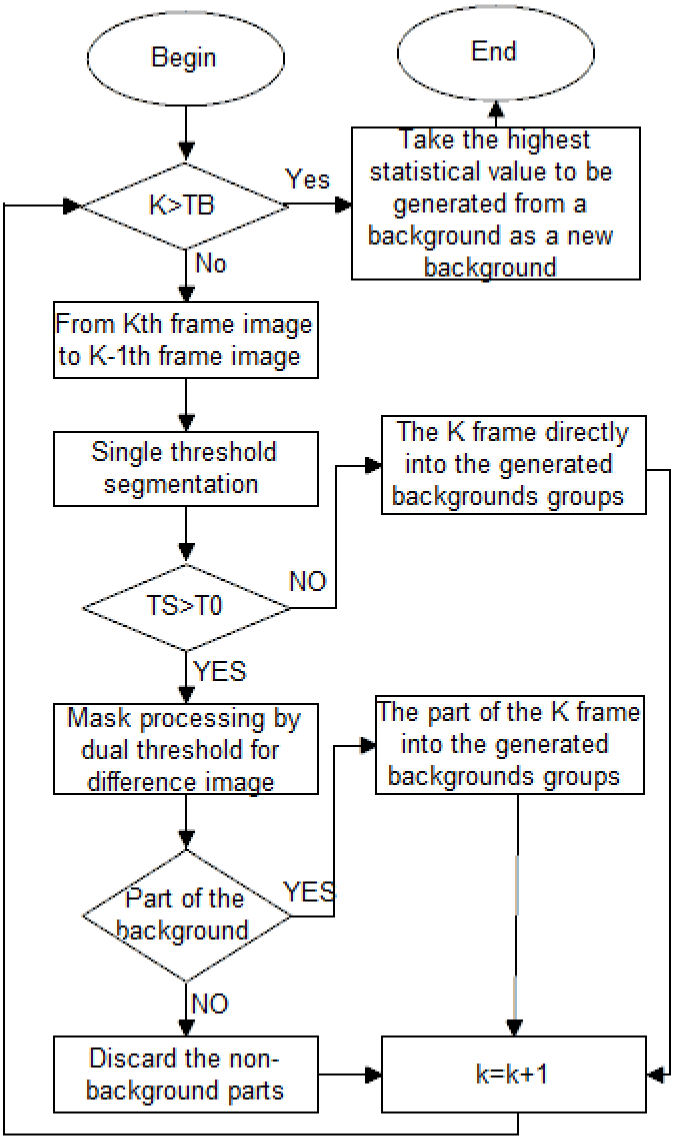


Figure 2. The Initial Background Algorithm Flow Chart

3. Dynamic Background Update

3.1 Dynamic Background Update Tactics

Assuming the current, the initial background algorithm has been used to generate a stable background image B. The current frame is Fn, the previous is Fn-1. Then it can obtain difference image FS according to the formula (1), and then use formula (2) to generate the corresponding binary image FB. Similarly, we can make use of the current frame to subtract the background image to get a difference image, as following the formula (3).

Correspondingly, we can use the double threshold in fragment 2.2 take the difference image to convert into a binary image, as following the formula (4).

Among the dual thresholds, T3 is larger threshold value, T4 is the smaller one.

Masked and expanded process for FB and BB to get FC and BC.

For the case velocity of the moving target is slow or stationary, and when a pixel BC is 1 and FC is 0, which indicates the moving target has a very slow velocity or stopped, so the pixel is not updated background, still using the previous background, as following the formula (5).

In the formula (5), update(X,Y) is marker for the updating, when its value is 1, the background of pixel is not updated; when its value is 0, this pixel is to be updated background pixels.

When the stationary objects in the background suddenly move, they need to quickly update their background.

Assuming the BC of the previous frame is remarked as BClast, the FC of the previous frame is remarked as FClast, thus we need to record the position of the pixels which the value of BClast is 0,and calculate the threshold value of RS which is on the position of these pixels in the current frame image, when the threshold value of RS is greater than T5(T5 taking the experience value of 10), which indicates the emergence of a new moving target in background, thus make the value of BClast as 0 and FC as 1,the pixel whose value of FClast is 0 will be updated to the current background.

For the moving object, it will not be updated, as following the formula (6).

The other part of the background uses the forgetting factor α to update

background, as following formula (7).

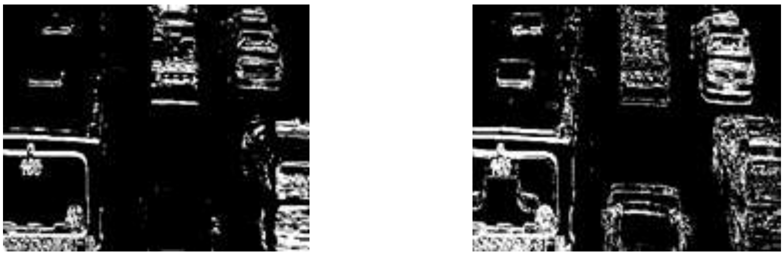
B_n is the updated background image. B_{n-1} is the background of the previous frame.

The forgetting factor takes the experience value of 0.7.

3.2 The Dual Threshold Value Image Segmentation

Under large number of experiments, it found that when the traffic flow is large, the vehicles are running slowly, so the body of vehicles represents the larger screen size, color differences evident in the case of vehicles, the single threshold image segmentation will lead to occur misjudge phenomenon. When there is much difference between the gray value of most vehicles and its background ,there is just only one vehicle existing small difference between gray value and the background, in which case the single threshold segmentation will be included in the frame difference in the context of a class of the vehicle, so that occurring misjudgment phenomenon. To solve this problem, we use Otsu dual-threshold image segmentation to get better results [11-12]. In order to improve computing speed, we make use of bacterial foraging algorithm to optimize the Otsu dual-threshold algorithm [13-14].

(a) The Image of Current Frame **(b) The Difference Image with Previous Frame**



(c) Single Threshold Image Segmentation (d) Dual Threshold Image Segmentation

Figure 3. The Effect Comparison Graph between Single Threshold and Dual Threshold

In Figure 3, graph a is image of the current frame, the vehicle is running slowly, graph b is the difference image between the current frame and the previous frame, graph c is the single threshold image segmentation, and graph d is the dual threshold image segmentation. The former dark edge contour of the vehicle is unclear, unable to correctly determine its edges, the latter is better. After testing, each frame processing time is less than 1/25 second, it meets real-time requirements.

3.3 Dealing with Global Background Mutation Strategies

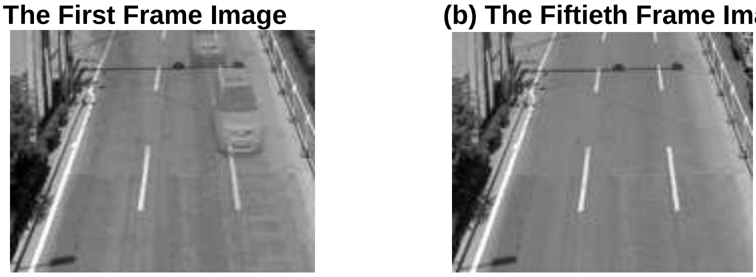
Due to light, weather and emergencies and other reasons, the background may appear sudden global change, now, slowly updating the background cannot quickly get the current background. Thus we need to re-initialize the background.

According to the share of the vehicle on the screen a pixel width W and length L, lateral intervals of W pixel tag an anchor, vertical L mark an anchor every pixel. When there are more than 50% of the anchor, five consecutive frames change exceeds the threshold T6 (taking the experience value of 30), that make global background initialization.

4. Results and Analysis

By using this method we can quickly generate stable initial background. In order to verify its effectiveness, we selected a video clip which is 25frames/s. Took 50 frames to generate the initial background, and compared it with Kalman algorithm.

(a) The First Frame Image (b) The Fiftieth Frame Image



(c) The Background Generated by Kalman Algorithm (d) The Background Generated by our Method

Figure 4. Comparisons of the Two Kinds of Initial Background

Test results as shown in Figure 4: Figure (a) is the first frame image; Graph (b) is the fiftieth frame image; Figure (c) is the background generated by using Kalman algorithm [15], in which you can clearly see the smear; Figure (d) is the background generated by using our method the result is better and faster than by other methods.

The effect of this method was optimized, in the cases of heavy traffic, vehicle occupies a large proportion in all pixels, vehicle moving slow and has a short stay. In order to verify its effectiveness, we selected 600 frames (25 frames per second) and took a frame from each two frames, at the same time, compared it with Kalman algorithm. Test results as shown in Figure 5: Graph (a) is the first frame image; Graph (b) is the 145th frame image; Graph (c) is the 145th frame background image by using Kalman algorithm; Graph (d) is the 145th frame background image by using the algorithm; Graph (e) is the targets which are extracted from video, by using Kalman algorithm, because of the error update of background, the difference between the 145th frame and the background is very small, almost all the target area is white after binarization processing. Graph (f) is binary image based on the algorithm.

(a) The First Frame Image

(b) The 145th Frame Image

(c) Background of 145th Frame Generated by Kalman Algorithm

(d) Background of 145th Frame Generated by our Method

(e)The Targets Extracted from Video by Kalman Algorithm

(f) the Targets Extracted from Video by the Algorithm

Figure 5. Comparison of the Results Extracted by the Two Algorithms

At the beginning of the video, the traffic is smooth, it is about to jam in the 15th frame and slows to a near standstill in the 145th frame. As can be seen from the figure, when traffic is heavy and standstill appears, error update occurs in Kalman algorithm, it takes part of the vehicles as background, so that it can not accurately identify the target vehicles. Our algorithm can well identify stalled vehicles. By using this method we can get the correct background, so that obtain the target vehicles completely.

The algorithm proposed in this article has been tested on the following two kinds of circumstances: indoor moving target contribute a large proportion to the whole picture, and the target moves slowly. The test results as shown in Figure 6, the video sampling rate is 25frames / s, and experiment tested 200 images.


（a）The First Frame Image **（b）The 200th Frame Image**


(c) Background Generated by Kalman Algorithm （d）Background Generated by our Algorithm

Figure 6. The results of Indoor Test

As can be seen from the result of the experiment, the smear appears in the background generated by Kalman algorithm, and the background generated by our method is complete. Our method is fast and the result is satisfying.

5. Conclusion

In this paper, by adopting improved background pixel statistics and mask processing, we can get stable initialized background faster and more accurately. Double thresholding can be used to extract information from moving objects effectively because that it can get accurate marginal information from objects. We have optimized case of heavy traffic, large vehicle screen and vehicle pauses. We have also had validations under different kinds of situations and achieved satisfactory results.

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