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A METHOD FOR AUTOMATIC DETECTION OF THE RUNNING RED LIGHT BY USING OPTICAL FLOW MIXED FRAMES SUBTRACTION

[1]JIANGFAN FENG, [2]WENWEN ZHOU
[1,2] College of Computer Science and Technology, Chongqing University of Posts and Telecommunications, Chongqing, 400065, China
E-mail: [1]fengjf@cqupt.edu.cn , [2]venn8737@yahoo.com.cn

ABSTRACT

Running red lights (RRL) currently become a hotspot social issue. Although it is commonly mentioned to detect and warn by using traffic monitoring, this idea has still remain in human recognition. Therefore, this paper designs a method to remedy it, which can detect the behavior of the pedestrians crossing the road automatically. From the sequential images taken by traffic monitoring, the use of optical flow estimating the track of motion objects whether cross the designated area enables automatic identification, then we carry out frames subtraction to isolate and identify the pedestrians from the moving objects. Combine the advantage of both algorithms, a system is presented to recognize the RRL event. Ultimately, the experiment confirms and indicates that what we proposed works effectively in some way.

Keyword: *Optical Flows, Frame Subtraction, Target Tracking, Event Detection, Algorithms*

1. INTRODUCTION

Running red lights, a serious and common social issue, this not only cost our physical safety but also brings us a huge problem about daily regulatory control. And that is why stringent enforcement of traffic rules becomes such a significant topic. Recently, video surveillance systems are wildly used for traffic monitoring, special when it happened to the traffic light junctions. Unfortunately, according to existing conditions we still do the supervision by human, that means harmful effect could be caused by any carelessness. So, we set out to do is to build a system, that gain images from the video surveillance and recognize the movement path by the automatic computer, then detects if here happened any transgress behavior [2]. It may somewhat relieves intension of the supervisor from the daily work and mostly avoid unnecessary human caused error.

Presently, the researched referred to this situation still retains in exploring. On detecting from images of moving camera, Tomonori Hashiyama(2003) developed a system for fast and robust pedestrian detection from a camera on a vehicle using contour based template matching[1], Osama Masoud and Nikolaos P. Papanikolopoulos (2001) addressed the method of tracking blobs and modeling pedestrians as rectangular patches that enables tracking and counting pedestrians in real-time[8]. Shi Jiadong(2008) based on the sum of absolute differences(SAD) and optical flow introduced an intergraded method of real-time detect human motion[6] and Zhu Minghan(2005) proposed an algorithm based on two consecutive frames subtraction and background subtraction, aimed at detecting the moving objects[4]. By using the traffic

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monitoring system to detect and track vehicles, Lu Jianming(2006) compared correlative methods and achieve data acquisition from MPEG video stream[2], also Hu Juehui(2010) improved optical flow algorithms in vehicle identification and tracking[3].

In this paper, according to the position of the traffic monitoring video, we define a target event as that when the pedestrians are walking cross the roads happened during the red light, then accordingly declare someone is crossing the street in this red light time when a event is detected. In the case, we combine the advantage of the frames subtraction and optical flow algorithms to be the main judging rule to detect the event. The main process goes as:(1) preprocess the images, get rid of the noise and limited the object regions. (2) detect if there over run events happen to mobile targets by optical flow. (3) after event identified, re-check it by employing frames subtraction to exclude any erroneous judgements aroused by moving vehicles, also make feasible to obtain the information of interest objects in this event. As a result, implement semantic analysis based on the scene classification and the traffic monitoring video, eventually success in detecting if the target event happened.

2. SUMMARY OF RELEVANT MESUREMENT AND SLECTED APPROACH

2.1 Relevant measurement

Among several relevant measurement techniques which the domestic and international are studying on, texture analysis, frames subtraction, background subtraction and optical flow are mainly included.

Texture is a kind of regional characteristics, not depends on the color or various intensities, and is thus area the size and shape of the relevant. It is the reflection of the feature, also the clue to gain the objects in the images. Targets elements have textural attributes varied from the background elements; also means to analyze texture is the approach for object classification and to capture the targets from the background. When the target and the camera has the relative motion, observe the changes of the certain texture enable the detection of this relative motion. However, the noise along with the images may weaken the texture feature.

In continuous video sequence images, the intensity of the pixels barely changed for the background while varying each frame when it happens to the moving objects. Consequently, it is able to capture the general profile by comparing the adjacent frames, which almost is the frame subtraction performs. Nevertheless it also brings some useless regions involved.

Compared to frames subtraction, background subtraction is the way to separate the foreground from the background through the motion information of the targets. It will capture some elements about the motion target such as location, size and shape, but it also omits them when the gray scale barely distinguishes the foreground and the background. Of low light sensitive, that indicates the method lacks of robustness.

Of relevance another main stream method is the optical flow, whose two-dimensional velocity vector is the projection of the visible three-dimensional velocity vector, is a kind of two-dimensional instantaneous vector field. It was put forward completed by Horn and Schunck in 1981[5], they established the point on the premise of the two hypothesis, which is that the grayscale of the moving objects remain unchanged in a short time intervals, and in the given region the velocity vector field slowly change. The use of the method could clearly describe the location and the velocity vector of the given motion targets, that extreme help us track them. But at the same time, the optical flow way may also bring a large sum of computation, and work at expensed of costing the storage space.

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2.2 Approach

In the paper, we find that frames subtraction is used based on optical flow can integrate it efficiently. By marking the motion track, the output video frame explicitly shows in the picture the direction of the targets move, besides that, provide possible approach for judge the target event. Then frames subtraction devotes to achieve pedestrians detection, which isolate pedestrians from the background and vehicles avoid the affection caused by other mobile objects, also ensure the robustness of the system. Besides that, make the possibility lock on the object of interest and extracted information about the exact pedestrian crossing the street.

What's more, the combined as well benefit on the compute aspect. It cuts down the areas to be calculated also improve the operating rate by detecting the movement of the target areas only, on the other hand, conquer the low anti-jamming of frame subtraction and the computation intensive of optical flow, plus it may reduce the computational cost at the same time.

3. SEMANTIC ANALYSIS BASED ON THE TRAFFICE MONITORING VEDIO

3.1 Images pre-processing

Interference and noise always accompany the process that images generation and adopt in the visual system, which reduce the quality of images. Hence, the first step we move is to exclude the interference factors before images processed and analyzed that through denoising processing to improve the quality of images, meantime Gausscian Bluris is the method we proposed to solve the noise cancellation problem. In this way, it changes the quality of images of each frame and also keeps the profile of the targets at the same time. In the paper, based on the traditional Gausscian function in two dimensions, we fuses with the method which described by reference[7], by improving the median filtering method of the sliding window. After removing the random noise by using the median filtering to pre-processing images, we transfer the color image of the video frames to the grayscale images then get the grayscale map.

3.2 Subdivision Panoramic Scene And Extract Features

3.2.1 Traffic sign line

In the paper, we view traffic sign line as a major clue to detect the road junction scene and also to hint the direction of the traffic flow which crossed the track of the pedestrians. Any long parallel and low slope sign lines we consider them as traffic sign line, meanwhile those parallel lines with width means the zebra crossing, the others belongs to not determinable. We bring Hough Transform to be the algorithm by what detect the sign lines.

3.2.2 The detection of the target area

The margin of the road shows the region the pedestrians supposed to not be before the green light turns back. According to the complication of the road condition, it challenges us to acquire the edge of the road immediate by using edge detection. But in this situation, at fixed spot the traffic monitoring camera locates, which lead to that the region for pedestrians always at the same zone of the frame image. Thus, we consider the particular part as the target area, that is pictured in the output images as showed in Fig 1. And any pedestrian objects move across the area after the red lights are the ones we focus on, then can declare the target event it is.

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Fig 1 Video Of Monitor Scenario

3.2.3 The breakpoint of the video

As it was announced that the target event happen after the traffic turn red, we put the breakpoint at the moment the traffic change then detect these frames after that, which reduce the unnecessary computation and also release more storage space. So that, we put a color probe on the traffic light zone acknowledging the in-time color of the light, accordingly stop detecting during the red light time.

4. EVENT DETECTION BASED ON THE OPTICAL FLOW

4.1 The principle of the optical flow

Described this method in mathematical formula as: presume the coordinate of one pixel in the frame locates at (x, y) in time t, and with the intensity I(x, y, t), after ⊿t, it will move to I(x+⊿x, y+⊿y, t+⊿t). Then according to the premise, the following constraint equation can be given as equation (1):

I(x, y, t) = I(x+⊿x, y+⊿y, t+⊿t) (1)

Using Taylor series on the right of the equation (1), then get to equation (2):

$$I(x+\Delta x, y+\Delta y, t+\Delta t) = I(x,y,t) + \frac{\partial I}{\partial x}\Delta x + \frac{\partial I}{\partial y}\Delta y + \frac{\partial I}{\partial t}\Delta t + \sigma$$

Compare to equation (1),

$$\frac{\partial I}{\partial x}\Delta x + \frac{\partial I}{\partial y}\Delta y + \frac{\partial I}{\partial t}\Delta t$$

is equivalent to zero and then each item is divided by Δt as equation (3) shows:

$$\frac{\partial I}{\partial y}\frac{\Delta y}{\Delta t} + \frac{\partial I}{\partial x}\frac{\Delta x}{\Delta t} + \frac{\partial I}{\partial t}\frac{\Delta t}{\Delta t} = 0$$

Which results as: $V_x = \frac{\Delta x}{\Delta t}$ and $V_y = \frac{\Delta y}{\Delta t}$, means the x and y components of the velocity. Thus, the equation (3) can be written as equation (4):

$$I_x v_x + I_y v_y = -I_t \text{ or } \nabla I^T \cdot \vec{V} = -I_t \quad (4)$$

There are two unknowns in one equation, so introduce some additional conditions to estimate the optical flow lead to various optical flow methods.

4.2 Event detection and experiments

Mark the pixel point, where the feature point locates at each frame, along with the coordinate of the moving feature point transforming. That imprints optical flow lines in the output images clearly as the track of the motion targets. The results in the experiment shown in Fig 2.

Fig. 2 the result of event detection

Using the image optical flow function I (x, y) describes the feature points at each pixel location (x, y), from which the gradient I (x, y) and $\hat{I}(x,y)$ generates. Assume the line parallel to the width of the target zone as Z(x, y), and $|\hat{Z}(x,y)|$ as its absolute. Base on the respective gradients, we define θ as the angle between them, here θ is equivalent to equation (5) :

$$\theta = \arctan[(|I'(x,y) - |z'(x,y)||/(1 + I'(x,y) \times |z'(x,y)|)], \theta \in (0, \pi/2)$$

Proving the T as the threshold, the rule to estimate the target event goes as equation (6):

$$f(x) = \begin{cases} 1, \theta < T \\ 0, \theta \ge T \end{cases} \qquad (6)$$

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Once f(x) is equal to 1, it shows one excursion in the x axis direction to the moving object, as the clue which hints that the pedestrian is running the red light, however that also including some misjudgments caused by indefinite factors. To exclude that, we define this judgment as an alarm factor, the frequency of which shows in one red light time to be the way we propose to detect if the red light is ran.

A continuous behavior as one complete running red light action it is, including series various feature points excursions in x axis direction to the mobile objects. The introduction of threshold W, which represents total times of the alarm factor the moving objects played in one red light time, works as sensitivity for explicitly judging the target event, that means when the number of alarm factor is above W, there is running red light event during this red light. Differ value of W causes influences on the final output results, as which we picture a coordinate (shown as Fig 3) to visualize the different values, then compare the real result of the sample video to find the ideal W.

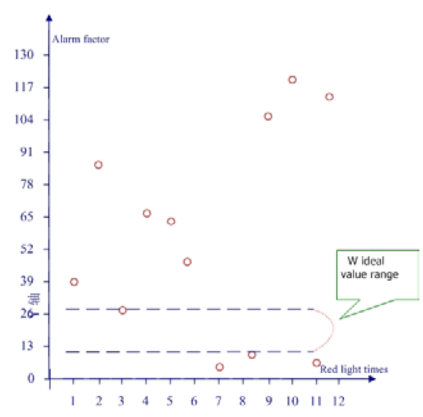

Fig 3 Ideal W Of The Result Video

In this coordinate, the x and y axis stand for red light times and alarm factor respectively, and the discrete points show the number of the alarm factor in this red light. Compare to the real data of the sample video, which has 12 times red light and 3 times of that are not be ran (which locates at the 7th, 8th and 11th time), and all the points indicates the running red light happened in this red light time must be above the the line of the value W. It comes to the result that when W ranges from 10 to 25, the detected target event data are the most closed.

5. PEDESTRIANS DETECTION BY FRAMES SUBTRACTION

Capture the information about the objects of interest in the detected event, mainly we focus on the frames subtraction. However, technically based on the principle of the method, the zone that the moving targets covered in the former frame but show in the present frame mistakenly is considered as the "detected target", and the shadow of the moving targets also locates the same situation. Theoretically, the other moving objects such as the cars are viewed as the moving targets as well, but not the targets we chase to. Consider to these circumstances, we take template matching into account based on the applying of reference [1].

5.1 The principle of motion targets detection by the frames subtraction

In order to exclude the effects of the background, we employ three sequential image frames, which are the present frame, the former and the latter ones, to subtract the frames. The whole process is shown in figure 4:

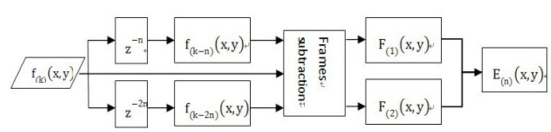

Fig. 4 Process Of Motion Target Detection

In the figure, the $f_{(k)}(x,y)$ represent the present schematic diagram from the source images, the z^{-n} means delay n frames before the present one then get $f_{(k-n)}(x,y)$, and the z^{-2n} and $f_{(k-2n)}(x,y)$ calculates by the same manner. The approach measures the time interval (that the n stands for) of the two image frames depends on the speed and the size of the

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moving targets. In this case, we choose n=3 here considering the moving targets as the pedestrians.

Calculate the current frame and the previous frame then get the frame difference image represented as $F_{(1)}(x,y)$. Likewise, get $F_{(2)}(x,y)$ through the current frame and the next frame. $E_{(n)}(x,y)$, the moving region of the moving targets comes from the calculation that is the process for the intersection of differential frame images $F_{(1)}(x,y)$ and $F_{(2)}(x,y)$. As shown in the equation (7).

$$E_{(n)}(x,y)= F_{(1)}(x,y) \cap F_{(2)}(x,y) \qquad (7)$$

Fig 5 shows the frames subtraction results obtained in this experiment as light-spots in the binary images.

(A))Original Image

(B) Obtained Motion Targets

Fig. 5 Results Of Frames Subtraction.

5.2 Contour Matching

As we mentioned above, this algorithm will cause the problem of detecting other irrelevant objects unconsciously. So to avoid this, we lesson the method applied by reference [1] based contour matching from the region we captured in the first part. It originated from the classic algorithm, Morphological Filtering, and operates only depends on the orders of the relative pixels regardless the value therefore are suited to the grayscale images of the case. Eventually, we can capture the pedestrians from the motion targets obtained by frames subtraction.

5.3 Summary

The choice of employing frames subtraction is supposed to recognize and isolate the pedestrians from the scene based on the detected event by optical flow, at the same time exclude the unexpected results caused by other mobile objects such as vehicles, which missed in the first detection step by optical flow. Nevertheless, the existing explorations we did make feasible that distinguish the pedestrians from the other objects just by costing a great quantity of complicated computing. That failed to improve the robustness of the system.

6. EXPERIMENT RESULT AND CONCLUSION

In our experiments, we employ a sample traffic monitoring video as long as 15 minutes to test our assumption. The result is supposed to automatically recognize the behavior that the pedestrians cross the road after the green light, which as accurate as human do. In the paper, we have demonstrated the basic principle of the optical flow and that the function it applied for the system, then mix anther algorithm, the frames subtraction in the second part. By this system we design, basically this supposal works out someway, our method generally capacitates automatic detection the particular event.

While some ambiguities involved during the procedure. Somehow the system sets as that the occlusions are minimal, consequently it runs but not enable itself to deal well with temporary occlusions. Once the occlusions and overlaps occur, they seem to be the primary source of instability for the system. So in existence method, we can exploit further in

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these specific situations in the image and so on, all which the approach has not satisfy the proposal, quest for forward perfection.

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