Relay Research Objectives under the Multi-Camera Tracking Algorithm

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Abstract—**For a target at multiple scenes and multiple camera monitoring status, how to achieve relay tracking problem proposes the use of improved algorithms and dynamic prediction CamShift tracking technology to achieve rapid target search, locate and track, with a strong anti-interference and adaptive capacity.**

Keywords-target search; locate and track; improved cam-shift algorithm

I INTRODUCTION

With the development of computer networks and communication technology, video monitors have been widely applied to national defense, military, transportation, social security and other aspects. In an ordinary city, there are thousand cameras for the security of the city which has played a very important role, but once the police intelligence on how quick the video in thousands of search and tracking suspects, police officers became more difficult problem. With computer vision and image processing technology in target tracking applications, the computer automatically searches for and track suspicious targets, tracking the escape vehicle has become possible.

[1] presented in a multi-camera target tracking method in case of overlapping field of view, but cannot be used when there is no overlap; [2] the use of two cameras goals Bhattacharyya coefficient matching similarity, target handover, achieve two scene target tracking; [3] The appearance model and trajectory tracking approach combining multi-camera target, but the effect of changes in scene illumination is not ideal; before [4] aim to take two cameras feature matching method track, but due to different camera brightness and viewing angle, resulting in matching adaptation is not high [5-7]. In this paper, in-depth study after CamShift algorithm, the improved CamShift proposed algorithm is applied to the case of multi-camera multi-target scenarios relay trace. Although algorithms exist CamShift single color model cannot predict the direction of the moving target and rotation problems, but it also has an adaptive search window, a small light on the subject, calculation speed has nothing to do with the characteristics of the object model, it can be improved to achieve the relay track requirements.

II IMPROVED CAMSHIFT ALGORITHM

CamShift algorithm is a non-parametric method; it searches through clustering way of moving targets, using color information in the region to achieve rapid variable nuclear Bandwidth tracking. However, multi-track relay scene Shique powerless, analysis of the reasons are the following cases: 1) a single component of the HSV color model cannot meet the multiple effects of H scene switching time between illumination; 2) CamShift solve the target shift, but when different scenes, different camera angle changes caused by changes in target appearance features, it cannot identify the target correctly; 3) when the target disappeared from the scene, it could not predict the direction of the target movement speed. To this end, the need for CamShift improvements emerges.

Because CamShift algorithm uses a single HSV color model, it is difficult to adapt to changes in background object or scene switching large range of motion and caused significant changes in illumination; coupled with the use of only the HSV model as the target H component modeling features, when S or bound to reduce black V value is smaller or larger, gray and other colors indexable fuzzy object model and background model, leading to tracking failure. Therefore, to achieve the goal of a multi-track relay scene to fit in the context of a complex, moving target or target rich colors and background colors can be accurately track approaches the paper through the establishment of a variety of color models to achieve environmental adaptive variable scene tracking.

HSV color space is set based on 3 H, S, V color distribution histogram qi, respectively, the target model to make Q = [qi], i = 1, ..., n. To ensure the different models under different scenarios optimal construct a convex combination model:

$$q_x = \sum_{i=1}^{n} x_i q_i = QX \tag{1}$$

Where $X = [x_1, x_2, \cdots, x_n]^{\mathrm{T}}$ is a combination of vector coefficients, and to meet:

$$\sum_{i=1}^{n} x_i = 1, x_i \geq 0 \quad \text{i=1, 2…} n \tag{2}$$

In order to determine the optimal coefficient x_i^*, to obtain a combined model and target model has a high degree of similarity, but there is a big difference between the background mode, the color will be the target area and the background area around the target distribution of probability and statistics, respectively, pa, pb respectively, the Euclidean distance squared model them with the convex combination between qx expressed as:

$$d_a^2 = \| q_x - p_a \|^2 \tag{3}$$

$$d_b^2 = \| q_x - p_b \|^2 \tag{4}$$

Optimal target model should enable d_a^2 as small as possible while making as large as possible. This is a typical multi-objective programming (LVP) problem with linear weighting method to convert it into a single objective programming problem that was the objective function:

$$d^2 = \beta_1 d_a^2 - \beta_2 d_b^2 \tag{5}$$

Where β_1 , β_2 for the selected weights and its size reflect the degree of trust in both the objective functions, which satisfies:

$$\beta_1 \geq 0, \quad \beta_2 \geq 0, \quad \beta_1 + \beta_2 = 1 \tag{6}$$

The (5), (7), (8) into (9), the obtained:

$$d^2(X) = (\beta_1 p_a^{\mathrm{T}} p_a - \beta_2 p_b^{\mathrm{T}} p_b) + (\beta_1 - \beta_2) Q^{\mathrm{T}} X^{\mathrm{T}} Q X - 2(\beta_1 p_a - \beta_2 p_b)^{\mathrm{T}} Q X \tag{7}$$

Model selection problem is transformed for the sake of $x_i \in X$, so $d^2(X)$ minimum:

$$x_i = \arg \min_{x_i \in X} d^2(X) \tag{8}$$

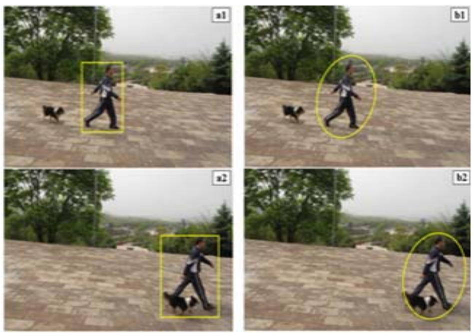
By solving the following multi-objective planning process to obtain corresponding optimal coefficient $X = [x_1^*, x_2^*, \cdots, x_n^*]^{\mathrm{T}}$. The solution process is described specifically below.

1) According to the structure of the target and the background area multi-objective linear programming (LVP) issue the appropriate sub-problems $\{s_i\}$, i = 1, ..., n.

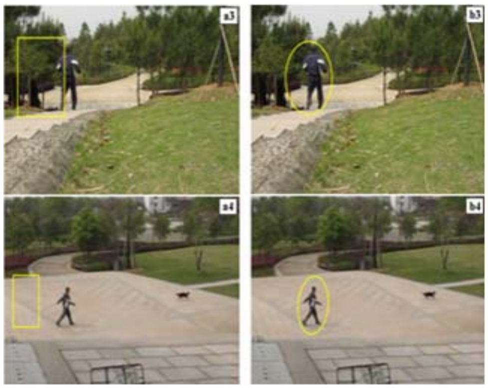
2) the use of the simplex method for solving each subproblem $\{s_i\}$, i = 1, ..., n.

3) If the sub-problems $\{s_i\}$, i = 1, ..., n, no feasible solution, then (LVP) has no solution, the algorithm terminates.

4) If $x^{i*} = x^{j*} (\forall i, j \in \{1, 2, \cdots, n\})$, then (LVP) have absolute optimal solution, x^* and $f(x^*)$ value output, the algorithm terminates.



(a) CamShift algorithm



(b) Improved algorithm CamShift

FIGURE I. ALGORITHMS COMPARE RESULTS.

5) According to the convex combination qx too weakly efficient solution subset Ω . Determine the combined coefficient

$$\beta^i = (\beta_1^i, \beta_2^i, \cdots, \beta_n^i)^{\mathrm{T}}, i = 1, \cdots, n$$

6) $\beta^i (i = 1, \cdots, q)$ obtained by the n $\{x^i\}$, i=1, ..., n, if $x^i \in \partial \Omega_{i=1,\cdots,n}$, then x^i weak effective solution; otherwise discarded $x^i \in \partial \Omega$, re-select β^i , until $x^i \in \partial \Omega$ so far. Remember to weakly efficient solution for $x^1, x^2, \cdots, x^n$ configuration set X.

7) Weighted on the set X pecking order.

8) Calculated x^* and $f(x^*)$.

9) If the $| x^{i*} - x^{j*} | > \varepsilon$ (differential threshold) then re-construct a finite set Q, turn 5) continue the calculation until the meet so far, the output of the optimal solution.

III TARGET DIP FORECAST

Due to different camera angle changes caused by inclination, appearance and other characteristics change, a first-order CamShift cannot correctly identify the target for this matrix dip and strike a target search window by second-order.

Second moment are:

$$M_{20} = \sum_x \sum_y x^2 I(x, y), \quad M_{02} = \sum_x \sum_y y^2 I(x, y)$$
$$M_{11} = \sum_x \sum_y xyI(x, y) \tag{9}$$

Let: $a = M_{20} / M_{00} - x_c^2$, $b = 2(M_{11} / M_{00} - x_c y_c)$

$$c = M_{02} / M_{00} - y_c^2$$

Then the next frame search window length (l), width (w) and the direction of the major axis are respectively:

Major axis:

$$l = \sqrt{\frac{(a+c)+\sqrt{b^2+(a-c)^2}}{2}} \tag{10}$$

Minor axis:

$$w = \sqrt{\frac{(a+c)-\sqrt{b^2+(a-c)^2}}{2}} \tag{11}$$

The direction of the major axis:

$$\theta = \frac{1}{2}\arctan\left(\frac{b}{a-c}\right) \tag{12}$$

IV DYNAMIC FORECAST TRACK

In order to better predict that the position of the target may occur in the next time, and the motion characteristics of the region, following the establishment of the state model of the moving object:

$$Z_n = (p_k, \hat{p}_k, \Delta p_k, v_k, \hat{v}_k, \Delta v_k, a_k, \hat{a}_k, \Delta a_k)_{k=1,\cdots,n} \tag{13}$$

Construction acceleration displacement equation:

$$\hat{p}_{k+1} = p_k + v_k \Delta t + a_k \Delta t^2 / 2 \tag{14}$$

$$\Delta p_{k+1} = \Delta p_k + \Delta v_k \Delta t + \Delta a_k \Delta t^2 / 2 \tag{15}$$

Where in: p_k is the centroid position of the target, (x_c, y_c) the centroid predicted position in the next frame, Δp_{k+1} regional prediction target may exist; $v_k = (p_k - p_{k-1}) / \Delta t$, $a_k = (v_k - v_{k-1}) / \Delta t$ target centroid velocity and acceleration; △t is two frame interval. $\hat{p}_{k+1}$ and Δp_{k+1} can be obtained by matching the search target range $\hat{p}_{k+1} \pm \Delta p_{k+1}$.

To ensure the tracker can accurately describe the current movement moving targets, improve tracking efficiency, the need to measure the value of the newly acquired correction, this article will use the IIR filter for fast calculation:

$$\hat{v}_{k+1} = \alpha v_{k+1} + (1-\alpha)\hat{v}_k \tag{16}$$

$$\Delta v_{k+1} = \alpha \mid \hat{v}_{k+1} - v_{k+1} \mid + (1-\alpha)\Delta v_k \tag{17}$$

$$\hat{a}_{k+1} = \beta a_{k+1} + (1-\beta)\hat{a}_k \tag{18}$$

$$\Delta a_{k+1} = \beta \mid \hat{a}_{k+1} - a_{k+1} \mid + (1-\beta)\Delta a_k \tag{19}$$

Where α、β is a constant of a $0 \le \alpha$、$\beta \le 1$.

In order to improve the efficiency of video retrieval using velocity vector v_k target in the next video in the direction predicted 45o angle to the direction of the extraction area scanned video data tracking.

V IMPLEMENTATION AND ANALYSIS OF ALGORITHMS

Experiment, using a combination of multi-model recognition scene environment, to determine the optimal combination, the use of CamShift target tracking algorithm, and the algorithm using the predictive frame may be the next target speed, pitch, direction of movement prediction; When the target disappeared (when the $M_{00} \le 0.3\hat{M}_{00}$) or of the end of the video segment, the reading of the second video; with the state before the first video frame of the final disappearance of the target object as the second video information of the target model, the target begins to search, if the second videos found the target, then start tracking and status information output target; if in a given time period △t (experiment △t=600s) has not found the target, then stop this video search, adjusting to remove a video until after all the video detection is complete, the cycle call again next △t time video, continue the search target. Improved algorithm flow shown in Figure 2.

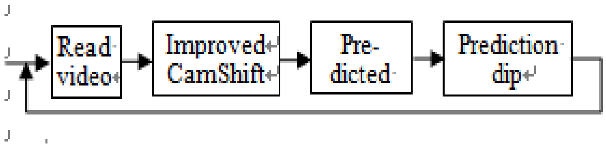


FIGURE II. IMPROVED ALGORITHM FLOWCHART CAMSHIFT.

Use VC6.0 and MATLAB9.0 use as a platform on P4 3.0 GHz 1G machine developed an experimental system for multiple cameras at multiple scenes video shot for continuous tracking experiments. Figure 1 is a result of two algorithms. Figure 1 is a column of the image using conventional CamShift target tracking algorithm results to track the target rectangle, a1 in figure. 1, a2 the figure, because it is in the same scene, so the traditional algorithm can properly track CamShift, but Figure 1 a3, a4, and I see the tracking target frame is lost, it is because the results of scene change; b columns of the image in Figure 1 is to track the performance of the proposed algorithm can be seen from Figure 1, the methods described herein can overcome the interference causing a scene change, can be a good track to the target. Figure 3 is a two algorithms in tracking the target centroid state simulation map, while the first 500 to 600 scene illumination increases, traditional CamShift algorithm significantly deviate from the target, but the algorithm is not subject to interference but also the normal track.

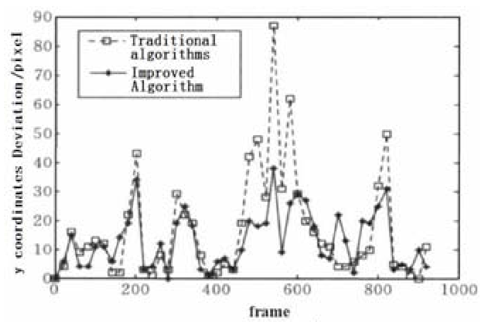


FIGURE III. TARGET CENTROID TRACKING STATE DIAGRAM.

VI CONCLUSION

For the case of modern society in general use in the camera, it is proposed based on an algorithm for target tracking relay CamShift improved algorithm under a variety of scenarios. The algorithm combines the multi-scene camera complex background environment, using the colors of CamShift better tracking algorithm and optimal combination of multiple color space model is introduced to the idea of the algorithm which is designed to optimize the objective function to enhance the algorithm to adapt to changing scene ability; to further improve the recognition rate target relay process, but also the establishment of a multi-state model variables and rotation tracking and forecasting, and to ensure that the target tracking accuracy and robustness. The large number of field experiments shows that the proposed algorithm is effective tracking, recognition rate, easy to promote and implement, there is a good prospect.

ACKNOWLEDGEMENT

This work was supported by the National College Students Innovation Project (201310397010) and Nanping docking project (N2011WZ02).

REFERENCES

[1] Jinman K, Cohen I, Medioni G. Continuous Tracking within and across Camera Streams [A].2003 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2003(1):267-272.

[2] Aggarwal J K. Object tracking in an outdoor environment using fusion of features and cameras [J]. Image and Vision Computing, 2006, 24(11): 1244-1255.

[3] Boyle M. The Effects of Capture Conditions on the CAMSHIFT Face Tracker[R]. Alberta, Canada: Department of Computer Science, University of Calgary, 2001:45-47.

[4] Nouar OULD-DRIS, Ali Ganoun, Raphael Canals. Improved Object Tracking with CamShift Algorithm[C]. IEEE International Conference on Acoustics, Speech and Signal Procession, 2006:165-167.

[5] ALLEN J G. Object tracking using CamShift algorithm and multiple quantized feature space[C]// Proceedings of 2003 Pan-Sydney Area Workshop on Visual Information Processing. Darlinghurst, Australia: Australian Computer Society, 2004:3-7.

[6] Nummiaro K, Koller-Meier E, Van Gool L. An adaptive color-based particle filter [J].Image and Vision Computing, 2003, 21(1): 99-110.

[7] Comaniciu D, Ramesh V, Meer P.Kernel based object tracking[J].IEEE Trans Pattern Analysis Machine Intelligence,2003, 25(5):564-575.