Research on Fish recognition algorithm based on Machine Learning algorithm

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Abstract: The study of fish behavior with the help of computer vision technology has gradually become a hot topic, this technology simulates the principle of biological vision, and obtains dynamic target parameter information by processing collected pictures or videos, in order to achieve the purpose of monitoring and analysis of fish swimming behavior. Using the traditional Vibe algorithm to monitor the swimming behavior of fish will consume a large number of video frames to eliminate ghosts, and the detection results of moving targets under the dynamic background of water surface ripples are not accurate, so an improved Vibe algorithm is proposed. In view of the fact that a large number of video frames are consumed to eliminate ghosts, a hierarchical traversal search algorithm is proposed to mark and count the target image to adaptively adjust the background update probability to quickly eliminate ghosts. In view of the fact that the detection results of moving targets in the dynamic background with water surface ripples are not accurate enough, a method based on LBP and HSV to remove water surface ripples is proposed to improve the detection accuracy.

1. Introduction

Computer vision (Computer vision) technology is a fast, economical and effective means of measurement and evaluation, through the realization of human visual function to perceive, identify and understand three-dimensional scene [1]. Moving target detection is a cutting-edge topic in the research of computer vision, and the study of fish behavior with the help of moving target detection has gradually become a hot topic. By detecting the moving fish, the trajectory, position, size, shape and acceleration of the fish can be obtained to identify and analyze the swimming behavior of the fish [2]. The study of fish swimming behavior provides a theoretical basis for improving fishing techniques, optimizing culture environment, monitoring water quality of water sources [3][4], and enhancing the ability of protection and management of fishery resources. It is an important research content of fish behavior, physiology, ecology and other disciplines [5].

At present, the main solutions to the ghost problem are improving the initialization background model and improving the time sub-sampling factor. In view of this, on the basis of previous studies, in view of the fact that eliminating "ghosts" requires a large number of video frames, the author proposes a hierarchical traversal search algorithm to mark and count the target image to adaptively adjust the background update probability. in order to quickly eliminate ghosts. In order to solve the problem that the result of motion detection in dynamic background is not accurate enough, this paper proposes to remove water surface ripples based on LBP and HSV to improve the detection accuracy, which aims to quickly eliminate ghosts by consuming a small number of video frames, and accurately detect moving targets in the dynamic and complex background of water surface ripples.

2. Materials and methods

2.1 Object and material

Grass goldfish was used as the experimental object, and the body length was 3~5cm. Before carrying out the experiment, the experimental fish were reared in the laboratory aquarium for several months to make them fully adapt to the experimental environment. In order to ensure the imaging quality, the camera is installed directly above the aquarium to take pictures. The experimental hardware platform is configured as follows: IntelCore8 core CPU,8GB memory, Windows10 operating system. The test data were taken by Nikon D90 and tested by vs2010+OpenCV2.4.9.

2.2 Testing method

2.2.1Vibe Arithmetic

The Vibe algorithm assumes that each pixel in the image has a similar distribution with its neighboring pixels. Under this assumption, the background model can be represented by each pixel and its adjacent pixels, and enough background models can be established to comply with the statistical law. When the first frame image is obtained, that is, tweak 0, the background model is established by formula 1:

$$\mathrm{BM} = f(x^i, y^i) \mid (x^i, y^i) \in C(x, y) \tag{1}$$

In the equation, $C(x,y)$ represents the neighborhood pixels of the current point, $f(x,y)$ represents the pixels of the current point. During the N initialization process, the number of times selected for the pixel (x^i, y^i) in $C(x,y)$ is Nimbus 1, 2, and 3, and the number of times that the pixel is selected is $N = 1,2,3,\cdots,n$.

The distance difference between the pixels of the subsequent image and the background model is calculated and the number of distances less than the radius R is counted to determine the moving target.

$$f^k(x,y) = \{ \begin{matrix} \mathrm{num}(f^k(x^i,y^i), \mathrm{BM}^{k-1}(x^i,y^i)) \\ \mathrm{num}(f^k(x^i,y^i), \mathrm{BM}^{k-1}(x^i,y^i)) \end{matrix} \tag{2}$$

If the number of moving targets detected by hierarchical traversal search algorithm is not equal to the actual number of moving targets, the background update probability should be increased to speed up ghost elimination. If equal, the initial background update probability should be used to prevent the correct foreground pixels from being updated to the background. As shown in Formula:

$$P(x) = \{ \begin{matrix} P(x) \times (1 + a) & \mathrm{num} \neq \mathrm{fnum} \\ P(x) & \mathrm{num} \neq \mathrm{fnum} \end{matrix} \tag{3}$$

In the formula, an is a fixed parameter with a value of 20. Fnum is the number of actual moving targets, and num is the number of moving targets. The ghost can be eliminated quickly by adapting the background update probability.

2.2.2Ghost elimination of adaptive background update probability

The common problem in traditional Vibe algorithms is the existence of ghosts in the detection results. When the algorithm uses the first picture to initialize the background modeling, the picture may contain moving objects, and they will produce ghosts when they start to move in subsequent frames; when the moving objects in the picture change from a moving state to a still state, and then start moving will also produce ghosts. A conservative update strategy is adopted for the traditional Vibe algorithm: when a pixel is judged as a foreground pixel for n consecutive times, the pixel is determined to be a ghost, and the ghost pixel is updated to a background pixel with a global fixed background update probability, so that a lot of video frames are consumed to eliminate the ghost. The basic idea of the conservative update strategy of improving the traditional Vibe algorithm is to first use the traditional Vibe algorithm to detect the moving target, and then use the hierarchical traversal search algorithm to mark and count the moving target in the target image after obtaining the moving target image with ghosts. If the counting result is not equal to the actual number of targets, speed up the background update probability, if equal, do not change the background update probability.

3. Results and analysis

3.1 Experimental results of ghost elimination based on adaptive background update probability

In the experiment, the number of sample models, the minimum number of matches, the initial distance threshold of min=2;, the probability of background update, the probability of background update, and the fixed parameter, P (x), are 20, 20, 20, 10, 1, 30 and 10, respectively. As can be seen from figure 4, the improved Vibe algorithm based on adaptive background update probability can remove ghosts quickly.

In order to show the effect of the improved Vibe detection in detail, count the number of frames needed to eliminate ghosts in each video, as shown in Table 1.

The results show that the improved Vibe algorithm uses the hierarchical traversal search algorithm to mark and count the moving objects in the target image to dynamically adjust the background update probability.

That is, there is no need to wait for a pixel to be judged as a foreground pixel for n consecutive times, and the background update probability can be accelerated in the presence of ghosts, so the number of video frames required to eliminate ghosts is more than 50% less than that required by the classical algorithm.

Table 1. Comparison between classical and improved Vibemethods

Detection times	Category	Number of test strips	Actual number of entries	The number of frames required to eliminate ghosts
1	Classic VibeClassicalVibe	14	8	70
1	Improve VibeClassicalVibe	14	8	30
2	Classic VibeClassicalVibe	32	20	300
2	Improve VibeClassicalVibe	32	20	120

3.2 Experimental results of ghost elimination based on adaptive background update probability

In the experiment, the LBP threshold is set to 2000,230, the H threshold range is set, the threshold range is set to 0.52, the S threshold range is set, and the threshold range is set to 1100.127, the V threshold range is set to 0.50. In figure 1, due to the existence of dynamic background (water surface ripple), there are many noises in the detection results. As shown in figure 1 b, the detection accuracy is greatly improved after the dynamic background is removed in the HSV color space. In order to show the improved Vibe detection effect in detail, the accuracy (Precision), recall rate (Recall) and evaluation value (Rating) are used to judge the improved Vibe performance index. The accuracy index reflects the ratio of the number of correct foreground pixels to the detected foreground pixels, and the recall index reflects the ratio of the number of foreground pixels detected to the number of real foreground pixels. As shown in formulas 4 and 5, the test results are shown in Table 2.

Table 2. The test results of recall rate

Category	Accuracy	Recall rate
Classic Vibe Classical Vibe	0.42	0.80
Improve Vibe Classical Vibe	0.80	0.25

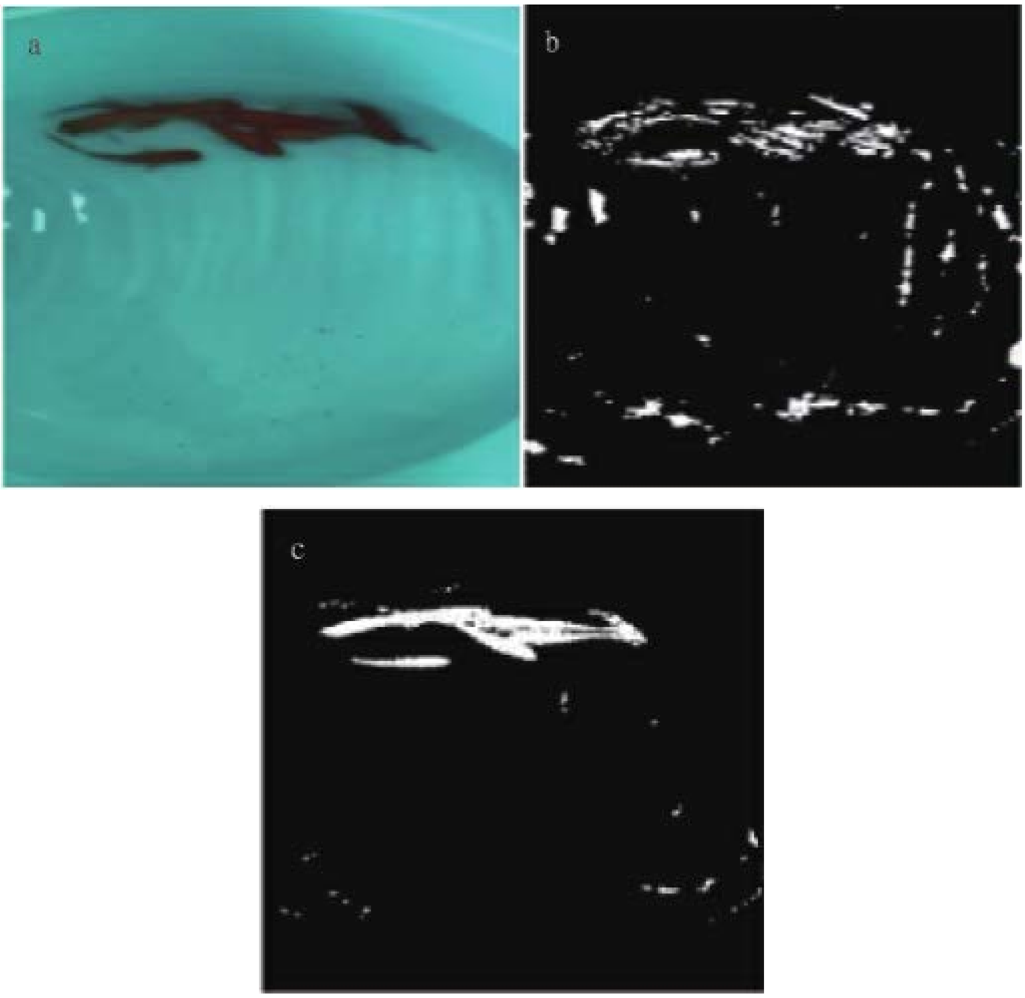

Figure 1. Improved comparison of dynamic background removal based on HSV color space

4. Conclusion

In order to solve the problem that the traditional Vibe algorithm consumes a large number of video frames to eliminate ghosts, and the moving target detection results are not accurate enough in the case of dynamic background, the author proposes adaptive dynamic background update probability and dynamic background removal based on LBP and HSV. The experimental results show that the number of video frames needed by the improved Vibe algorithm to eliminate ghosts is more than 50% less than that of the classical algorithm. The detection accuracy of the improved Vibe algorithm is greatly improved under the dynamic background of water surface ripples.

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