Video moving target detection and tracking based on hybrid algorithm

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Abstract

With the level improvement of sports competition, the requirements of sports training have been improved. In the past, the training of the coaches has been unable to meet the needs of sports training. In order to adapt to this situation, computer vision technology is more accurate and memorable than the human eye, it can faster and more efficient capture of moving objects, and the ability to record various movements of the target data, the movement of athletes provide more theoretical, data-based description. A new hybrid tracking algorithm, which is made up of mean shift algorithm and color histogram algorithm, is proposed to track the characteristics of sports objects. Its principle and characteristic are introduced respectively. Mean shift algorithm is a feature matching and tracking algorithm, which can keep the stability and precision of tracking. The color histogram is mainly for the color distribution of target, and the rotation of dynamic video image and the observation point of view changes have a good adaptability. The combination of these two algorithms greatly improves the sporty object tracking of the rod and the accuracy of Matlab and is given by the simulation example, the experimental results show that this method has the ideal effect.

Keywords: image representation, interpolation algorithm, physical education visual frequency, target measurement, equalization method

1.INTRODUCTION

With the development and deepening of information technology, more and more people use computers to obtain and process kinds of information (Tan et al., 2015; Man et al., 2010; Qi et al., 2014). According to statistics, about 75% information was obtained from the outside world which is from the visual or image information (Agrawal and Meena, 2013). It is the most effective way of human information acquisition and communication, because of its large amount of information, intuitive, the image has been widely publicized and applied multimedia occupy an important position in recent years (Xiao et al., 2015; Kim, 2015). Image segmentation is an indispensable part of image analysis and visual system. It is a basic and difficult problem in computer vision research (Mai, 2014). The difficulty is that the image segmentation itself is a pathological problem, the purpose of segmentation is to understand, but the segmentation requires the knowledge obtained after the understanding. This morbidity poses have great difficulties and becomes a bottleneck hinders the development of computer vision problem (Lu et al., 2016; Wallace, 2015).

Image segmentation is a basic problem in computer vision. Segmentation results have a great influence on the performance of visual system (Pinto, 2015). So image segmentation is always a hotspot in computer vision (Hadi and Sabah, 2014). The deep research of human visual mechanism and the rapid development of computer technology will provide a new way to solve the image segmentation problem. Image technology in a broad sense is a general term for a variety of image-related technologies. There are many types of image technology, but they cannot be attributed to an overall framework of an image project. Image engineering is a new subject for the research and application of the whole image field (Kim, 2015). It is rich in content and can be divided into three levels according to the abstraction and research methods (Figure 1): image processing, image analysis and image understanding.
In practical application, we can obtain the athletes’ competitions and the training video during the training. Through the cameras with the same height and the same height, they are erected at the match site or the training ground. Through the image processing, we can get all kinds of reference data. According to the camera given by the height and angle, the mathematical relationship can be sports video in the actual target space in the specific coordinates. Through the computer vision technology, digital image processing and pattern recognition technology deal with the collected image analysis, researchers can get the required statistical data (Thida et al., 2013; Ingersoll, 2015).

Moving object detection and tracking system is based on digital image processing, pattern recognition, computer vision and other technology-based intelligent identification system. This system can be widely used in traffic regulation, astronomical observation, biomedical research, traffic statistics and sports and other related fields. In the field of sports video analysis, the moving object detection and tracking technology has played an indispensable role. Through the real-time detection and tracking of the athlete’s movements, the trajectory can be analyzed to facilitate the athletes in training. Game cannot detect the human eye subtle action difference, thereby enhancing the training of athletes and game results was needed. Therefore, it is very important to research and discuss the target detection and tracking technology in sports video, which will have a positive impact on other fields based on moving target tracking. So it has very important theoretical and practical value.

2. MATERIALS AND METHODS

2.1 History and current situation of hybrid intelligent algorithm

Since the study of machine learning in the 1950s, many learning algorithms have been proposed and developed, included supervised learning algorithm, unsupervised learning algorithm, hard computing method and soft computing method. The so-called soft computing method is represented by Artificial Neural Network (ANN), Fuzzy Logic (FL), Evolutionary Computation (EA), Probabilistic Reasoning (PR) and Rough Set (RS). The concept of soft computing was first founded by the founder theory of fuzzy sets, Berkeley professor L. Zadeh put it, also known as “intelligent computing.” On the one hand, people constantly put forward new learning methods, such as Support Vector Machine (SVM) and Immune Algorithm (IA), on the other hand, combine different learning methods and put forward many mixed learning method. Especially in recent years, the research of hybrid intelligent computation method has been paid more and more attention. It also forms a research direction called “hybrid intelligent system”,and it has been applied in decision support, image processing, process control, mechatronics, robotics and complex automation tasks, and many other applications showed its excellent performance.

Intelligent systems are important for dealing with practical computational problems because they provide us with the knowledge of human expertise such as domain knowledge, uncertainty reasoning, adaptive experience with noise and time-varying environments. To achieve a high degree of intelligence systems, the various methods of calculation between the integration is essential. Compared with traditional artificial intelligence methods, it can only deal with the accuracy, certainty and strictness of information. The guiding principle of
hybrid intelligent computing methods is the use of inaccurate, uncertain, partially accurate tolerance and low solution cost and Stickiness to get on the practical problems of easy handling and better harmony. Because a variety of soft computing methods are complementary, mutual improvement in many cases, the combination of these methods of a single method than using a single more effective solution to the problem. The purpose of the combination overcomes the limitations of individual methods by blending them with each other.

Figure 2 showed the various hybrid structures resulting from the combination and interaction of ANN, FL, GOA. With the development of other new computational methods, such as immune algorithm and quantum computation, the content and scope of hybrid intelligent algorithm are expanding.

Figure 2. A general framework for hybrid intelligent systems

2.2 Genetic algorithm

Genetic algorithm is carried out in a biological community, we use $n_i$ represented the first generation of groups, and each solution is seen as a $n_i$ in the individual, with $l_i$ represented that in the algorithm for each $l_i$ are compiled into a certain code. The string $S_1 = a_1a_2...a_L$ represents the genetic code chain of the individual genetic characteristics. Each generation includes a certain number of parents offspring, respectively, with $U_1, V_1, E_1$ coding operator, there are:

$$U_i = \{I_1, I_2, \cdots, I_n\}$$ (1)

$$V_i = \{I_{m+1}, I_{m+2}, \cdots, I_n\}$$ (2)

$$\Pi_i = U_i \cup V_i, E_c : I_i \rightarrow S_i$$ (3)

For each individual $i$, there is only one $F$. Corresponding to:

$$f_i = ff(I_i), i = 1, 2, \cdots, n$$ (4)

The higher the $F_i$, the better the quality of the $i$-th individual, that is, the environment described by the function $ff(.)$. Genetic algorithm has advantage of search space parallelism and thus rarely falls into the local optimal solution. Genetic algorithm is relatively easy to implement, once compiled a genetic algorithm program to solve different problems, often need to modify the coding scheme and fitness function. Of course, this is only relatively easy, because the coding scheme and fitness function selection sometimes will become difficult. The basic flow chart of genetic algorithm was shown in Figure 3.
$K = 0$, produce initial Group $N(0)$

- Calculate fitness
- Select Operand
- CrossOperand
- MutationOperand

$K = K + 1$, produce new Group $N(K + 1)$

Whether the termination condition is satisfied

- Output the best individual, end the genetic algorithm.

Y

N

Figure 3. The basic flow chart of genetic algorithm

If the interpolation algorithm is adjusted along the edge of the image, rather than through the edges of the image, a better interpolated effect is obtained. Hamilton’s adaptive interpolation algorithm and its improved algorithm for the use of gradient information interpolation, the main focus on how to use the edge or the correlation between pixels to get a higher resolution color images. However, there are few literatures on the edge detection of Bell template images.

2.3 Color difference image representation

The brightness of each pixel position in the image is independent of the modulation function. The weighting coefficients of the luminance are estimated to be uniform. On this basis, a 3x3 normalized space symmetric convolution kernel is used for processing. The luminance of each pixel position can be estimated. The color difference representation of each pixel position:

$$
\Delta_{CFA}(x, y) = \sum \Delta_{CFA}(x, y) f_S(x, y) = c_R f_R(x, y) + c_B f_B(x, y) + c_G f_G(x, y)
$$ (5)

Where, $C_r$, $C_g$, and $C_b$ are the modulated color difference images:

$$
C_x = \int E(x, y, \lambda) \rho_x(\lambda) d\lambda
$$ (6)

Then $C_r$, $C_g$, and $C_b$, respectively, the formula:

$$
c_R = \frac{3}{4} C_R(x, y) - \frac{1}{4} C_B(x, y) - \frac{1}{2} C_G(x, y)
$$ (7)

$$
c_B = \frac{3}{4} C_B(x, y) - \frac{1}{4} C_R(x, y) - \frac{1}{2} C_G(x, y)
$$ (8)

$$
c_G = \frac{1}{2} C_G(x, y) - \frac{1}{4} C_B(x, y) - \frac{1}{4} C_R(x, y)
$$ (9)

It can be seen from the $C_r$, $C_g$ and $C_b$ by adjusting the color difference image after sampling down to form a Bell template color difference image:
\[ \tilde{\theta}_{GS}(m_x, m_y) = \sum_{s=R,G,B} \tilde{f}_s(m_x, m_y) * \tilde{C}_s(m_x, m_y) = \sum_{s=R,G,B} p_s \tilde{C}_s(m_x, m_y) + \frac{1}{8} \sum_{r=0}^{1} \sum_{s=0}^{1} \tilde{C}_s(m_x, m_y) \] (10)

Image compression is a technique for representing the amount of information contained in an image or an image with as few bits as possible. The purpose is to reduce the amount of data representing the image. General digital image data has spatial and frequency domain redundancy, and has a time correlation. Therefore, this redundancy can be fully utilized to reduce the data rate. Image compression algorithm in accordance with the degree of distortion when encoding and decoding can be divided into lossless compression. The former compression process is reversible, while the latter due to the loss of information. Compression technology from the classic coding to modern coding, the efficiency has been greatly improved.

2.4 Image compression and preprocessing

Lossless compression, also known as reversible compression, refers to the method of reducing the amount of data needed. To represent the required amount of image data, lower bit rate image data without any loss of image. The elimination of redundancy in the data is the working mechanism of lossless compression. In the compression process, since only the use of coding redundancy and inter-pixel redundancy, and therefore did not cause any loss, which can be decoded without distortion to restore the original image data.

In practice, image compression technology has evolved from simple entropy coding to transform coding, predictive coding, quantization coding, multi-resolution coding. At present, the main image compression technology was shown in Figure 4.

![Figure 4. The main methods of image compression](image)

The general image processing was shown in Figure 5. As can be seen from the figure, image segmentation is a key step from image preprocessing to image recognition and image analysis, occupying an important position in the image. On the one hand, it is the basis of expression and has important influence on feature measurement. On the other hand, image segmentation and object representation based on image segmentation, feature extraction and parameter measurement transform. The original image into a more abstract and more compact form enabled higher-level image recognition and image analysis to be possible.
2.5 Hybrid tracking algorithm

The bit mean shift algorithm is a nonparametric kernel density estimation method. It is an iterative method to calculate the extreme point of the probability density function by gradient method. The algorithm has the characteristics of no parameters and fast pattern matching, so it is widely used in the field of computer vision and computer image processing. The mean shift algorithm is able to move each point to the local maximum point of the density function along the shortest path in the probability distribution.

According to the kernel $K(x)$ and the window radius $h$, we can get the multivariate kernel function density estimate $f(x)$ at some point $x$, which is calculated as:

$$
\hat{f}(x) = \frac{1}{nh^d} \sum_{i=1}^{n} K\left(\frac{x - X_i}{h}\right)
$$

(11)

The average global error minimization between the density estimate and the true density can be achieved by the Epanechnikov kernel:

$$
K_{\epsilon(x)} = \begin{cases} 
\frac{1}{2} \xi \xi (d + 2) \left(1 - \frac{1}{2} \|x\|^2\right) & \text{if } \|x\| < 1 \\
0 & \text{else}
\end{cases}
$$

(12)

Where white is the volume of the unit $d$-sphere. There is also a common kernel for multiple Gaussian:

$$
K_N(x) = (2\pi)^{-d/2} \exp\left(-\frac{1}{2} \|x\|^2\right)
$$

(13)

Gaussian kernel contour function can be expressed as:

$$
K_N(x) = (2\pi)^{-d/2} \exp\left(-\frac{1}{2} x\right)
$$

(14)
C is the normalization constant used the gradient of kernel function density estimate to define the gradient of the probability density:

\[
\nabla_s f_{K(i)} = \nabla_s \hat{f}_{K(i)} = \frac{1}{nh^d} \sum_{i=1}^{n} \nabla_s K\left(\frac{x - X_i}{h}\right) = \frac{1}{nh^d} \sum_{i=1}^{n} K\left(\frac{x - X_i}{h}\right)
\]

(15)

\[V K(x) = \left(\frac{\partial K(x)}{\partial x_1}, \frac{\partial K(x)}{\partial x_2}, \ldots, \frac{\partial K(x)}{\partial x_n}\right)
\]

(16)

3. RESULTS AND DISCUSSION

3.1 Experimental data set

As the movement of human body is a non-rigid target, from the example of the map, it can see the location of target moving abrupt change. The shape is also changing, so the difficulty was tracked. It can be seen from the tracking results that the tracking method proposed in this paper can track the position of target accurately and adjust the tracking window according to the shape of the human object in the current frame. From the video tracking of basketball games, it can be seen that the proposed algorithm can adapt to set different goals. So it is proved that this algorithm has ideal application effect. Mobile light dish display equipment was shown in Figure 6.

Figure 6. Mobile light dish display equipment

A new hybrid tracking algorithm, which is made up of mean shift algorithm and color histogram algorithm, is proposed to track the characteristics of sports objects. Its principle and characteristic are introduced respectively. Mean shift algorithm is a feature matching and tracking algorithm, which can keep the stability and precision of tracking. The color histogram is mainly for the color distribution of target, and the rotation of dynamic video and image. The observation point of view changes have a good adaptability. The combination of these two algorithms, which greatly improves the sporty object tracking of the rod and the accuracy of Matlab is given by the simulation examples. The experimental results showed that this method has the ideal effect. In order to verify the effectiveness of the algorithm, two sets of video tracking simulation experiments are carried out under the platform of MATLAB. Figure 7 showed the tracking result of the basketball game video.
The color histogram algorithm proposed in this paper can not only track the non-rigid moving object, but also has the drawback of relying on the moving target color. Once the background color and the moving target are close, the background has similar color of the object, it is very easy to track the results of interference. In the future, it can also tap other new features as a tracking condition to improve the tracking effect.

3.2 Simulation analysis

The complexity of sports itself brought many difficulties to the actual detection and tracking of moving objects. In order to effectively detect and track the athletes, this paper improves the common single tracking algorithm, and proposes a tracking method combining the mean shift algorithm. The color histogram algorithm improved the detection and tracking effect of the sports object. In order to verify the effectiveness of the algorithm, this paper uses Matlab for simulation and gives an example of detection and tracking effect. Matlab analysis of existed sport image was shown in Figure 8.
At present, the tracking algorithm based on moving target of sports video can still deal with the single-angle visual information and cannot obtain the omni-directional information of the whole 3D moving object, so it can achieve good tracking effect if the foreground detail is not high. It is often difficult to achieve good results by increasing the details of the requirements for the future. If the multi-camera can be used to take multi-angle shooting of the moving object, the correlation between the cameras can be tracked. The robustness and stability of the algorithm will be greatly improved. The development of multi-source information fusion should be strengthened in the future research.

4. CONCLUSION

With the improvement of the level of sports competition, the requirements of sports training have been improved. In the past, the training of the coaches has been unable to meet the needs of sports training. In order to adapt to this situation, computer vision technology the more the machine vision is more accurate and memorable than the human eye, it can faster and more efficient capture of moving objects. The ability to record various movements of the target data and the movement of athletes provided more theoretical, data-based description. A new hybrid tracking algorithm, which is made up of mean shift algorithm and color histogram algorithm, which is proposed to track the characteristics of sports objects. Mean shift algorithm is a feature matching and tracking algorithm, which can keep the stability and precision of tracking. The color histogram is mainly for the color distribution of target, and the rotation of dynamic video image point of view changes. The combination of these two algorithms, which greatly improved the sporty object tracking of the rod and the accuracy of Matlab, is given by the simulation examples. The experimental results showed that this method has the ideal effect.

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