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Pedestrian Movement Tracking Model in Road Environment Based on UAV Video

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ABSTRACT. *The development of science and technology provides new methods for traffic flow survey, the method based on UAV video is one of the widely used methods. UAV is widely used in many kinds of monitoring and measurement due to its advantages. In particular, its flexibility is more applicable to the pedestrian flow survey. However, due to the randomness and uncertainty of pedestrian movement, as well as the many obstacles on the pedestrian road, the UAV cannot accurately track and locate the pedestrian movement, resulting in poor application effect and low measurement accuracy. Based on this, this paper proposes a method of pedestrian tracking model in road environment based on UAV video, which can effectively track and locate pedestrians. The calculation model in this paper is compared with other algorithm models. The results show that the calculation results in this paper are better than other methods, and the accuracy of the model used in this paper can be effectively overcome. In order to overcome the obstacles in the process of tracking, accurate positioning can be carried out to improve the tracking accuracy, which can provide reference for the follow-up research.*

KEYWORDS: *UAV, Road Environment, Pedestrain, Tracking Model*

1. Introduction

With the rapid development of economy, unmanned aerial vehicle (UAV) [1-3] is gradually developed. Because of its flexibility, low cost and easy operation, it has been widely used in various industries, not only in commerce, but also in transportation. Therefore, there are more and more researches in this field. Intelligent monitoring [4-5] and target tracking based on UAV scene have become the main research direction. The general collector can achieve good results for target tracking and acquisition in static state, but it can only collect scenes within a certain range, and targets beyond this range cannot be collected. This is far from enough for long-term tracking and acquisition [6-7]. For dynamic target tracking and positioning, UAV can track specific targets according to the measured images, and can also change its own direction and position in the tracking process [8-10], so as to

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realize long-term and large-scale accurate tracking and positioning. Therefore, with the help of UAV, new application direction begins to appear in the field of computer vision [11-12].

Due to the randomness of pedestrian movement, it is not easy to determine the position, and the pedestrian is intertwined with a variety of objects, which makes it difficult for pedestrian tracking. Therefore, compared with the target tracking in ordinary scenes, pedestrian tracking in UAV scene needs to consider many problems, such as long-term occlusion, severe deformation and so on. These problems are more challenging in the tracking process. If only through the previous traditional target tracking algorithm, it is difficult to achieve the purpose of high-precision tracking and positioning. In the process of pedestrian movement, not only the randomness is strong, but also the range of deformation is very wide, which makes the fluctuation range of tracking target's aspect ratio become larger, so it is not easy to capture and learn its state, and the difficulty of tracking is greatly improved. In the tracking database, there is a variety of target categories. In terms of overall tracking accuracy, most tracking algorithms have high accuracy, but it is difficult to achieve the purpose of accurate tracking if the tracking target has undergone severe deformation.

Based on the above background, in order to study a method that can accurately track the pedestrian movement, this paper establishes the pedestrian motion tracking and simulation modeling based on UAV video in road environment, looking for the method to overcome obstacles in the tracking process, and improve the accuracy of UAV in the process of tracking.

2. Method

2.1 Model Establishment

The video data acquired by UAV is mainly based on the dynamic information acquisition of moving targets under the condition of high-speed movement. Secondly, the moving target information is easily affected by many factors. If we want to detect and track the moving target accurately, we must consider the background displacement estimation, that is, the global motion compensation; According to the actual situation to eliminate the influence of the background, so as to reduce the error, so that the moving target can be more accurately extracted and tracked. After the moving target estimation and motion compensation operation, it can serve for the subsequent moving target detection and tracking.

In the continuous measurement process, assuming that I_0 and I_1 represents the illumination of two consecutive images, the geometric parameter changes between I_0 and I_1 can be estimated by motion model. Many models can calculate these parameters, among which affine transformation model and quadratic approximation model are the most commonly used models. In this model, three parameter models of rotation translation are used, namely horizontal displacement, vertical

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displacement and rotation angle. According to these three parameters, the image background displacement caused by camera motion is estimated.

$$I_1(x,y) = I_0(x\cos\theta - y\sin\theta + \Delta_x, y\cos\theta + x\sin\theta + \Delta_y) \quad (1)$$

Δ_x is the displacement in the horizontal direction of the detected object, Δ_y is the displacement in the vertical direction of the detected object, θ represents the rotation angle of the detected object. According to the mathematical knowledge, when θ infinite hours, $\cos\theta$ tends to be 1, $\sin\theta$ equal to θ. Therefore, $\cos\theta$ and $\sin\theta$ can be replaced by 1 and θ. According to Taylor formula, formula (1) can be converted into:

$$I_1(x,y) \approx I_0(x,y) + (\Delta_x - y\theta)g_x(x,y) + (\Delta_y - x\theta)g_y(x,y) \quad (2)$$

In the above formula, g_x and g_y are the partial derivative of $I_0(x,y)$.

Therefore, it can be concluded that the three motion parameters of the detected object are as follows:

$$\begin{bmatrix} \Delta_x \\ \Delta_y \\ \theta \end{bmatrix} = \begin{bmatrix} \sum g_x^2 & \sum g_x g_y & \sum g_x g_{xy} \\ \sum g_x g_y & \sum g_y^2 & \sum g_y g_{xy} \\ \sum g_x g_y & \sum g_y g_{xy} & \sum g_{xy}^2 \end{bmatrix}^{-1} \bullet \begin{bmatrix} \sum g_x g_t \\ \sum g_t g_y \\ \sum g_t g_{xy} \end{bmatrix} \quad (3)$$

2.2 Model Refinement

Because the above formula is calculated under the assumption that the displacement and rotation angle are very small, the calculation accuracy is not very high, and the iterative motion estimation can be used to improve the calculation accuracy. The parameters calculated according to formula (3) are brought into I_0 and I_1 as initial values and the above calculation process is repeated until the calculation result is less than a set value. Through this method, accurate results can be obtained quickly. Because the pedestrians on the road are always in the process of movement, the background pixels can be preferentially selected in the pedestrian movement tracking, which can greatly improve the accuracy of the results.

In addition, the measurement accuracy can also be improved by the following methods:

(1) Regularly Check the Imaging Parameters of UAV

Any experiment cannot get satisfactory results without good instruments, and accurate instruments are the premise of obtaining accurate results in the experiment. If the instrument measurement is not accurate, there is no satisfactory result. Before any experiment, it is very important to check the instrument parameters and accuracy. Because in the use of UAV, there will inevitably be problems such as

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collision and instrument aging, so the results will be inaccurate in the measurement process, which will affect the accuracy of the results. Therefore, it is necessary to check the instrument parameters and accuracy regularly to ensure that each parameter conforms to the standard specification, so as to ensure that the measurement accuracy will not be affected by the problems of the instrument. For the parts with problems, the parts need to be replaced in time to make them meet the standards before use. At the same time, the accuracy of the instrument must be checked and the parameters must be adjusted before the instrument starts its task.

(2) Enhance the Extraction of Motion Segmentation and Improve the Recognition Technology

In the process of tracking pedestrians, the movement of pedestrians is uncertain and the range of motion is widely distributed. In addition, there are many structures and obstacles in the road. Therefore, it is necessary to strengthen the segmentation and extraction of moving regions, improve the recognition of tracking objects when they are blocked, and improve the technology in this field. For moving objects, segmentation will encounter a variety of complex environments, and the model used in this paper needs to be further improved. When tracking a moving pedestrian, when it is blocked, a part of the body is usually exposed in the field of vision. Therefore, we can enhance the tracking and positioning of the target by properly improving the weight of some part of the body features, so as to achieve the purpose of improving the accuracy.

(3) The Parameters are Improved According to the Practice

In the process of pedestrian movement, especially when the road environment is relatively crowded, sometimes in order to avoid collision with the opposite person, the pedestrian movement will follow the people in front. At present, there is little research on this kind of follow-up effect. However, this phenomenon is very common, especially in areas with large pedestrian flow. Therefore, the corresponding calculation model can be established according to the actual situation to improve the parameter structure, comprehensively consider various factors, find the appropriate calculation method, improve the algorithm, and improve the accuracy in the tracking process. At the same time, the pedestrian movement on the road will be affected by many uncertain factors, which can also effectively improve the tracking effect. In a word, the model should be corresponding to the actual situation as much as possible, and various factors should be fully considered. According to the appropriate algorithm, the satisfactory results can be achieved.

3. Experimental Background and Parameter Setting

In the experiment, the setting of parameters often determines its effect. Setting the correct parameters can make the results more accurate. If the parameters are set incorrectly, it may lead to the failure of the results, or even get the opposite conclusion. Therefore, parameter setting is particularly important in the experiment. In this experiment, the final parameters are determined after the model is debugged. Part of the parameter settings used in this paper are shown in Table 1. The overlap ratio refers to the ratio of the area of the overlapping part of the tracking frame and

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the whole tracking target frame to the total area of the target. At the same time, in order to verify the success of this experiment, the results of this experiment are compared with other algorithms. In order to ensure the rationality of the results, the experimental environment and parameter settings of the other two methods are the same as those in this experiment. During the model test, the field test of UAV tracking is also carried out.

Table 1. Parameter setting

Parameter name	Numerical value
Hardware	Inter Core i7-4810
Frequency	2.8 GHz
Overlap value	0.5
Number of iterations	5
Scale factor	1.002
Regular parameter	0.01

4. Discussion

4.1 Comparison of Different Algorithms

In this model, the calculation results are shown in Figure 1, it can be seen from the figure, the mean DP was 80.1%, the mean OP was 86.3%, and the average FPS is 54.6 FPS. In order to illustrate the validity of the model calculation results, the results are compared with the other two algorithms, CTT algorithm and SAMF algorithm. The average range accuracy, average overlap accuracy and average tracking speed of CTT and SAMF are 76.3% and 68.6%, 78.5% and 72.6%, 48.2 and 31.9 FPS respectively. The results of the model proposed in this paper is better than those of CTT algorithm and SAMF algorithm. It means that under the same conditions, the results of the algorithm in this paper are optimal, which shows the success of the experiment, and can provide certain reference value for the follow-up research. Compared with the CTT algorithm, the average distance accuracy is improved by 5%, the average overlap accuracy is increased by 10%, and the average tracking speed is increased by 13%. Compared with the SAMF algorithm, the accuracy is improved more, which shows the rationality of the model parameters and the accuracy of the algorithm.

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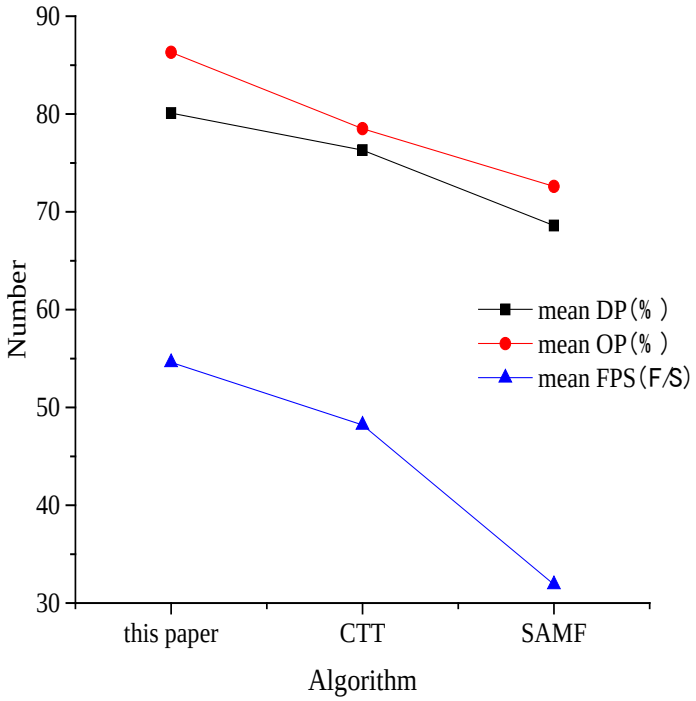

Figure 1. Comparison of the results of three methods

4.2 Accuracy Analysis

In the analysis of the previous results, it can be found that the calculation results in this paper are better than the other two schemes, and the accuracy is higher than the other two methods. The experimental results are good, which also reflects that the experiment is relatively successful. At the same time, the UAV tracking pedestrian experiment is also carried out. Figure 2 shows the tracking evaluation results of the three methods. The value of the curve in the figure represents the corresponding success rate curve under different algorithms and the area of the area surrounded by the coordinate axis. The larger the value, the higher the accuracy of the experimental results obtained by this method. According to the curve in the figure, the accuracy of the results of this algorithm is higher than that of the other two algorithms. According to the experimental results, the algorithm model established in this paper can overcome the obstacles in the process of UAV tracking pedestrian, improve the efficiency and accuracy of tracking, and has a good application prospect in reality.

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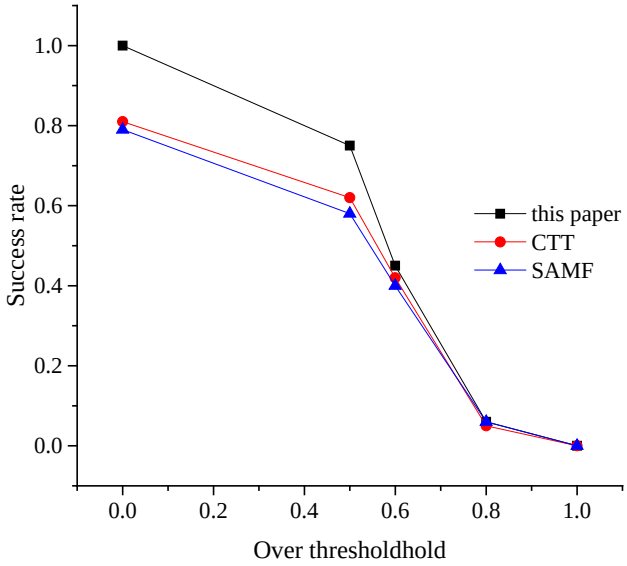

Figure 2. Accuracy comparison of three methods

4.3 Factors Affecting Tracking Accuracy

Due to the advantages of UAV, such as maneuverability, flexibility, low cost, and not limited by air traffic control, UAV is widely used in various activities, including national conditions monitoring, land use, new rural construction and development, urban planning and construction, geological disasters and other emergency rescue aspects. The application of UAV in this field has been relatively mature, but due to the pedestrian transportation, it has been widely used in various activities Due to the uncertainty of movement and more obstacles on the road, the accuracy of tracking pedestrians is far from enough. After repeated research, experiment and thinking, the UAV can be reformed and innovated from the aspects of technical route, method and equipment, so as to achieve the purpose of overcoming obstacles and improving precision in the process of tracking pedestrians.

In the process of UAV video tracking, the result accuracy is affected by many aspects. In the process of low altitude photogrammetry, the measurement accuracy of UAV is mainly affected by the flying state, the quality of camera and image, as well as the accuracy and density of image control points, base height ratio, encryption and mapping software, etc., and each of the above factors can not be ignored. Each factor may affect the accuracy of the results. Any error in any factor may lead to the opposite result. Therefore, in order to improve the accuracy of UAV tracking pedestrian movement, we must consider many factors, from the system and

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source to consider and solve, so that UAV tracking technology can serve the development of human beings.

5. Conclusions

In this paper, a tracking model of pedestrian movement in road environment based on UAV video is established, and the results are compared with other methods. It shows that the model in this paper is better than the other two methods, which proves the accuracy of the model used in this paper. Meanwhile, the factors that affect the measurement accuracy of UAV are analyzed, and some suggestions are put forward to improve the pedestrian motion tracking accuracy of UAV considering the internal and external factors. The calculation model used in this paper can overcome UAV The obstacle in the tracking process improves the accuracy of tracking pedestrian motion using UAV technology, which provides a certain reference value for pedestrian flow data survey and the other follow-up research.

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