Motion Track Optimization Based On Compound Eye Vision System

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Abstract. Aiming at many defects of human eye and computer vision system, based on the principle of multi-channel independent imaging, a method for fast determination of moving trajectory of moving target based on compound eye vision system is proposed. The principle, structure and algorithm of the traditional vision system and the compound eye vision system are compared and analyzed, and it is concluded that the compound eye vision system is superior to the traditional human eye and the computer vision system in the aspects of large wide angle, reaction speed and pixel. The SIFT method is used to extract image features quickly from different images, and the compound eye vision system is used to optimize the motion trajectory.

Keywords: Compound eye, vision system, motion track, optimization

1. Introduction

In the computer age, the computer vision system presents the characteristics of great speed and accuracy by optimizing the motion trajectory detection. Its design inspiration comes from the human eye, and there are also similar defects with the human eye, such as using two-dimensional information to construct and reflect the three-dimensional scene, the volume and mass of the device system is high and the resolution is poor. In nature, there are some compound eye animals, which have the compound eye to find, locate, track, recognize and capture the object in their field of view, and the advantage over the human eye is obvious, so that a wide range of people's research is obtained. With the further development of the science and technology, the compound eye vision system appears in the people's field of view, which is a system that uses the multi-channel imaging principle, and successfully solves the three fatal defects of the single-channel imaging optical system similar to the human eye[1]. In this era of great social development and prosperity, the optimization of the movement trajectory of the compound vision system has an indelible contribution to military national defense science and
technology, industrial detection and intelligent transportation. It is of great significance to deeply study the compound vision system for the safe, orderly and efficient development of the society[2].

2. Compound Eye Vision System

2.1. Compound Eye

Compound eye is a unique visual information collection and pre-processing system of compound eye insects. It is composed of many hexagonal eyes arranged together. Each eye is not only a part of the compound eye, but also a separate photosensory system with the conical lens behind it. The image information received by all the hexagonal eyes is collected to the compound eye to become the image seen by the compound eye. The sub-eye is particularly sensitive to the reaction of the moving target image, and the reaction can be made at a very fast speed [3]. For example, the reaction time of human eyes to targets in the field of vision is about 0.05 seconds, while that of compound-eye insects bees is only 0.01 seconds, which is five times faster than that of human beings. Each eye of the compound eye can be accurately judged by the slight movement of the target without interference from the other eyes. Therefore, the more eyes in the compound eye, the shorter the judgment time is, the more accurate the judgment is. The compound eye number of butterfly insects is 12 000 ~17 000, while that of dragonflies is as many as 28000. The research course of human eye on compound eye is as shown in Figure 1.

2.2. Imaging Principle of Compound Eye Vision System

Under the action of lens, light is projected on the perceptual device of adjacent sub-eyes (Figure. 1), and finally aggregates together to form an imaging point. The transmission of light in the compound eye is more complex, such as refraction, reflection, scattering and so on [4]. The focal length of the imaging system composed of the compound eye is smaller, some even less than 1. It is particularly sensitive to the irradiation of light and is especially suitable for insects that move more at night.

Figure 1. Schematic Diagram of Compound Eye Imaging
2.3 Ranging principle of compound Eye Vision system And Its Advantages

In the working process of the traditional human eye or computer vision system, the system projects the information obtained from the three-dimensional space into the plane, and the three-dimensional spatial data is partly lost in the imaging process, which makes the information obtained by the observer not complete. Compound vision system is the principle of multi-channel, which can recover the information lost in the process of single-channel imaging [5]. This technique enables the observer to obtain a wide range of visual angles and more comprehensive and detailed spatial information as shown in figure 2, and maintains the encryption of information data in the process of transmission. This method obtains stereoscopic information, including target distance and trajectory, through plane imaging, which is especially suitable for military attack and defense and road traffic supervision.

3. Traditional Motion Trajectory Algorithm

3.1 Optical Flow Method

Each pixel in the field is represented by a velocity vector, and the motion state of the obtained scene is analyzed according to its characteristics. According to the difference of pixel vector relative to background, the motion trajectory can be obtained. The disadvantage of this method is that it is lagging behind.

3.2 Interframe Difference Method

The moving trajectory of the moving target is obtained by using the brightness difference between the two frames when the moving target moves. This method is simple and easy to realize, and is not easy to be interfered by light, but the selection of time is required to be high, and the continuous trajectory cannot be obtained.
3.3 Background Difference Method

It is a key step to obtain the background reference model as a reference. The difference between the current frame and the reference is calculated to obtain the trajectory of the target.

4. SIFT Algorithm for Compound Eye Vision Trajectory

4.1. Principle of SIFT Algorithm

In the process of optimizing the motion trajectory of the complex eye vision imaging system, the imaging of the target in the same moving scene is different by different sub-eye imaging, and the information of the target motion trajectory is included in the difference between the imaging. This difference is inversely proportional to the distance between the target and the compound eye. Through the imaging characteristics of the same target in different sub-eyes, we can determine the trajectory of the target. From this we can know that the matching results of parallax features have a direct impact on the trajectory, and the matching of parallax features also affects the performance evaluation of the algorithm. Based on the local features of imaging parallax, we use SIFT method to extract the related features from the image.

4.2. SIFT Algorithm Process

First of all, according to the size of the image choose the image. Secondly, determine the main part of the image. Finally, the image features are obtained as angle-independent images. Use the following formula to calculate.

\[
m_0(x, y) = \sqrt{(L(x+1, y) - L(x-1, y))^2 + (L(x, y+1) - L(x, y-1))^2} \tag{1}
\]

\[
\theta(x, y) = \tan^{-1}\left(\frac{L(x+1, y) - L(x-1, y)}{L(x+1, y) - L(x, y)}\right) - L(x, y) \tag{2}
\]

Among them, mo is the stage module, L is the image scale, and the vector angle is the vector angle. This formula is used to measure the motion distance and optimize the motion trajectory at the same time.

5. Conclusions

The research on compound eye vision system in our country started relatively late, and because of its weak foundation, the optimization of movement trajectory by using this technology is still in the stage of novice on the road, which is still far behind the developed countries, and cannot be compared with the real compound eye insects in nature. However, this technology plays a great role in promoting the modernization of national defense, industrial modernization and the construction of intelligent city circle, and is worth making great efforts to study deeply.
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