Intelligent Detection Method of Remote Sensing Image Target based on Visual Attention

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Abstract

Aiming at the problems of low accuracy of image filtering, low production efficiency and high input cost of mobile remote sensing satellite receiving and processing station, this paper proposed a fast remote sensing image segmentation method based on visual attention. By using remote sensing image fast segmentation equipment and software, and through visual attention screening strategy, remote sensing images can be quickly filtered based on artificial vision before advanced product production, so as to obtain slice areas of interest to interpreters, and discard useless or redundant targets, which will greatly reduce the amount of data in the subsequent standard product production process. The analysis results show that the proposed scheme can reduce the amount of data required to be calculated by the target detection model to one 512 * 512 image slice every 3 seconds, and the single service node resource can be used for near real time processing.

Keywords

Mobile Remote Sensing Satellite Receiving and Processing Station; Visual Attention; Target Intelligent Detection; Satellite Remote Sensing Image.

1. Introduction

With the development of high-resolution remote sensing technology and global positioning system (GPS), remote sensing has become particularly prominent as a means to quickly obtain information. Accordingly, remote sensing image target detection technology has become increasingly important, which has caused a research boom [1].

Yi Zhang and other scholars proposed a target detection technology based on traditional edge detection algorithm, which mainly used the contrast between target and background in remote sensing images to achieve target detection [2]. In terms of segmentation algorithm, BS Dinesh Maru proposed a threshold segmentation method,that used the difference in gray scale characteristics between the target and the background in the optical remote sensing image to achieve target detection [3].M Chen et al. proposed an improved threshold selection method for image segmentation to improve the calculation efficiency [4]. S Nezarat et al. proposed an automatic image segmentation algorithm based on improved PCNN, which realized less misclassification errors and higher segmentation performance [5]. However, the traditional remote sensing image target detection methods need to invest a lot of manpower and material resources, which has been unable to meet the interpretation needs of massive remote sensing data. Intelligent inspection technology of remote sensing image targets has been widely used in remote sensing image processing because it can free people from the

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huge interpretation work. Meanwhile, in many scenarios, the limited computing resources and large single data will bring great challenges to the intelligent target detection technology of remote sensing images.

The mobile system has the capabilities of telemetry, remote control, reception, processing and application, which fully support the operation and use of remote sensing satellites as a ground system. Although the intelligent detection and recognition of remote sensing image data provides a new method for the "last mile" of professional remote sensing data applications with the landing of intelligent data applications, most devices are occupied by traditional reception and data preprocessing capabilities. In the current mobile reception and processing system, the processing resources that can be allocated are very limited, which limits the speed of remote sensing image screening. At the same time, when the mobile remote sensing satellite receiving and processing station works independently in the field, image pre-processing usually uses image filtering technology based on shooting time and target coordinates. This method is limited by the influence of positioning accuracy error of space-based system. Therefore, multiple scene redundancy selection is usually adopted before and after the target scene is used to ensure the accuracy of image filtering, which will lead to a sharp increase in the number of remote sensing image data to be processed, with a year-on-year data increment of about 20%~95%.

The continuous progress of remote sensing image target intelligent detection technology brings hope to break this difficult problem. Cheng et al. proposed learning rotation invariant Convolutional Neural Network (RICNN) to achieve multi class ground object detection under the R-CNN framework [6]. Liu et al. proposed a bounding box based on YOLO ship detection network that can directly predict rotation and orientation [7]. KunFu et al. proposed a remote sensing image detection method combining feature pyramid network and deep reinforcement learning to achieve the detection of ship targets [8]. For aircraft detection target, Yuhang Zhang et al. proposed a method to integrate multiple model results by using multiple model integration [9]. Jiachen Yang et al. proposed an algorithm based on convolutional neural network and hyper vector coding for aircraft detection in remote sensing images [10].

However, the above literature only considers the detection of a single target type, and the production efficiency is low. Therefore, this paper proposed a fast segmentation method of remote sensing images based on visual attention, which included remote sensing image fast segmentation equipment and software. Before the production of advanced products, the remote sensing images can be quickly screened based on artificial vision to obtain the slice areas of interest to the interpreters and discard useless or redundant targets, which will greatly reduce the amount of data in the subsequent standard product production process, improve the product production efficiency and improve the system application efficiency.

The structure of this paper is as follows. The second section introduced the system model; The third section proposed an intelligent target detection method based on visual attention; The fourth section analyzed the proposed scheme through examples; The fourth section mainly summarized the contents of this paper.

2. System Model

In this paper, an intelligent detection method of remote sensing image target based on visual attention is proposed to solve the problems related to large amount of data in advanced product production process and low system application efficiency.

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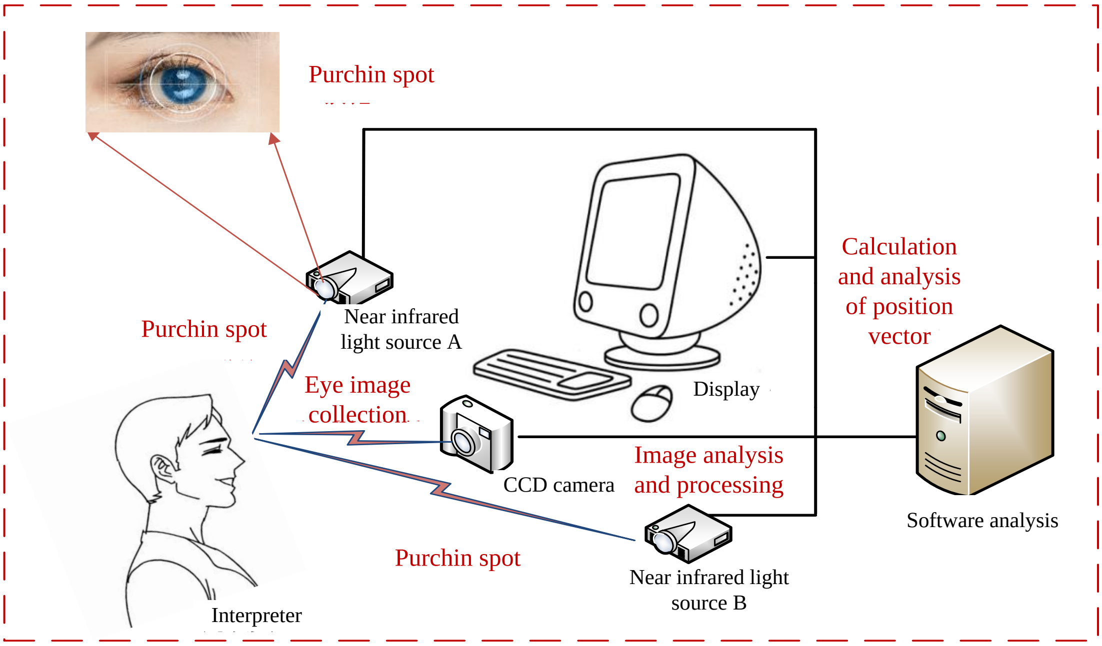

Fig. 1. The system model

Fig. 1 described the system model of remote sensing image target intelligent detection based on visual attention, which is mainly composed of near-infrared light source A, near-infrared light source B, CCD camera, display screen and software analysis software. The system processing flow is divided into four stages. The first stage is the original image information acquisition stage. The interpreter starts the special image preview software, wears and starts the eye movement capture equipment, and then sets the remote sensing image data loading strategy and target recognition strategy; The second stage is the image data acquisition stage. After the remote sensing image data is loaded, the image slice is produced according to the scope of the interpreter's gaze. The third stage is the image data processing stage. Push the image slice to the background computing service node for target detection and recognition. The fourth stage is software analysis stage. The valuable recognition results will be displayed in the pop-up window on the screen, and the corresponding position of the image will be marked.

3. Remote Sensing Image Target Intelligent Detection Method based on Visual Attention

This section mainly introduces the core technology and workflow of remote sensing image target intelligent detection method based on visual attention.

3.1 Line of Sight Tracking and Location Technology based on Pupil Corneal Reflex

Line of sight tracking and positioning technology based on pupil corneal reflection is the core part of this paper, and its basic principles are as follows:

(1) Use multiple (not less than 2) near-infrared point light sources to transmit near-infrared light signals to the eyes of the interpreter.

(2) The method of line of sight feature extraction based on gray level feature and the geometric feature of the facula in the eye area of the interpreter are used to realize the extraction of corneal reflective facula, and then the position information of Purchin's spot is obtained.

(3) Remove the image information of the light spot position to avoid interference with the pupil positioning, and then combine with the improvement of the Purchin spot position and the least square ellipse fitting method to achieve the pupil positioning.

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(4) After obtaining the line of sight parameters such as Puccin's spot information and pupil position, the line of sight direction is estimated by calculating the vector between the pupil center and the corneal reflex, or the position characteristics of the pupil center and the corneal reflex.

(5) According to the information of line of sight direction, the images of the cornea area composed of Purchin's spot and pupil were collected as remote sensing image data.

(6) After the remote sensing image data is loaded, the high-speed digital signal processor in the device performs basic pre-processing such as filtering and noise reduction on the information.

(7) Push the image slice to the background computing service node, and then use the deployed depth learning object recognition algorithm to complete the eye area segmentation and recognition operations such as corneal area recognition, pupil position recognition, so as to achieve target detection and recognition.

(8) In particular, since the original image taken by the high-definition CCD camera is the image of the whole interpreter's eyeball and the pupil and Purchin facula are located in the iris area, while the area outside the iris belongs to the invalid area. Therefore, this paper selects the gray distribution method or iris location method to segment the original image and locate the iris region, so as to determine the staring range of the interpreter and produce image slices.

3.2 Remote Sensing Image Target Intelligent Detection Method

The workflow of remote sensing image target intelligent detection method based on visual attention is as follows.

(1) Start the special image preview software, and the interpreter will wear and start the eye movement capture device. The schematic diagram of desktop vision tracking system and headworn vision tracking system is shown in Fig. 2.

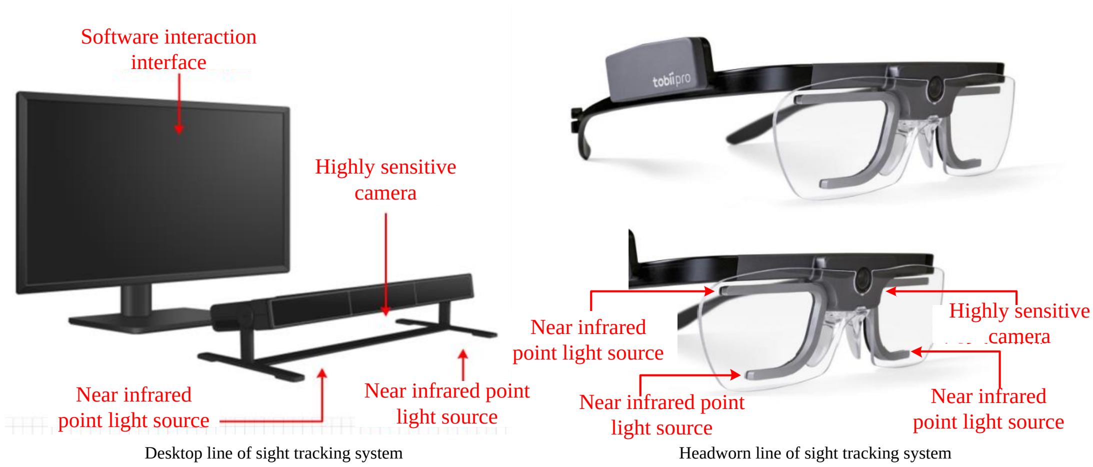

Fig. 2. Schematic diagram of desktop and headworn sight tracking systems

(2) Set remote sensing image data loading strategy and target recognition strategy, which are mainly divided into two modes: real-time processing and post interpretation.

1) In real-time processing mode, bind processing task flow, configure automatic loading of real-time processing results and read remote sensing data type, load working mode, resolution and other attributes from the task. Then wait for data loading.

2) In the post interpretation mode, configure the loading data path and data attributes, including data type, channel definition, resolution, etc.

3) In addition, it is necessary to configure the target type of concern and set a priori parameter. The priori is usually deeply bound to the target to be identified, and it is generally not modified.

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(3) After the remote sensing image data is loaded, the image slice is produced according to the staring range of the interpreter. The specific steps are as follows.

1) Use matching equipment and eye tracking and positioning technology of pupil cornea reflection to locate the staring position of the interpreter.

2) When the gaze of the interpreter exceeds the time threshold, which is 3s by default, the gaze coordinate will be sent to the software background image slice message queue.

3) The image slice module extracts the coordinates from the message queue and compares the generated slice list. when the coordinates are not included, a new slice will be produced. The volume attribute in the target prior is combined here. If the gaze is located at the edge of the original slice and is less than the prior judgment threshold (which may cause the target to be segmented by the slice), the slice will be produced again with this coordinate as the center.

4) According to the staring error range (less than 1cm) and the image observation level, the slice production strategy is as follows: at a lower level (0-8 levels), the overall image is smaller and the error range is larger, so no slice production is conducted. At medium level (9-13 levels), the overall image size is moderate and the error coverage span is less than the width of 2 slices. At this time, 2 to 5 slices around the production area ensure that target recognition is covered; At the higher level (greater than 13 levels), the error range plus the target prior can generally be covered by one slice, so a single slice is produced with the staring center.

(4) Push the image slice to the background computing service node for target detection and recognition.

(5) The valuable recognition results will be displayed in the pop-up window on the screen, and the corresponding position of the image will be marked.

4. Examples

This paper will select the real-time processing mode of a system as an example for analysis. In this mode, it is necessary to bind the processing task process and configure automatic loading of real-time processing results. At the same time, before the interpreter starts the eye movement capture device, all devices and software are connected. The data receiving subsystem has received the tracking receiving plan, and the fast preprocessing subsystem can receive the sent original code stream data in real time (before decryption). The specific process is shown in Fig. 3.

Step 1: Develop tracking and receiving plan, mainly including local self construction and central system distribution.

Step 2: According to the tracking and receiving plan and the principle of taking the data sender as the service party, the equipment and software in a system establish TCP connections 3 minutes before the data transmission task, mainly including the connection between the modem and the decryption device, the decompression device and the fast preprocessing platform.

Step 3: The modem and the decryption and decompression equipment conduct real-time processing of data transmission according to the pipeline mode, and send the data transmission to the fast preprocessing platform.

Step 4: After receiving the data, the fast preprocessing platform implements the following steps:

(1) The subsystem establishes a communication link with the data receiving subsystem according to the work plan, and starts the data transmission configuration item data transmission service.

(2) The data transmission service receives the original code stream data (before decryption) sent by the data receiving subsystem in real time, performs the processing of de formatting, decryption, decompression, etc. on the original code stream data, and sends the spliced formatted data to the subsystem of the above subsystem.

(3) The subsystem of the above subsystem receives the strip image data generated in real time and carries out data synchronization processing. It performs operations such as auxiliary data separation,

segmentation and scene segmentation, and fast filtering. In the fast filtering, remote sensing image fast segmentation equipment and software based on visual attention are used to process the data.

Step 5: After scene segmentation, the preprocessing platform will automatically call the corresponding processing plug-ins according to the plan, and then carry out advanced product production. During production, the system adopts parallel processing mode for task level parallelism and distributes scene processing to different processing nodes.

Step 6: After the scene is processed by different processing nodes, the level 2 product will be generated and then pushed to the resource library.

Step 7: Start the special image preview software, and the interpreter shall wear and start the eye movement capture instrument.

Step 8: Through tracking and receiving the plan content, the software loads the level 2 product scene data that meets the configuration requirements from the resource library in real time. When there are multi scene images, they are processed in a queue mode.

Step 9: After the remote sensing image data is loaded, the image slice is produced according to the staring range of the interpreter. In this step, the line of sight tracking and location method based on pupil cornea reflection is used for remote sensing image data loading and target recognition.

Step 10: Push the image slice to the background computing service node for target detection and recognition.

Step 11: Display the valuable identification results in the pop-up window on the screen, and form a label at the corresponding position of the image to assist the interpreter in interpretation.

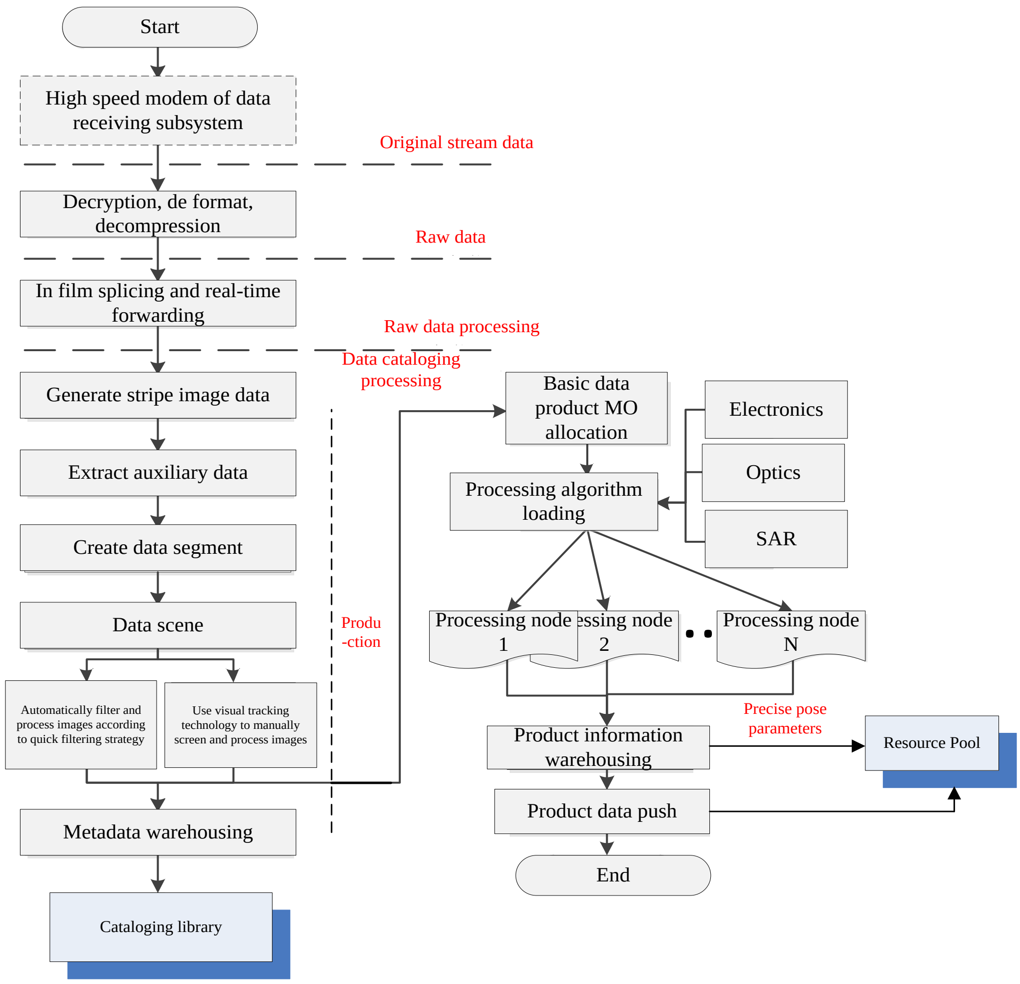

Fig. 3. Flow chart of remote sensing image target intelligent detection based on visual attention

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5. Conclusion

Based on the target detection system, this paper studied the remote sensing image target detection method using visual attention. By using the line of sight tracking and positioning technology based on pupil cornea reflection, remote sensing images can be quickly filtered before advanced product production to discard useless or redundant targets. Furthermore, the real time processing mode of a certain system is used to analyze an example in order to make contributions to the development of remote sensing target recognition technology.

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