Video Monitoring System for Natural Environment Protection Area Supporting Image Recognition

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Abstract: Today in the 21st century, the destruction of the natural environment has seriously affected the ecological balance, which has a serious impact on the earth's ecological environment on which human beings rely. Environmental protection has become an important obligation of global citizens. The setting of video monitoring system in natural environment protection areas is an important means of environmental monitoring. Based on image recognition technology, this paper studied the video monitoring system of natural environmental protection areas. First, it introduced the categories of natural environmental protection areas, which were divided into natural protection areas and natural tourism protection areas. Subsequently, the role of the video monitoring system in the nature reserve was explained, which was of great significance to improve the monitoring efforts, reduce the damage of external factors to the nature reserve and maintain the ecological balance. This paper proposed to use the image recognition technology yolo algorithm to improve the real-time performance and efficiency of the system in the video surveillance system, and test the system from the two aspects of detection time and recognition accuracy. The data showed that the detection time of video surveillance system based on yolo algorithm was shorter than that of traditional algorithm. The number of tests was 1-9, and the detection time of yolo algorithm was in the range of 11s-42s. The detection time range of video surveillance system based on traditional algorithm was 31s-79s. From the data of recognition accuracy, the average recognition accuracy of video surveillance system based on yolo algorithm was 82.69%, and the average recognition accuracy of traditional algorithm was 71.2%. Finally, it was concluded that yolo algorithm based on image recognition could make video monitoring system play a better monitoring effect in natural environment protection.

1. Introduction

With the progress of human productivity and the utilization of energy and natural resources, while creating huge wealth for mankind, the problems of the natural ecological environment of the earth have become increasingly serious. The rising global temperature has led to the rise of sea level and the reduction of biodiversity. Therefore, it is urgent to protect the natural environment. In order to protect natural resources, people set up natural environment protection areas. However, some people still destroy animal and plant resources unconsciously, making their habitat destroyed and unable to survive, resulting in the extinction of animal and plant species, and thus causing the destruction of ecological balance. Natural environment protection is a complex task. Therefore, the use of intelligent technology to monitor natural environmental protection areas has become the main work of protecting the ecological environment, making rational use of resources, and achieving the goal of sustainable development. It is necessary to strengthen the environmental monitoring of the nature reserve, and set up a video monitoring system in the nature reserve to improve the monitoring intensity, and reduce the damage of external factors to the nature reserve, which is of great significance to maintain the ecological balance.

Natural ecological reserve is an important measure to promote biodiversity and maintain ecological balance, and is the focus of ecological environment research in recent years. Vlasenko V N discussed the following points: information support in the field of environmental protection, national accounting in the field of environmental protection, supervision in the field of environmental protection, national environmental supervision and negative environmental impact cost management. When implementing national environmental supervision, the inspection should be planned according to the hazard category of the negative impact object, and the remote control method should be used when conducting the inspection [1]. Hays G C compiled a wide range of case studies from different marine taxa to show how tracking data can help protect policy and management, including the reduction of fishery catches and ship strikes, as well as the design and management of marine protected areas and important habitats. Using these examples, he emphasized that the investment in collecting animal tracking data in the past and future may be better used to achieve tangible protection benefits [2]. These studies have certain reference significance, but most of them are from the theoretical aspect.

Image recognition is an essential method to protect the ecological environment of video surveillance system. Many relevant personnel have carried out research on it and have made certain research results. Trofymchuk O considered the space-time method of regional environmental monitoring system. His paper introduced the advantages of establishing an integrated environmental monitoring system based on integrated ground survey and remote sensing data, and showed an example of remote sensing technology for natural resource management [3]. Bicknell A W J reviewed the use of remote cameras to monitor the marine environment related to human activities, and considered emerging and potential future applications. The rapid technological progress of equipment and analysis tools affected the application location, reasons and methods of remote camera images, and encouraged the inclusion of cameras in multi-methods and multi-sensor methods to improve the understanding of ecosystems, and help manage human activities and minimize impacts [4]. These studies have certain research value in the field of video monitoring system in natural environment protection areas, but they are not analyzed in combination with reality.

In view of the environmental detection requirements of the nature reserve, the advanced intelligent technology should be combined to improve the performance of the video monitoring system and provide an efficient and convenient overall solution for remote monitoring. This paper studied the video surveillance system based on image recognition technology.

2. Video Monitoring System and Natural Environment Protection

2.1. Categories of Natural Environment Protection Areas

The setting of natural environmental protection zones is based on the distribution range of natural resources. Natural environmental protection zones are a reserve of natural ecosystems and biological provenance, which is of great importance for maintaining the unified and coordinated growth of human and nature. Different natural resources are divided into different natural environment protection areas, which can be divided into natural protection areas and natural tourism protection areas, as shown in Figure 1.

Figure 1. Different natural environment reserves

1) Nature reserves: Nature reserves refer to the protection of natural resources and ecological resources on the earth, including plant resources and animal resources, and the establishment of key reserves for some endangered rare animal and plant resources, as well as areas rich in ecological resources such as wetlands and rainforests. Once these environments are destroyed, it has unpredictable consequences for the balance of the ecological environment. For the protection of migratory birds, it is necessary to ensure that the habitat of migratory birds is not damaged, including the breeding of migratory birds, the adjustment of the number of migratory birds, and the monitoring of the living habits of migratory birds. Therefore, the nature reserve can be divided into wetland reserve, rare animal and plant reserve, etc.

2) Natural tourist destination protection area: The protection of natural scenic spots refers to the ability to operate and manage as the protected objects, and form tourist sites, including scenic spots, cultural heritage, historical sites, cultural landscapes, natural parks, etc. Within a certain period of time, such reserves are easy to cause damage to the natural environment in many aspects due to the excessive flow of people. Therefore, it is also very difficult to monitor.

According to the scattered distribution of nature reserves, the inability to grasp the situation of nature reserves in real time, resulting in inadequate supervision, and the inability to detect potential environmental safety hazards in time, it is urgent to build a set of networked environmental video monitoring system that can monitor the audio and video, environment, and operating parameters of monitoring equipment in various scattered nature reserves in a centralized 24-hour real-time and remote way. On-site video recording systems have become more and more popular in ecological research because they can accurately capture plant-insect interactions [5].

2.2. Video Monitoring System

As a means of monitoring, the video monitoring system can monitor the environment of nature reserves in many ways. The role of this system in natural environment protection can be divided into the following points, as shown in Figure 2.
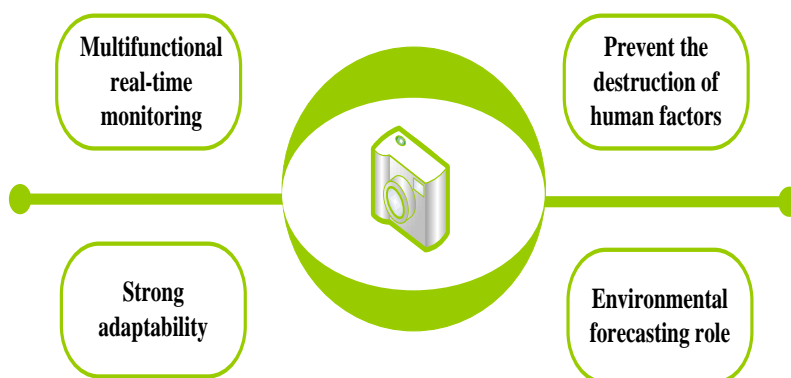
Figure 2. Application of video monitoring system to nature reserves

1) Multi-functional real-time monitoring: The video monitoring system is not only limited to monitoring the external environment of the reserve, but also can observe and monitor the various habits of animals in real time, and protect and manage the nest. Its role in plant protection areas is reflected in the monitoring of plant diseases and insect pests in the protection areas, and the monitoring and protection of plant water environment.

2) Strong adaptability: The intelligent video monitoring system can monitor in the daytime and at night, even in rainy and foggy days. As long as the system does not power off, the video monitoring system can monitor the environment of the protected area in real time 24 hours a day, and it can monitor the environment from all directions and from multiple angles. It can be seen that the system performance of video surveillance is powerful.

3) Prevention of damage by human factors: The installation of video monitoring system in the natural environment can not only monitor the damage of some people to the natural environment, but also prevent some human activities from causing damage to the ecological environment of the reserve. For example, if the catching and killing of poachers and the driving and scaring of birds by uncivilized tourists are found and warned in time, the management center can contact the site administrator at the first time to stop them and play a role of supervision and management.

4) Environmental prediction function: The video monitoring system can set alarm linkage area in the animal and plant activity area of the reserve, so that when the weather and temperature change, it can be detected and early warning in time. The management personnel can find and strengthen the

management in time, and make necessary preparations for the change of the living environment index of animals and plants.

2.3. Image Recognition Technology and Its Application in Video Surveillance

Image recognition technology refers to the use of computer technology to monitor significant areas in the image, including objects, people, etc. The existing monitoring system has low accuracy and sensitivity and needs laboratory analysis. Therefore, an improved monitoring system is needed [6]. With the development of recognition technology, the application of image recognition technology is more and more extensive. Image recognition plays an essential role in face recognition system and video surveillance system. The convolutional neural network on the basis of deep learning has improved the image recognition technology to a certain extent, realizing the image recognition from terminal to terminal. Convolution neural network has achieved the most advanced performance in image classification and other computer vision tasks [7]. Image recognition technology uses cameras and computers instead of human eyes to identify, track and measure targets for further image processing [8]. This paper introduces the Yolo target monitoring algorithm model. Yolo algorithm is a regression algorithm in the convolutional neural network. It has the characteristics of fast recognition speed and stronger real-time. The principle of Yolo operation is to transform image detection into a regression problem, and predict the boundary frame and classification probability through the pixels of the target image, as shown in Figure 3.
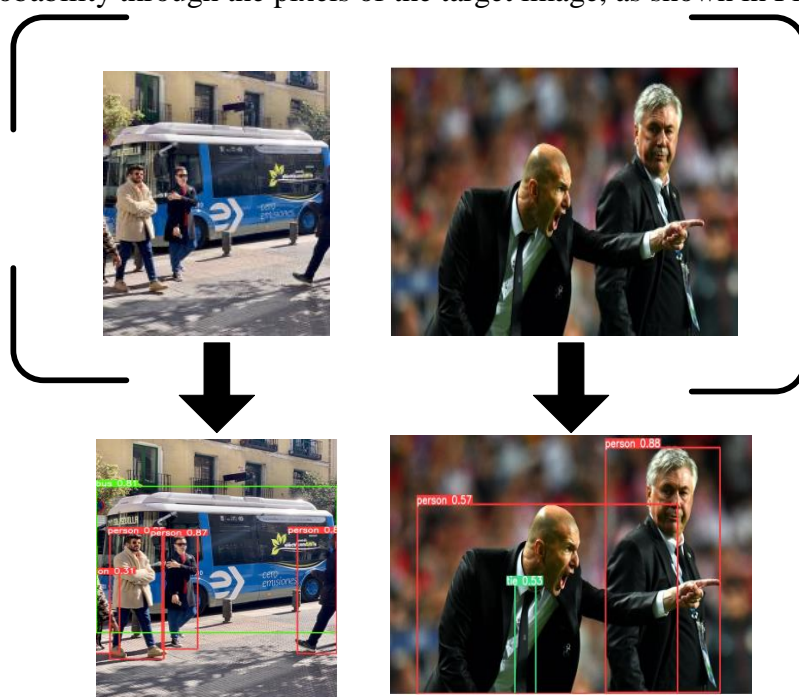

Figure 3. Yolo algorithm target detection

Yolo algorithm first divides the picture into $m \times m$ squares. When the target object falls in the center of the grid, yolo predicts the object. Each grid predicts N boundary boxes, and predicts the confidence level among them. Then the accuracy of the target object prediction and the accuracy of the border are given. During detection, the center coordinate of the border, the width and height of the border, and the IOU (standard performance measure of object category segmentation) of the prediction box and the label box should be predicted. The probability of a category appearing in a border and the matching degree of the objects in the prediction box should be calculated by the

following formula:

$$P(class_i|object) * P(object) * IOU_{pred}^{truth} = P(class_i) * IOU_{pred}^{truth} \quad (1)$$

In Formula (1), $P(object) * IOU_{pred}^{truth}$ is the calculation formula of confidence score, and $P(class_i|object)$ is the probability of condition class. The conditional category probability is multiplied by each confidence score, which can represent the possibility of each category in a box, and can represent the matching degree between the prediction box and the measured object. Yolo algorithm model is mostly used for target detection and recognition, such as automatic driving. A large number of collected videos make extracting useful information a difficult and time-consuming task for humans. A promising way to solve this problem is cutting-edge in-depth learning technology [9]. The Yolo algorithm based on deep learning can monitor the objects in video monitoring in real time, thus strengthening the protection of rare animals and plants, wetlands and nature reserves. Next, the performance test of video surveillance system based on yolo algorithm is carried out.

3. Simulation Test

The purpose of video monitoring the environment of the nature reserve is to better understand the dynamics of the nature reserve and monitor the status of animals and plants in the nature reserve in real time. Therefore, video monitoring system came into being. Wireless network is used for wireless data transmission to mobile terminals. Managers can monitor and control the front-end area through the Internet at any time. This paper applies yolo image recognition technology to the video surveillance system, selects a natural reserve as the sample data to test and analyze the video surveillance system based on yolo algorithm, and tests the performance from the detection time and recognition accuracy.
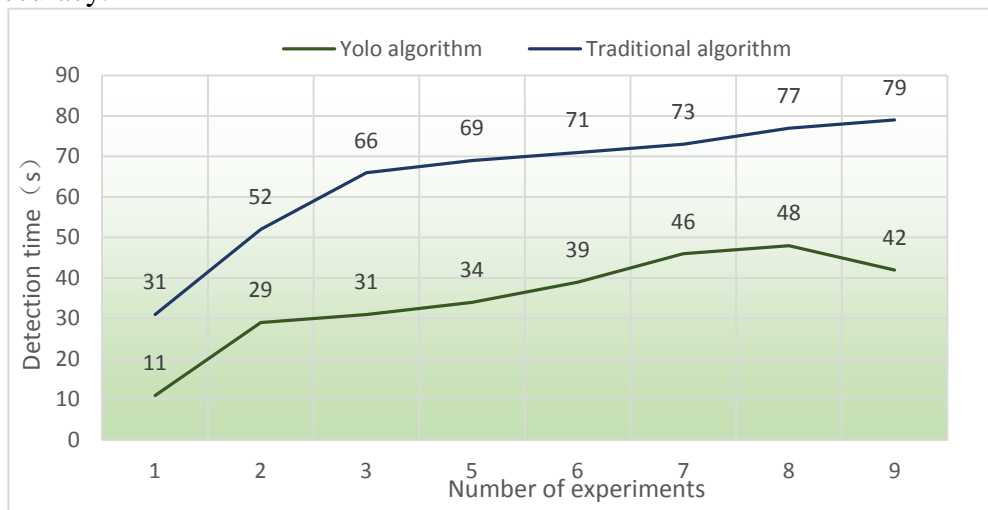

Figure 4. Comparison of detection time between yolo algorithm and traditional algorithm

Figure 4 shows the dynamic detection duration in the video monitoring system under different experimental times. From the data in the figure, the detection time increases with the increase of the number of experiments. The results show that the detection time of video surveillance system based on yolo algorithm is shorter than that of traditional algorithm. The number of tests is 1-9, and the detection time of yolo algorithm is in the range of 11s-42s. The detection time range of video surveillance system based on traditional algorithm is 31s-79s. When the number of experiments is 1, the detection time of yolo algorithm is 11s. When the number of experiments is 9, the detection

time is 42s. At this time, the duration of the traditional algorithm has risen to 79s, with a large gap. Therefore, it is concluded that the yolo algorithm improves the detection efficiency of the video monitoring system, thus improving the efficiency of the environmental monitoring of the nature reserve. The following tests the recognition accuracy, which determines the performance of the video monitoring system.
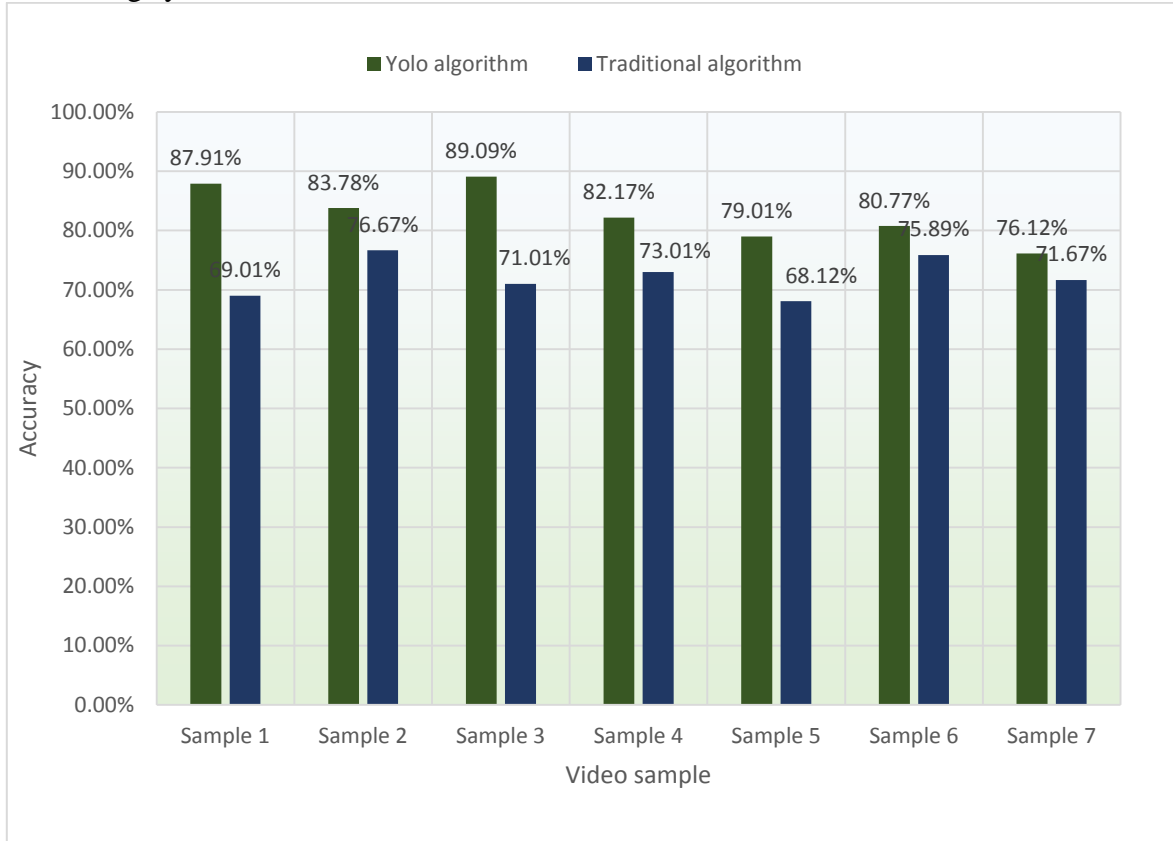

Figure 5. Accuracy of yolo algorithm and traditional algorithm

Figure 5 is about the recognition accuracy of objects in the recognition video, including people, animals, plants and other objects, in seven video samples. The data in the figure shows that the video monitoring system based on Yolo algorithm has the recognition accuracy of 87.91%, 83.78%, 89.09%, 82.17%, 79.01%, 80.77% and 76.12% for seven video samples. The recognition rate of the traditional video surveillance system for seven samples is 69.01%, 76.67%, 71.01%, 73.01%, 68.12%, 75.89% and 71.67%. It can be seen that the recognition accuracy of yolo algorithm is higher than that of traditional algorithms, and the highest recognition accuracy of video surveillance system of yolo algorithm reaches 89.09%. However, the recognition accuracy of traditional algorithms is below 80%. After calculation, the average recognition accuracy of video surveillance system based on yolo algorithm is 82.69%, and the average recognition accuracy of traditional algorithm is 71.2%. Therefore, it can be concluded that video surveillance system based on Yolo algorithm has better recognition effect, can better monitor and recognize objects in video, and has better performance.

4. Conclusion

The globalization of AI is promoting the technological foundation of the world order. Machine learning and intelligent robot technology can promote environmental knowledge and protection [10].

The video monitoring system can be used to monitor the key nature reserves in real time anytime and anywhere, master the real-time situation of the key nature reserves, and conduct a comprehensive survey of the detection area, so that the key nature reserves can be strictly monitored in real time. This paper studied the video monitoring of natural environment protection based on image recognition technology, and introduced the classification of natural environment protection areas. Subsequently, it was proposed that a real-time and fast video monitoring system was needed to dynamically monitor the nature reserve, so that the environment of the nature reserve could be protected. Finally, the image recognition technology yolo algorithm was applied to the video surveillance system. After experimental analysis, the yolo algorithm model was tested from two aspects of detection time and recognition accuracy. Finally, it was concluded that the video monitoring system based on image recognition yolo algorithm improved the efficiency of environmental protection in the nature reserve, which could truly achieve the main functions of the system such as high efficiency and effective control, and reduce the work intensity for the nature reserve at the same time.

Funding

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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