Research on Recognition Technology of Amur Tiger Gait Features Based on Video

Zhou Lili¹,², Wang Jinyu¹,², Liu Tongjun¹,²

¹. Institute of Intelligent Manufacturing, Heilongjiang Academy of Sciences, Harbin 150090;
². Institute of High Technology, Heilongjiang Academy of Sciences, Harbin 150001.
zhoulilivip@126.com

Abstract. With the continuous advancement of technology, people are paying more and more attention to the living environment of wild animals. Located at the top of the food chain of the forest ecosystem, the Siberian tiger is a flagship species and umbrella species for biodiversity protection. The effective protection and sustainable survival of its population has far-reaching natural and social significance for China's ecological security. At present, the research on the Siberian tiger is mainly concentrated in the biological fields such as genes and heredity. Only a small amount of research on the detection of Siberian tigers and their footprints in static images. Research on the behavior recognition of Siberian tigers in videos is currently in its infancy. In the field of computer vision, as an independent research object, more and more researchers pay attention to the automatic recognition of gait. Based on the human gait model, a standard database for evaluating the performance of gait recognition algorithms has been established to promote the research of gait recognition. This article will use deep neural convolutional networks and feature subspace learning algorithms to extract the gait features of the Siberian tiger from video images and establish a gait model of the Siberian tiger. This will lay the foundation for the identification of Siberian tigers and further research on their health status, and provide a foundation for the wild Provide theoretical support for animal protection.

1. Introduction
The Siberian tiger (Panthera tigris altaica) is the largest and most northern tiger subspecies. The Siberian tiger population and its habitat have experienced drastic fluctuations. The Siberian tiger was once widely distributed in the northeast forest area. In the past century, the population of Siberian tigers has dropped from a few thousand to about 500, and more than 95% are distributed in Russia. At present, there are only more than 20-40 in China, mainly distributed in scattered patches in the Laoyeling, Zhangguangcailing and Wandashan areas near Russia. In the past 10 years, the Siberian tiger population in my country has recovered, but it still faces arduous difficulties and challenges. The first is the degradation of habitat quality. Although measures such as the natural protection project and the suspension of commercial logging have played a very good role in protecting the forest ecosystem, new types of human disturbances such as the construction of high-speed railways, highways, and the rapid development of understory planting and aquaculture have caused severely reduced and fragmented habitats. The situation further deteriorated. Second, China's Siberian tiger population is severely fragmented and its spread is severely hampered. The main population of Siberian tigers in China is distributed in the Laoyeling area and concentrated in the Hunchun border area. Zhangguangcailing and Wandashan are only scattered; the female tigers are only distributed in the
Laoyeling areas of Hunchun, Wangqing and Suiyang, and it is difficult to guarantee the long-term population. The need for survival and development. Third, the lack of prey population limits the development of Siberian tiger populations. Poaching caused more than 80% of prey deaths and reduced the environmental capacity of Siberian tigers. Insufficient food has led to 33.6% of livestock biomass in China's Siberian tiger diet. Fourth, the conflict between humans and tigers is getting worse. On the one hand, the human-tiger conflict is manifested in the Siberian tiger preying on livestock and the Siberian tiger prey population damages crops and causing resistance to the original residents in the distribution area. On the other hand, it is manifested in the understory resource collection, understory planting and breeding and other human activities against the Siberian tiger. Encroachment and compression of its prey habitat.

The number of Siberian tigers in my country is sparse and the active area is too wide. With the implementation of Siberian tiger protection and monitoring projects, the deployment of far-infrared automatic monitoring cameras for population monitoring is gradually being realized, and the accumulated monitoring image data is increasing. Far-infrared automatic monitoring cameras often have problems such as different shooting angles affecting accurate identification and inability to judge individual health conditions. This makes the study of Siberian tiger gait through video images to realize individual identification and health analysis has considerable practical value and urgent needs. This project uses deep neural convolutional networks and feature subspace learning algorithms to realize cross-view simulation and reconstruction of Siberian tiger's conventional movement movements, and construct the characteristic structure and movement standard model of Siberian tigers. It is more common for Siberian tigers to complete individual identification of Siberian tigers. Gait research, the establishment of basic information storage, the realization of the physiological state and living environment of the Amur tiger, to achieve the purpose of protecting the wild Amur tiger.

At present, most of the video-based gait recognition technologies are for the recognition of human gait, and there is very little recognition of animal gait. This project identifies and analyzes the gait of the Siberian tiger in the video image, helps monitor the physical, mental health and reproductive status of the Siberian tiger, and contributes to the improvement of the health status and population number of the Siberian tiger population, and can also be similar Species gait recognition technology provides research methods and foundation.

2. Research foundation

2.1. Deep Neural Convolutional Network

Convolutional Neural Networks (CNN) is a deep learning algorithm and the most important classification learning method in image classification processing. In 1989, Le Cun used a simple 4-layer convolutional neural network LeNet-5 for the first time to obtain an unprecedented recognition rate on the MNIST dataset. Subsequently, convolutional neural network models with more network layers and stronger learning capabilities are widely used in text recognition, language recognition, face recognition, object detection and other fields. CNN one-dimensional convolution mainly processes sequence type data, two-dimensional convolution is mainly used for image type text recognition, and three-dimensional convolution is mainly used for processing video image category information containing spatiotemporal information. CNN is generally divided into a feature extraction layer and a feature mapping layer. The feature extraction layer includes a convolutional layer, a pooling layer, etc.; the feature mapping layer is composed of multiple feature maps, and each group of features is mapped to a corresponding plane with equal weights. Form different computing layers.

Convolutional Layer : Convolution generally has two uses. One is for signal analysis, which is often used to calculate the cumulative delay of the signal; the other is for image processing. CNN converts features into filters to try The process of matching all possible positions in an image is called convolution. Each convolutional layer can contain multiple feature maps. Each feature map is a "plane" composed of multiple neurons, and a feature of the input is extracted through a convolution filter. The main function of convolution is to use a sliding window on the convolution kernel to
gradually extract the image features of the previous input layer according to the corresponding step size. The first layer of the convolutional neural network is generally the convolution layer. Each parameter of the convolution kernel is connected to the corresponding local pixel, and the output value of the convolution layer after calculation is the result of the accumulation of each parameter of the convolution kernel and the pixel value of the corresponding local pixel.

Pooling Layer: Also known as the down-sampling layer, it is mainly used between convolutional layers. The pooling function uses the overall characteristics of adjacent outputs at a certain position to replace the output of the network at that position, thereby reducing data. While retaining useful information, that is, feature selection, while reducing the number of features, it improves the robustness of the selected features.

Fully Connected Layer: The fully connected layer is to classify the features processed by the convolutional layer and the pooling layer. The fully connected layer is the most typical neural network structure. It connects many single "neurons" together, so that the output of one "neuron" can be the input of another "neuron". In this model, the neuron receives input signals from d underlying neurons. These input signals are transmitted through a weighted connection. The total input value received by the neuron will be compared with the neuron's threshold, and then through the "Activation Function" (Activation Function) processing to produce neuron output.

2.2. Gait recognition technology

According to biological research in the 1990s, the joint action of limbs, joints, and muscles constitutes the unique walking mode of each organism, which is called gait. Summarized from the research results, gait is not easy to change, and can be used to distinguish individual organisms. Gait research expert Boyd defines gait as a coordinated and periodic movement synthesis that drives biological displacement. Gait recognition has great advantages over other biometric recognition. One is the long-distance perception of gait. Compared with the appearance that requires close observation, gait can realize long-distance perception; this also leads to advantages. The second is non-contact information collection, which can be obtained through the free movement of the measured object. No human contact interference is required; finally, compared with other measurement schedule requirements, gait measurement requires less clarity, and even thermal infrared images can be used. These measurement advantages are more conducive to the research of biological gait.

2.3. Feature subspace learning algorithm

The feature subspace learning algorithm establishes the connection of gait samples from different perspectives through a learning process to realize cross-perspective gait recognition. It is mainly divided into two steps: View Transform Model (VTM) establishment and subspace learning. Through the establishment of VTM to realize the perspective conversion, the gait features under any perspective can be converted into the gait features under the perspective required for measurement; then through the method of subspace learning, the relationship between samples from different perspectives is established, due to the unique subspace. The function of eliminating viewing angle obstacles can match different viewing angle samples projected to the subspace, and realize cross-view gait recognition simply and efficiently. Further research through the multi-view maximum interval subspace learning method, to give the feature subspace learning algorithm higher discriminative ability.

The article mainly combines deep neural convolutional networks and feature subspace learning algorithms to automatically obtain cross-view gait features of Siberian tigers through video images. Convolutional neural networks are mainly used to extract deep features for classification and recognition, to extract internal features from complex and changeable images, and to match and recognize these features. The feature subspace learning algorithm mainly improves the accuracy and resolution of gait recognition by dividing the maximum interval subspace of the asynchronous state, different angles, and different individuals, and finally realizes the use of video images to extract the
gait features of the Siberian tiger. The gait model of the Siberian tiger provides a basis for the study of habitat restoration of the Siberian tiger population.

3. Research methods

3.1. Siberian tiger gait analysis

Because the Siberian tiger is different from humans and cannot perform the agreed actions autonomously, the gait analysis process of the Siberian tiger is much more complicated than that of the human body. According to the research, the main walking styles of Siberian tigers can be divided into three types: fast running, jogging and pacing. The other modes account for a small proportion and are not the main research objects in the preliminary study. At the same time, the wild Siberian tigers are not easy to observe frequently. The preliminary research process mainly to breed Siberian tigers. The Siberian tiger lives in an artificially constructed environment. Compared with the wild environment, the activity space is limited and the environment is not rich enough. The proportion of each gait may be different from that of the wild Siberian tiger, but for the recognition of single step and gait model The establishment and inspection of the system have minimal impact. As the gait characteristics of different walking modes are quite different, it is necessary to perform corresponding gait recognition for different walking modes.

3.2. Gait recognition algorithm of Siberian tiger based on deep convolutional neural network

Compared with the traditional pattern recognition process of computer vision, which requires manual extraction of features first, the deep convolutional neural network learning method no longer requires manual extraction of features. It can directly input images and output their classification results. Because of its powerful feature extraction, classification and recognition capabilities, deep convolutional neural networks are often used to learn and extract deep features. Only one or more pictures or videos are input at the input to achieve feature classification. In this research, the deep convolutional neural network directly establishes the mapping relationship between the input image
and the category through learning, and realizes the learning from the input end to the output end. In the preliminary stage, just input the Siberian tiger gait video to obtain the corresponding Siberian tiger feature information.

In the research of this paper, we mainly input the Siberian tiger activity video into the deep convolutional neural network, and finally obtain the corresponding gait feature data through the convolution-fully connected layer. The preliminary design is to extract 19 feature points from any frame of video through a convolutional neural network, and form a feature model through the movement features of these points in a significant recognition cycle, and finally perform gait features through the comparison of feature models Classification and identification.

![Figure 4 Recognition process of deep convolutional neural network](image)

3.3. A Cross-view Amur Tiger Gait Recognition Algorithm Based on Feature Subspace

Due to research cost considerations, in the process of monitoring the Siberian tigers, only limited cameras can be used in scattered locations, and the Siberian tigers captured by each camera will show different observation angles, which will cause great gait recognition. Using the multi-view subspace learning algorithm based on the feature subspace, the data collected from different perspectives can be projected into a common subspace. In this subspace, it can directly match the data of any perspective, and finally effectively solve this problem. One problem.

![Figure 5 The same individual Siberian tiger shot from different angles](image)

As shown in Figure 5, the gait data that the same Siberian tiger can observe under different viewing angles may have great differences. Similarly, different Siberian tigers may have very little difference under the same viewing angle. In order to effectively distinguish between different individuals and different angles, this study will use algorithms to discretize the normal curve, so that the data difference of the same tiger is as small as possible, and the difference between different tigers is as large as possible. At the data level, different features are projected into the same common subspace after classification by the convolutional neural network, and gait samples from different angles of the same individual are gathered together to form a cluster, and different individuals will form a larger interval. Far different clusters.
Figure 6 Schematic diagram of the maximum interval subspace

By stacking the common subspaces of the asynchronous state at regular intervals, the Siberian tiger gait model space is formed. In this space, the Siberian tiger models of different individuals will present different three-dimensional structures with big differences.

Figure 7 Schematic diagram of the gait model space of Amur tiger

Due to the scarcity of wild Siberian tigers in my country and the lack of a Siberian tiger individual feature database, the early stage can only collect video data based on existing video data or capture Siberian tigers in captivity, and at the same time can only perform semi-supervised learning on known feature individuals. When the Siberian tiger gait model spatial database is initially established, only the existing individuals in the database can be used for verification experiments. After the verification is passed, subsequent field collection and identification and modeling of new videos can be carried out.
3.4. Programming
Functional Requirements
   1) Video import, supports a variety of video formats, and allows to intercept and edit videos.
   2) Feature point extraction: Display 19 feature points obtained through analysis, and display the heading angle of the Siberian tiger.
   3) Gait analysis: display the trajectory of the characteristic points during the gait movement.
   4) Video classification: After the behavior recognition of the video frame images, they are classified according to different individuals and asynchronous states.
   5) Establish a model space: the model space is formed by stacking data of different individuals, asynchronous states, and different angles.

Operating environment
   1) Operating system: Windows10
   2) Programming language: Python and matlab

Acknowledgments
Through this research, we can realize the cross-view simulation and reconstruction of the normal movement of the Siberian tiger, construct the characteristic structure and movement standard model of the Siberian tiger, and establish a basic information repository through further research on the common gait of the Siberian tiger to support the physiological state and living environment of the Siberian tiger. The research, so as to achieve the purpose of protecting the wild Siberian tiger and improving the health status and population of the Siberian tiger population, and can also provide research methods and foundations for other similar species gait recognition technologies.

References
[1] Ma Jianzhang et al. (2015) Challenges and countermeasures facing tigers and their habitat protection in my country. [J] Journal of Wildlife. 2015, 36(02): 129-133
[2] Ma Yiqing. (1983) Historical changes in the distribution area of the Siberian tiger. [J] Natural Resources Research. 1983, (04): 44-48
[3] Tian Yu et al. (2009) Temporal and spatial dynamics of the Siberian tiger population and its cause analysis. [J] Biodiversity. 2009, 17(03): 211-225
[4] Ma Jianzhang, etc. (2019) Follow the laws of natural ecology and strengthen the protection of Northeast tigers and leopards. [J] National Land Greening. 2019, (01): 14-17
[5] Lan Cunzi et al. (2015) The protection status and restrictive factors of the Amur tiger in my country. [J] Sichuan Animals. 2015, 34(05): 780-786
[6] Gu Jiayin et al. (2017) Research on the population status, winter prey selection and movement characteristics of the Siberian tiger in China. [D] Northeast Forestry University. Harbin
[7] Zhou Shaochun et al. (2011) Population size, habitat selection and evaluation of Amur tiger and its prey. [D] Northeast Forestry University. Harbin
[8] Li Bing et al. (2010) Research on advancing the development strategy of animal husbandry in Heilongjiang Province. [J] Modern Agriculture. 2010, (05): 45-46
[9] Zhang Shifang. (2017) The impact of under-forest breeding industry in Heilongjiang Province on wildlife resources. [J] Journal of Wildlife. 2017, 38(02): 332-335