Motion Analysis and Transfer Applications Based on Posture Recognition

Yuhao Zhang*, Mingyue Li, Jianhao Jiao

College of Artificial Intelligence, Tianjin University of Science and Technology, 300222, China

*E-mail: * a15839176622@163.com*

www.tust.edu.cn

Abstract

This paper investigates the posture trajectories in human motion using pose recognition technology based on the deep learning framework MediaPipe. By detecting key points on the human body and plotting and calculating these trajectories in the temporal dimension, we further conduct comparative analysis of these trajectories with professional sports coaches' motion guidance to assist athletes in correcting their posture. Additionally, this technology has been deployed on Jetson Nano, enabling its practical application in mobile scenarios, and providing robust tools and methods for fields such as rehabilitation therapy, sports training, and animal behavior analysis. This study offers insights into the transfer applications of posture recognition.

Keywords: deep learning, MediaPipe, posture recognition, Jetson Nano

1. Introduction

With the continuous development of artificial intelligence, artificial intelligence technology has played a huge role in the development of the sports and fitness industry. Moreover, with the continuous development of economy and society and the continuous improvement of people's living standards, people are more and more willing to strengthen their health through physical exercise. The application of artificial intelligence technology in sports will inject vitality into the sports industry.

People in the usual self-training, because there is no manual coach guidance, which will make the athletes can not get timely feedback when improving skills. Through the use of the MediaPipe framework developed by Goole company to realize the identification of human bone key points, through the changes of bone points in continuous time to draw the human movement trajectory, and then analyze the movement Angle of each action [1]. This will provide a wealth of data for athletes to continuously optimize their level.

The posture analysis of athletes has been deployed on the Jetson Nano, so that athletes can be monitored by moving the jetson nano, whether they are exercising outdoors or indoors [2]. In addition, we added the camera to the steering gear, so that the camera can follow the movement in real time and accurately analyze the attitude data.

In addition, the continuous actions in the same period of time can be transferred to the movement of animals, such as octopus, snake and other animals, through deep learning to train a model to identify key points, and then analyze the movement behavior of animals, which will help us better understand animals [3].

The rest of this article is organized as follows. The second part introduces the hardware. The third part introduces the software part. The fourth part analyzes the captured motion changes. The fifth part summarizes the main content of this paper.

2. The Hardware Structure

The main hardware used in this research is jetson nano, steering gear and high-definition camera. The camera is moved through the steering gear to better capture people's posture information, and the powerful image processing capability of jetson nano is used for data analysis.

2.1. Jetson nano

Jetson Nano is an embedded computing platform based on NVIDIA Maxwell architecture with a 128-core NVIDIA Maxwell GPU and quad-core ARM Cortex-A57 CPU that delivers high-performance deep learning and computer vision capabilities. The board supports a variety of peripheral connections, including GPIO pins, I2C buses, UART serial ports, and more, making it an ideal platform for integrating a wide range of sensors and actuators [2]. Jetson Nano runs Ubuntu Linux with strong software support for deep learning and computer vision applications. The jetson nano used in this study is shown in Fig. 1.

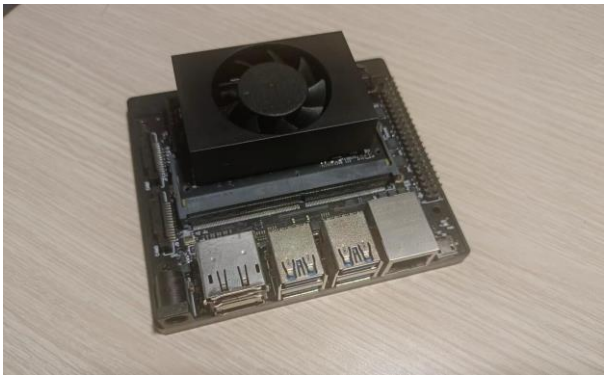

Fig. 1 Jetson Nano

2.2. IMX415 HD camera

Sony's IMX415 HD camera is our choice. The camera features 8.46M effective pixels, a frame rate of up to 120fps, and a field of view Angle of 130 degrees, providing the system with clear, high-resolution images. To provide the system with clear, high-resolution images. The IMX415 is an advanced image sensor for applications that require high-quality image capture, such as our attitude recognition system. The IMX415 HD camera used in this study is shown in Fig. 2.

Fig. 2 IMX415 HD camera

2.3. DS3230 digital steering gear

Two DS3230 digital steering engines are used in this study. This steering gear provides precise Angle control, enabling the system to dynamically adjust the direction of the camera according to the movement of the target object, achieving a 360-degree rotation. Through the steering engine, we can realize the full range of the target object trajectory capture. The DS3230 digital steering gear used in this study is shown in Fig. 3.

Fig. 3 DS3230 digital steering gear

3. Software Distribution

In software development, this design is based on MediaPipe open-source framework development, and combined with OpenCV to achieve the complete code.

3.1. Introduction to MediaPipe

MediaPipe is an open-source computer vision library developed by Google to provide developers with a flexible and efficient set of tools to build visually aware applications. It is designed to simplify the development process of computer vision tasks by providing pre-trained models and easy-to-use Apis that make it easier for developers to implement a variety of visual tasks. The main performance is as follows:

(1) Real-time performance: MediaPipe focuses on real-time computing, enabling low latency and efficient real-time image processing on multiple hardware platforms.

(2) Multimodal input: Support a variety of input sources, including images, videos, camera streams, etc., making it suitable for a variety of scenes and devices.

(3) Rich pre-trained models: MediaPipe offers a range of pre-trained models covering many areas such as human pose estimation, hand tracking, face detection, etc., which can be used to quickly build various computer vision applications.

(4) Cross-platform support: MediaPipe supports multiple operating systems (including Linux, Windows, Android, iOS) and a variety of hardware accelerators (such as Gpus, Tpus), making it widely portable.

In this design, we chose the MediaPipe framework as the basis to realize the key function of attitude recognition. By combining OpenCV, we were able to flexibly process camera input and use the pre-trained model provided by MediaPipe to accurately capture key pose information of the target object. This combination allows us to quickly build a powerful computer vision system for monitoring and analyzing the movements of target objects.

3.2. Establishment of trajectory analysis model

Let's take the motion analysis of one arm as an example. Using the MediaPipe framework, call the poseLandmarkerResult function to generate the three-dimensional coordinates of the key points. In Fig. 4 below, A, B, and C represent the three nodes of the arm. The poseLandmarkerResult function can be used to return the three-dimensional coordinates of the node, and can draw the trajectory motion [1].

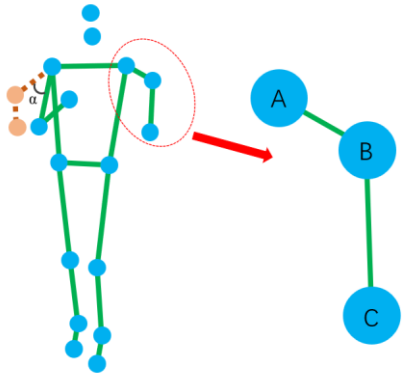

Fig. 4 Keypoint graph

Then according to the following formula, the angular distance change of the node relative to the previous state can be calculated.

$$\theta = arc\ cos\left(\frac{\overrightarrow{AB}*\overrightarrow{BC}}{|\overrightarrow{AB}|\cdot|\overrightarrow{BC}|}\right) \quad (1)$$

4. Introduction of Result

Running the code on the jetson nano shows the trajectory on the screen and can calculate the Angle between the nodes.

4.1. Effect of display

As shown in Fig. 5 below, the trajectory of the key points of the arm in a period of time can be drawn, so that the movement posture of the professional athlete can be compared, and the change of the Angle of the joint can be accurately viewed to help the athlete find the correct movement posture.

Fig.5 effect display diagram

Through the object detection algorithm, the camera can capture objects such as tennis balls and ping-pong balls, which can better identify the position of people [2]. The display effect is shown in Fig. 6.

Fig. 6 object identification

4.2. Idea transfer application

It has far-reaching and multi-level significance to transfer human posture recognition technology to animals to realize key point detection and trajectory tracking. This not only provides new research avenues in the field of biology, deepening the understanding of animal ecology, behavior, and physiology, but also brings substantial contributions to wildlife conservation, livestock management and scientific education. Through the application of this technology, we can monitor the movement patterns, posture changes and behavior patterns of animals in real time, providing a scientific

basis for protecting endangered species, monitoring wildlife migration, and improving the efficiency of livestock production [3].

5. Conclusion

Through the movement posture analysis of human arm as an example, the trajectory of the athlete is successfully analyzed, which also reflects the key points of the whole body, and the movement posture analysis will help the athlete to correct the posture in a more three-dimensional way. And this model is deployed on the jetson nano, which will facilitate device movement. The transfer of posture analysis to animal movement behavior will greatly help the study of animals.

Acknowledgements

This paper is supported by the project "Fire Hero - Fire rescue intelligent robot" of Tianjin University of Science and Technology, with the project number of 202310057042.

References

1. Han K, Li X, Research Method of Discontinuous-Gait Image Recognition Based on Human Skeleton Keypoint Extraction, *Sensors*, 2023, 23(16):7274.
2. Zhang Shang, WANG Hengtao, RAN Xiukang, Lightweight traffic sign detection method based on YOLOv5, *Electronic Measurement Technology*, 2002, 45(08): 129-135.
3. Li Yandong, HAO Zongbo, Lei Hang, Convolutional neural networks research review, *Journal of Computer Applications*, 2016, 36(09): 2508-2515+2565.

Authors Introduction

Mr. Yuhao Zhang

He is an undergraduate majoring in artificial intelligence at Tianjin University of Science and Technology. He learns about electronic information and artificial intelligence, and currently focuses on digital image processing, deep learning and pose estimation.

Ms. Mingyue Li

She is an undergraduate majoring in artificial intelligence at Tianjin University of Science and Technology. She currently focuses on digital image processing and deep learning.

Mr. Jianhao Jiao

He is an undergraduate majoring in artificial intelligence at Tianjin University of Science and Technology. He learns about electronic information, and currently focuses on deep learning and pose estimation.