Application Development of Dance Pose Recognition Based on Embedded Artificial Intelligence Equipment

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Abstract. With the development and popularization of artificial intelligence and machine vision, human posture recognition has become one of the most important research directions in the field of machine vision, but its application research in dance movement recognition is in its infancy, especially in the field of Chinese classical dance. In view of this situation, the application of artificial intelligence in basic hand position recognition of Chinese classical dance. Including analysis of basic hand position of Chinese classical dance, comparison of human posture recognition models, recognition and comparison of basic hand position of Chinese classical dance on NVIDIA embedded devices using TensorFlow deep learning framework, and combination of traditional culture and artificial intelligence technology.

Keywords: Artificial Intelligence, Machine Vision, OpenPose, Chinese Classical Dance, TensorFlow

1. Introduction
With the development and popularization of artificial intelligence and machine vision, human posture recognition has a wide range of applications in video surveillance, human-computer interaction entertainment, personal care and social services. Human posture recognition has become one of the most important research directions in the field of machine vision, but its application research in dance movement recognition is in its infancy, especially in the field of Chinese classical dance.

It is extremely urgent to use embedded artificial intelligence technology to research and apply the recognition and evaluation of basic movements and postures of Chinese classical dance, which is the protection and inheritance of traditional culture.

Chinese classical dance has a long history and is extensive and profound. It combines many movements and shapes in martial arts and operas, paying special attention to the role of eyes in performance, emphasizing the coordination of breathing, full of rhythm and shape, and unique aesthetic feeling of combining rigidity and softness in the Eastern style, which is intoxicating.

Chinese clothing and classical dance gradually became a new cultural wave, a fresh way of life, and even an expression of self-confidence. It is urgent to study and apply the recognition and evaluation of basic movements and postures of Chinese classical dance, which can be applied in the fields of online learning and evaluation of dance, fitness and entertainment of dance, etc., so that traditional culture and new artificial intelligence technology can collide with each other and contribute to the protection and inheritance of Chinese traditional culture[1].
This paper will use Google TensorFlow machine learning framework, and use OpenPose to recognize and evaluate the basic movements of Chinese classical dance. TensorFlow is one of the mainstream machine learning frameworks. Hardware deployment platform will adopt NVIDIA Jetson series embedded artificial intelligence development platform. The basic framework adopted in the study is shown in the following figure:

![Basic framework adopted](image)

**Fig. 1** Basic framework adopted

2. **Basic hand position of Chinese classical dance**

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The complete dance can be disassembled into the conversion and combination of basic movements. There are several basic hand positions in Chinese classical dance, as shown in the following figure:

![Basic hand positions in Chinese classical dance](image)

**Fig. 2** Basic hand positions in Chinese classical dance

3. **Pose model selection**

OpenPose and PoseNet are two popular models for human pose recognition. OpenPose is an open source library of human posture recognition developed by Carnegie Mellon University (CMU) based...
on convolutional neural network and supervised learning. It can realize the pose estimation of human body movements, facial expressions, finger movements and so on. It is suitable for single person and multi-person, and has excellent robustness. It is the world's first real-time multi-person two-dimensional attitude estimation application based on deep learning, and examples based on it are springing up[2]. PoseNet is a visual positioning model made by Cambridge University, which can position your pose information through a color image.

Posenet uses Tensorflow.js to realize gesture detection in browser, so OpenPose was adopted on embedded artificial intelligence devices. OpenPose can recognize 19 joint points of human body, as shown in the following table:

| Joint | Description  |
|-------|-------------|
| 0     | nose        |
| 1     | neck        |
| 2     | Rsho: Right shoulder |
| 3     | Relb: Right elbow |
| 4     | Rwri: Right wrist |
| 5     | Lsho: Left shoulder |
| 6     | Lelb: Left elbow |
| 7     | Lwri: Left wrist |
| 8     | Rhip: Right hips |
| 9     | Rkne: Right knee |
| 10    | Rank: Right ankle |
| 11    | Lhip: Left hips |
| 12    | Lkne: Left knee |
| 13    | Lank: Left ankle |
| 14    | Leye: Left eye |
| 15    | Reye: Right eye |
| 16    | Lear: Left ear |
| 17    | Rear: Right ear |
| 18    | | 18 pt19 |
| 19    | | pt19 |

**Tab. 1** 19 joint points of human body

Taking the basic hand position "Shunfeng Banner" as an example, five important joints which can represent dance posture are selected from 18 joints, namely: neck, left wrist, right wrist, left ankle and right ankle as shown in Table 2. During the experiment, we took three groups of photos: coach's standard action, student's action 1(qualified), and student's action 2(unqualified)

| Joint | Description  |
|-------|-------------|
| 1     | neck        |
| 2     | left wrist  |
| 3     | right wrist |
| 4     | left ankle  |
| 5     | right ankle |

**Tab. 2** Five important joints adopted

Through TensorFlow and OpenPose, the coordinate matrixes of five joint points corresponding to three groups of photos are obtained. Taking the neck as the center, translate and scale the coordinates of the joint points between the coach and the trainees[3]. Then calculate the similarity of coordinate matrix to judge whether the trainees' actions are qualified.Cosine_similarity method in sklearn.metrics.pairwise module is used to calculate the similarity of joint coordinates[4][5].

After translating, scaling and comparing the similarity of the five main joint points matrix, the evaluation of the students' movements is expressed with different stickers. The experimental results are shown in the following figure:
4. Embedded artificial intelligence
The next goal is to run the program on embedded devices. Artificial intelligence has two deployment modes: cloud computing and local computing. Although cloud server AI has high calculation accuracy, it is not suitable for all scenarios when it is applied to commercial applications, and there are four main reasons: bandwidth, delay, privacy and availability of cloud services. Embedded artificial intelligence is a kind of local computing, which is a deep learning algorithm running on terminal equipment. At present, many places in the world cannot be covered by cloud services, such as underground parking lots and public areas without signal coverage. However, embedded artificial intelligence is not limited by application places.

In terms of future commercial application requirements, the market demand of embedded artificial intelligence is great, and the future intelligent application must be the cooperation and division of labor between the cloud and embedded devices. In order to realize the low delay of dance action recognition and evaluation and reduce the dependence on network bandwidth, the deployment platform of this study chooses the embedded artificial intelligence platform.

NVIDIA Jetson series embedded system is an embedded artificial intelligence development platform specially designed for AI developers and oriented to edge computing. NVIDIA is the world leader in visual computing technology and the inventor of GPU. GPU computing has become the development direction of high performance computing and data center.

There are four series of jeston embedded artificial intelligence systems: Jeston Nano, Jeston TX2, Jeston Xavier NX and Jeston AGX Xavier. The price and performance of these four development platforms are increasing in turn, among which Nano is the cheapest but the price-performance ratio is higher than TX2. Jetson AGX Xavier, which came out at the end of 2018, has the highest performance and is widely used in various unmanned delivery vehicles. Jetson series platform will provide embedded artificial intelligence acceleration hardware with high computing performance for dance gesture recognition.

Download the system image from NVIDIA official website, burn it to Jetson series embedded development board, complete the configuration of camera and install TensorFlow. OpenCV is used to preprocess the image before recognition. OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV can be used to capture the camera image and change the image size. Access the development board through the remote login software on the computer side, and transfer the Openpose Python program to the development board to run.

5. Conclusion
Relying on NVIDIA Jeston series embedded artificial intelligence development board, real-time images are acquired and analyzed through camera and OpenCV library; Using TensorFlow artificial intelligence framework, combined with OpenPose gesture recognition model, the position coordinates of human joint points in video are extracted; According to the cosine similarity algorithm, the similarity between the imitator's action posture and the standard action sample is calculated and compared, so as to realize the recognition and evaluation of the basic posture of Chinese classical dance students.

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