Intelligent Classroom Teaching Behavior Analysis System Based on S-T Analysis Method

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Abstract: Compared with traditional classroom teaching observation, the classroom behavior analysis system using information technologies can effectively improve the validity and accuracy of interpretation of classroom teaching behaviors. With the development of information technology, the combination of the application of teaching methods and artificial intelligence has become an inevitable trend. Based on the S-T teaching behavior analysis method, an intelligent classroom teaching behavior analysis system using multi-modal recognition technology was proposed, which applied various information technologies to collect classroom teaching behavior data and code them automatically. The accuracy and reliability of the presented system was verified through the collection and analysis of a large number of classroom behavior data, which provided a valuable scientific analysis tool for classroom teaching behavior research.
Keywords: Classroom teaching behavior analysis, S-T analysis method, Multi-modal recognition technology

1 Introduction

Today, as education informatization is gradually deepening, the theory of teaching and learning continues to develop. Gradually integrate new educational concepts and technical means into classroom teaching, and traditional teaching evaluation methods have gradually failed to meet the needs of teaching development. Classroom teaching evaluation methods need to keep pace with the times, classroom teaching practice calls for in-depth study of classroom teaching behavior (Taut & Sun, 2014). This study completed an intelligent analysis system based on S-T analysis method and multi-modal recognition technology, and verified its accuracy and reliability. This not only provides a basis for teachers to improve teaching content and teaching methods, but also has great significance for promoting the development of teachers' professional ability.

2 Literature Review

2.1 the S-T Analysis Method

The advantages and disadvantages of classroom teaching are largely related to the interaction between teachers and students. Classroom is the main place where teaching activities take place. Classroom behavior takes place in this space and the information transmission between teachers and students interacts and interacts in this space. As the main body of the teaching process, the

behavior of students in the classroom can directly reflect their learning status. As a guide for students to learn, teachers also play an important role in guiding behavior. Therefore, analysis of classroom teacher and student behavior is conducive to analyzing classroom teaching process. Some scholars have been working on software for collecting and analyzing classroom teaching behavior data and have made good progress (Yun et al. , 2018). Some scholars have conducted classroom observations from multiple angles and at multiple levels, and also provided new ideas for data collection and processing of this study (Xie & Cao, 2010). Japanese scholars first proposed the S-T teaching analysis method for classroom teaching analysis. S-T analysis method is the Student-Teacher analysis method, which is a teaching analysis method that visually expresses the teaching personality in a graphical way (Jun & Ou, 2011). The main steps of the method are divided into data sampling, analysis of time series data, drawing S-T diagram, and drawing RT-CH diagram to judge the teaching mode analysis. In the actual classroom teaching process, the specific manifestations of Teacher's behavior and Student's behavior are shown in Table 1. Since the Student's behavior includes all behaviors other than the Teacher's behavior, in addition to the 11 behaviors described in Table 1, it can be classified as "Others" as a form of Student's behavior.

Table 1: Specific manifestation of T behavior and S behavior

Category	Number	Manifestations	Category	Number	Manifestations
Teacher's behavior	1	explanation	Student's behavior	7	Student's speech
	2	demonstration		8	Student's thinking, calculation
	3	blackboard		9	Student taking notes
	4	using various media to prompt		10	Doing experiments or finishing homework
	5	question and name		11	Keeping silence
	6	evaluation and feedback		12	Others

This study draws on the traditional classroom teaching behavior analysis method, and uses a variety of information technologies to collect and analyze classroom teaching behaviors. It will record actual classroom teaching behaviors, help researchers and teachers analyze classroom teaching behavior, and promote professional development of teachers.

2.2 Kinect System Principle

In 2010 and 2014, Microsoft released KinectV1 and V2 successively. KinectV2 includes a color camera, depth camera, infrared light emitter and microphone, which can realize real-time dynamic capture, image recognition, microphone input, voice recognition, social interaction and other functions. . The official system of Kinect, Kinect for Windows SDK, contains drivers, original sensing data flow development interface, user interface, installation file data, and can be used for secondary development. KinectV2 uses TOF technology (Time of Flight) to obtain depth

image information by calculating the projected infrared rays and the return time after reflection, and then segment the human body from the background image through the machine learning algorithm, and then estimate the three-dimensional coordinate information of the human body joint points (Roque et al. ,2019). It is less affected by the environment and light. It gets rid of the high requirements of traditional motion capture technology in experimental environment, experimental equipment, and the accuracy of markings. It can capture user actions, facial expressions and voice sequences in real time for the purpose of machine interaction. Skeleton tracking technology is the core function of Kinect. This technology uses deep vision technology and uses complex algorithms such as machine learning and matrix changes to determine the three-dimensional coordinates of joint points.

Skeleton tracking technology is the core function of Kinect. The deep vision technology adopted by this technology uses complex algorithms such as machine learning and matrix changes to determine the three-dimensional coordinates of the joint points. The working process includes(He & Li 2020):

①Human contour segmentation: Kinect obtains the depth image information through the depth sensor, and through edge detection, Noise threshold processing and other technologies separate the human target ("T"-shaped object, which will be recognized as a human body by Kinect) from the environmental background to obtain a depth image of the human body;

②Human body part recognition: the human body separated from the depth image Different parts of the human body are identified in the contour, and a large amount of data is used to train and classify through the classification algorithm of the decision forest. Each pixel is labeled with a category label and classification probability to classify various parts of the human body, such as the head and shoulders;

③Joint point positioning: After completing the recognition of human body parts, Kinect analyzes all aspects of the human body and uses machine learning algorithms for joint positioning.

In traditional sports teaching and training, the teaching method is one-to-many, and students' understanding and learning progress are uneven, resulting in poor teaching or training effects. In order to solve these problems, more and more professional sports training began to apply motion capture to sports training and teaching. Kinect determines the accuracy of the exerciser's movements by accurately grasping the contour and position of the exerciser's body, and performs corresponding training or operation according to the movement function. The trainer's technical movements are identified through the Kinect device. After the computer processes the collected data, it makes correct judgments on the technical movements and feeds them back to the practitioners to encourage them to practice repeatedly, correct wrong movements and improve teaching or training efficiency.

The system analysis results show that there are 22 researches on the development and application of Kinect in auxiliary physical education and training; these researches involve competitive events (badminton, basketball, etc.), flexibility events (yoga, Tai Chi, etc.). Kinect's process characteristics as an auxiliary teaching and training tool are:

① Use Kinect-based system equipment to capture human bones and depth information;

② Using self-occluded joint point information restoration algorithms and filters to collect depth images or motion information of each joint Process;

③ Compare and analyze the collected information with the pre-set standard actions;

④ Provide real-time feedback or evaluation to inform the trainer how to adjust the actions and posture, improve the actions in time, and continue training.

3 Model building

With the development of computer science and precision manufacturing, the automation of video-based classroom teaching observation has become an inevitable trend. Multi-modal recognition technology uses a variety of sensory recognition techniques such as depth image and phonetic intonation to perform behavior recognition. This will help to further improve classroom information collection efficiency, coding efficiency, information classification accuracy, and greatly enhance teachers' interpretation of classroom teaching effects. Therefore, in order to realize this idea, this study collected classroom teaching behavior data through the various information technologies, such as depth image analysis technology, human skeleton tracking technology, speech analysis technology and so on.

S-T analysis method is an analytical method that expresses the character of teaching in a graphical way. This analysis method divides the behaviors into two categories: student (S) behavior and teacher (T) behavior, which reduces the ambiguity of behavior classification in the teaching process and increases the objectivity. For the recorded behavior sequence data, it can calculate the T behavior occupancy rate (Rt), the behavior conversion rate (Ch), and plot the Rt-Ch diagram (Jun & Ou, 2011). According to this, the teaching mode adopted in the class can be judged, and the teaching method can be improved by using a visual method. It does not require other complicated calculations, and it is very convenient to use, which is conducive to promotion and implementation.

The depth image analysis technology is used to recognize the objects in the visual filed and analysis the geometric characteristics of objects (Yeloglu et al. , 2015). This technology improves the accuracy of computer image recognition and promotes its development. The human skeleton tracking technology is to recognize the joints of human skeleton and collect the coordinate data of human skeleton. Some scholars use the human skeleton tracking technology in the rehabilitation measurement of disabled people, determine and improve the accuracy of the system's joint tracking, which achieves good results (Mobini et al. , 2014). Some scholars use the human skeleton tracking technology to apply the somatosensory interaction system to multimedia teaching in the classroom environment (Sommool et al. , 2013). The speech analysis technology is to recognize the speech features of human, which has been used in many human-computer interaction systems.

Based on the above analysis, this study constructs a classroom teaching behavior analysis model based on S-T analysis method and multi-modal recognition technology, as shown in Figure 1.

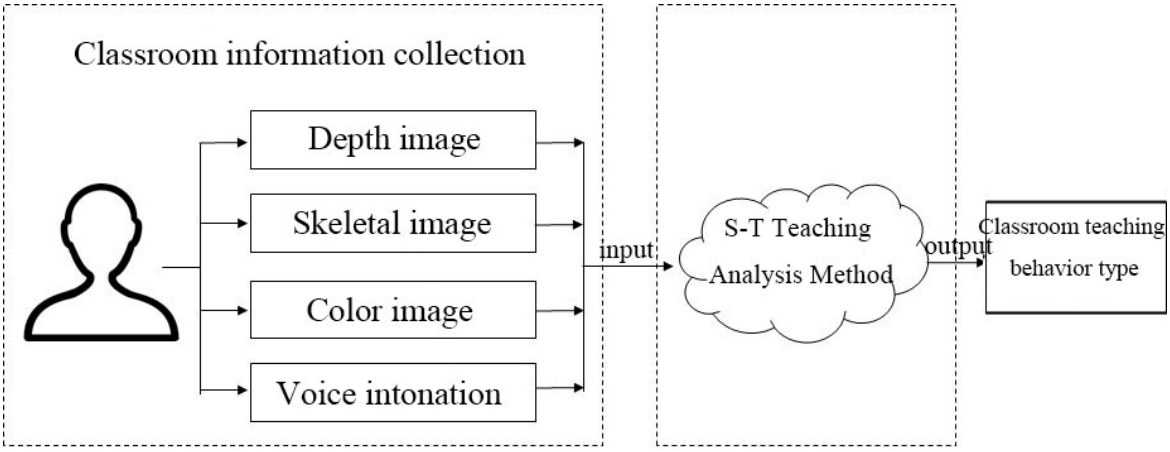

Figure 1 Classroom behavior analysis model

Through the depth image recognition technology and the human skeleton tracking technology, combined with the speech recognition technology, it can collect all the data such as posture and facial behavior of teachers. At the same time, the model combines with the S-T analysis method to encode the teacher behavior data, so as to comprehensively collect the teachers' status, to establish a low-cost, real-time classroom state detection system that does not affect the original listening state of the classroom.

The system software architecture based on S-T analysis method is mainly divided into display layer, business layer and data layer. The display layer is mainly used for the display of the interface and the interaction with the user, mainly using the Microsoft .NET Framework form application technology. On the interface, users can choose to run programs, draw charts, view statistics and view data sources. It is a simple and effective operating system for users. The business layer mainly implements the functions of data processing and chart drawing. It mainly uses the .NET Framework form application and Windows.Forms.DataVisualization. Charting to realize the chart drawing. It is a layer of internal logic implemented throughout the software. The data layer implements the function of storing data and reading data by the user, and uses a text file to store data, as shown in Figure 2. The design idea of the whole system is to complete the coding information of the program design by comparing the continuous changes between every 50 frames.

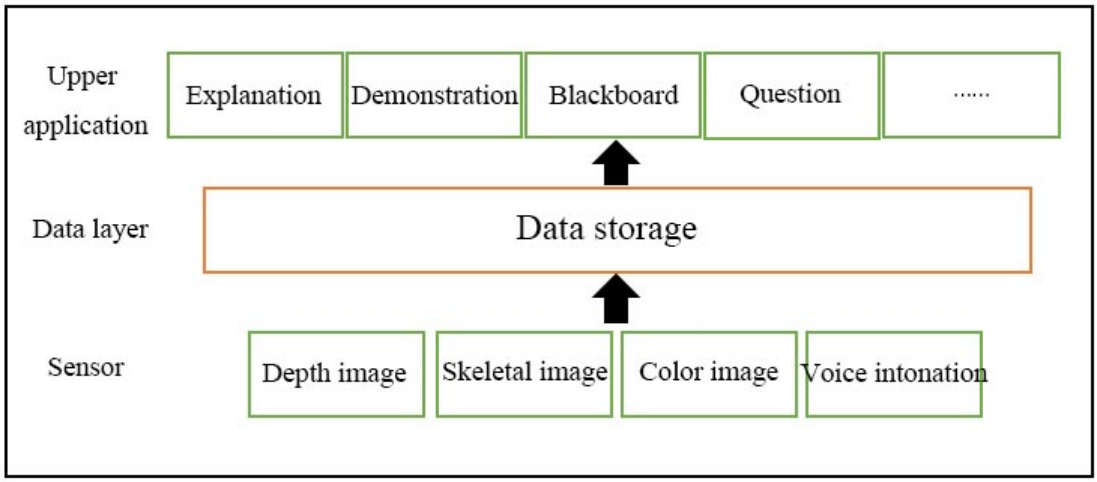

Figure 2 System software architecture diagram

4 Method

4.1 Participants

In this study, two teachers from a university in East China are used as experimental subjects to carry out experiments, and the course of "Human-Computer Interaction" in Educational Information Technology is selected as the research sample. The specific unit course selected is a practical course of human-computer interaction. The content of the course mainly guides students to use six degrees of freedom robotic arms. The course of this unit is relatively difficult, and students need to be guided to complete the course study, program writing, and exchange summary independently.

4.2 Experiment Procedure

The experiment is carried out on the basis of ensuring that the normal classroom order of teachers and students will not be affected. Before the course starts, first of all, arrange the equipment to ensure that the depth sensor camera and high-definition camera can record all the actions of the teacher in the classroom. Monitor whether the equipment is operating normally during the course. Then distribute the course videos to three researchers, and manually code the teacher behavior. Finally, the manual coding result is compared with the system coding. The specific classroom content is required to be designed to be diversified, including at least one of the codes in the S-T teaching analysis method, and to ensure a certain proportion of classroom interaction design.

5 Results

The system encodes and analyzes classroom behavior in a frequency of 5 seconds. In order to detect the reliability of the system, after the automatic coding is completed by the intelligent teaching behavior analysis system, the experiment initiator organizes the experimenter to complete the video-based classroom coding analysis, and finally compares their analysis results. The results show that the coincidence degree between the intelligent analysis system and the manual coding method reaches 86%, which verifies the feasibility and effectiveness of the presented intelligent system.

In order to increase the user's intuitive perception of the time dimension of classroom teaching behavior, this study visualized one course's classroom data according to time while ensuring accuracy. The broken line in Figure 3 not only reflects the changes in teachers' classroom behavior. The abscissa is time in seconds. 1-6 respectively indicate different classroom teaching behaviors, namely explanation, demonstration, blackboard, using various media to prompt, question and name, evaluation and feedback. From the overall behavior data, the teacher's classroom behavior corresponding to the data in Figure 3 has the largest proportion of explanations, indicating that the teacher has more explanation time in the classroom.

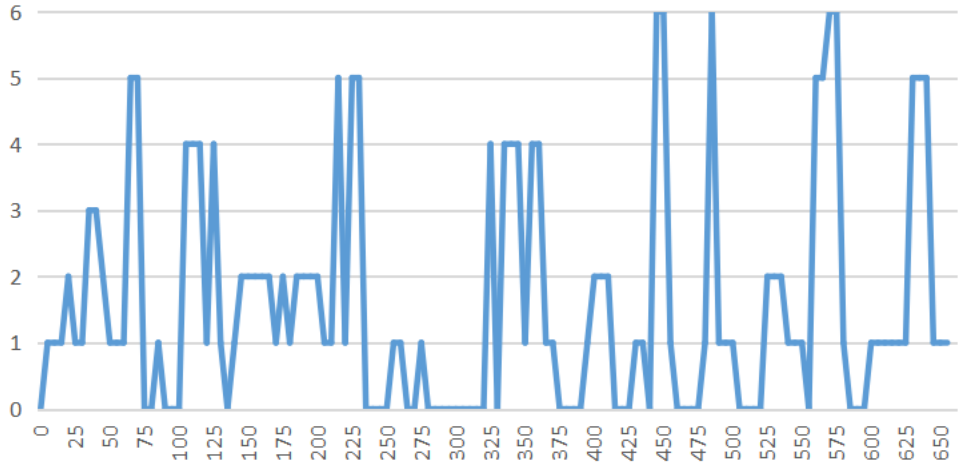

Figure 3 Distributions of classroom teaching behavior

6 Conclusion and Discussion

Researchers and teachers use the proposed intelligent classroom teaching behavior analysis system based on S-T method and multi-modal recognition technology to analyze teaching activities in the classroom, which will improve the quality of classroom teaching and learning effectively, be helpful to the professional development of teachers, and students can also benefit a great deal. This study explored the classroom teaching behavior model, designed and developed the intelligent analysis system to reduce the difficulty of classroom teaching behavior observation, improve the efficiency and quality of classroom teaching activities. It is of great significance to improve the quality of education.

This research has achieved multi-modal classroom behavior recognition, but the research currently only uses two teachers as samples for experiments. When it is extended to more teachers, different behaviors of different teachers need to be considered to improve the accuracy of classroom behavior recognition degree. Future research will add students' classroom behaviors to form a complete multi-modal classroom behavior recognition system for teachers and students.

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