Quantitative Analysis Technology of Classroom Teaching Based on Facial Expression Recognition Technology and Attention Analysis Technology

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Abstract. As the first classroom teaching mode with thousands of years of development history, it is still an irreplaceable teaching form now and in the foreseeable future. In this paper, the smart education laboratory built by our school is used, and the quantitative analysis of classroom attention teaching based on random cascade regression and PnP method is used to realize the visual display of learning attention. Using the quantitative analysis of facial expression recognition in classroom teaching based on FACS and KNN classification algorithm, using Gabor and ULBPHS feature fusion, after PCA + dimensionality reduction, the learning emotion judgment and output are realized. Using the quantitative analysis of teacher attention based on three-dimensional feature point coordinate transformation of face and viewpoint visualization, the intersection of the rays in the classroom coordinate system on the camera plane is calculated first, and then the mapping point coordinates of the intersection in the teacher's coordinate system are calculated. Finally, the viewpoint visualization in classroom teaching is realized.

Keywords: Quantitative analysis · FACS model · KNN classification algorithm · viewpoint visualization

1 Introduction

At present, information technology represented by the Internet has become an important driving force for social progress and development, and is comprehensively reshaping traditional industries and continuously subverting people's existing cognition. In the face of the surging digital wave, education faces challenges from two levels: theory and practice: the pursuit of more scientific and precise education by the theoretical circles and practitioners.

With the in-depth development of the digital age, the way of thinking of human beings to carry out scientific research and social practice is constantly evolving. The data-intensive scientific research paradigm and data literacy powered by technology have attracted widespread attention. At the same time, it attaches great importance to the data-based cognitive model based on quantitative information. The rapid development and

Z. Zhan et al. (Eds.): ICBDIE 2022, AHCS 5, pp. 884–892, 2023.
https://doi.org/10.2991/978-94-6463-034-3_91

in-depth application of information technology, especially mobile Internet, Internet of Things, cloud computing, edge computing, big data, artificial intelligence, etc., provide the possibility for all-round quantification of learning scenarios and learning processes around learners. The resulting data will facilitate deeper, panoramic insights into learners and provide new avenues for answering two core propositions (scientific and precise) in the new educational revolution.

The essence of learning is the process of self-construction of learning subject knowledge and continuous improvement of personality, and this process needs to be completed by relying on a series of learning scenarios and learning activities. The purpose of the all-round quantification of the learning process is to help the learning subject efficiently realize the construction of knowledge and even the perfection of personality in the learning scene and learning activities: by helping the teacher to more accurately grasp the state of the learner, and then carry out targeted teaching activities; teachers improve themselves by helping learners to have a deeper insight into their own problems and then take corresponding actions. In this sense, quantitative learning is a process of "unification of knowledge and action" that accompanies learners, and has a natural practicality. As an important starting point for exploring the deep integration of information technology and education, quantitative learning will help to build a new ecosystem of scientific and precise "learner-centred" learning.

In the process of quantitative learning, data is extremely important to education. The integration of information technology and economic society has led to the rapid growth of data. Big data technology has become a new generation of information technology and services by rapidly acquiring, processing, and analysing massive data and discovering new knowledge, creating new value, and enhancing new capabilities. In addition, big-data technology also has an important impact on global production, circulation, distribution, consumption activities, as well as economic operation mechanisms, social lifestyles and national governance capabilities.

Developed countries around the world have successively formulated and implemented big data development strategies, supported big data research with funds and policies, and used big data to promote national economic and social development. In March 2012, the U.S. government released the "Big Data Research and Development Program", which aims to improve the existing people's ability to acquire knowledge from massive and complex data, thereby accelerating the pace of U.S. inventions in the fields of science and engineering and enhancing national security, to transform the existing teaching methods. In 2014, the White House released a white paper titled "Big Data: Seizing Opportunity and Preserving Value." The white paper states that "the use of new data types has enabled researchers to make a qualitative leap in their ability to study learning behavior." In November 2010, the EU Communications Commission submitted the report "Open Data: An Engine of Innovation, Growth and Transparent Governance" to the European Parliament, and on December 12, 2011 formally implemented the core of the EU's open data strategy. The strategy mainly includes legal, policy, funding and project support for data processing, data integration, data portals, open data, etc. The core purpose is to provide innovative tools and materials on the basis of data openness and sharing, and to form effective sharing. And the integrated public data pool can better leverage the value of big data. The Australian Government Information Management

Office released the “Public Service Big Data Strategy” in August 2013, which aims to promote the use of big data analysis in the public industry to reform services, formulate better public policies, protect citizens’ privacy, and make Australia one of the best in this field. The strategy emphasizes data integrity and program reusability, technology and resource sharing during data development, citizen privacy protection, and strengthening industry-university cooperation and data openness. In 2012, the Ministry of Science, Technology and Education of the Government of India promulgated the “National Data Sharing and Access Policy”, which together with the “E-Government Advice” issued by the Knowledge Commission and the “Guidelines for the Implementation of the National Data Sharing and Access Policy” designated by the National Information Centre and other documents. It has become a guiding document for India to promote open government data, establishes the principle of active disclosure of government data and information, and promotes the sharing and use of government-owned data and information.

In the field of education, the big data era of “data-driven learning, analysis and transformation of education” has come, and big data has set off a revolution in human teaching and learning. Using educational data mining technology and learning analysis technology to build relevant models in the educational field, explore the correlation between educational variables, and provide effective support for educational and teaching decision-making has become the development trend of education. In October 2012, the U.S. Department of Education released the report “Promoting Teaching and Learning through Educational Data Mining and Analysis”, which pointed out that the emergence of educational data mining and learning analysis technology can realize the collection of a large amount of fine-grained educational big data. It will definitely change the paradigm of traditional educational data application, and will also provide more refined services for educational decision-making of educational institutions, teachers’ teaching decision-making and students’ self-learning monitoring. In 2013, the U.S. Department of Education issued “Expanding the Application of Evidence-Based Methods in the Field of Digital Learning”, pointing out that education evaluation based on big data can make full use of technical means to collect and integrate learners’ learning process data and learning result data, and integrate expert evaluation., teacher evaluation, learner self-evaluation, peer evaluation and other evaluation data, multi-dimensional, comprehensive, full-process, in-depth and reliable evaluation of learner memory. The U.S. Department of Education proposed in the “Department of Education Strategic Plan (2014–2018)” released in 2013 that it will help states build data systems and common data specifications and help educational institutions and teachers improve their ability to use data to improve teaching effectiveness. In 2013, the European Union officially launched a new seven-year research and innovation framework plan - “Horizon 2020”. The plan will invest 80 billion euros over the next seven years to remove barriers to scientific innovation and ensure that Europe produces world-class scientific results. Taking learners as the centre, collecting and storing educational data and developing systematic learning analysis services are listed as one of the research topics of the program. In order to better promote the application of big data-based education, the five-year plan issued by the Australian Department of Education and Training proposes to build a culture based on evidence and analysis, improve data analysis and sharing capabilities, and formulate effective education policies based on data and evidence, promote data collection for educational assessment and establish data-sharing mechanisms for policymakers, educational institutions, teachers, and parents. The “Twelfth Five-Year Plan: 2012–2017” issued by the Indian government pointed out that it will focus on data-driven educational decision-making, help teachers use information technology more effectively in the classroom, implement “teaching according to their aptitude”, and improve the quality of education. To achieve this, the government will build student profiles to track student enrolment, attendance, and withdrawals. At the same time, the government also cooperates with application developers to promote research and development in areas such as student learning diagnosis and real-time data collection.

The Chinese government also pays attention to the value and great potential of big data. In August 2015, the State Council issued the “Outline of Action for Promoting the Development of Big Data”, which raised the promotion of big data development to the national strategic level. The “Outline” proposes that big data is a new driving force for economic transformation and development, a new opportunity to reshape a country’s competitive advantage, and a new way to improve government governance capabilities., establish a management mechanism of “speaking with data, making decisions with data, managing with data, and innovating with data” to realize scientific decision-making based on data. Big data technology will promote deeper innovation and reform in the field of education, and bring new opportunities and challenges to my country’s traditional education claw. In the “Ten-Year Development Plan for Education Informatization (2011–2020)” issued in 2012, the Ministry of Education clearly stated that the construction of a national education management information system is the basic project to support the modernization of education management. The construction of the national education management information system includes the construction of basic databases, data sharing, the realization of system interconnection and data sharing, and the establishment of an education management information system that is vertically connected and horizontally related. In the “Outline”, it is further mentioned that it is necessary to “improve the public service platform for education management, and promote the accompanying collection and sharing of basic education data. Realize the vertical integration of student registration files at different educational stages.” It is suggested to promote the formation of an educational resource and cloud service system that covers the whole country, provides collaborative services, and is interconnected across the entire network. It is also important to explore and play the supporting role of big data in reforming education methods, promote education fairness, and improve education quality.

2 Quantitative Learning Behavior Analysis and Quantitative Classroom Teaching Behavior Analysis

Big data is having a wide-ranging impact on social production and life, and has also attracted the attention and attention of almost all important countries and organizations in the world, and has shown strong vitality and strong transformative power in industries other than education. To date, however, the education system has almost remained in the paradigm of ancient education, with managers still used to making decisions based on experience and inertia, and teachers relying primarily on personal experience to understand learners and implement teaching. If Confucius walked into today's classrooms, he might feel deja vu, and he could still guide learners in accordance with the philosophy of "teaching students according to their aptitude" that he advocated more than 2,000 years ago. This is a model of teaching that is driven entirely by personal experience, and is the way the vast majority of our classrooms are practising today. In this regard, Jobs also sighed before his death why information technology has changed almost all fields, but it is surprising that the impact on education is only small?

In the past, in the era dominated by the class teaching system, limited by the level of technological development, it was difficult to collect enough rich, detailed and objective data to characterize learners or assist teaching decision-making in classroom-based teaching activities. Today, with the popularization of emerging technologies represented by artificial intelligence (AI), blockchain (Block Chain), cloud computing (Cloud Computing) and big data (Data), as well as new technologies such as large-scale open online courses and flipped classrooms The impact of the new teaching mode, learners can finally completely get rid of the constraints of time and space, classrooms and schools are no longer the only place and preference for teaching activities to take place, tools such as online courses, e-books and computer-supported quizzes enable the tracking of the learning process and learning data. The collection of big data is no longer difficult, and the collection, processing and analysis technologies of big data have also matured, which is the creation of data-driven educational innovation and reform, the organic unity of educational scale and personalization, and the ultimate realization of people's pursuit of the ideal form of education in the future. condition.

In China, learning analysis has also aroused the research interest of many scholars. Li Yanyan and other scholars believe that learning analysis technology is a technology that records, tracks, and analyses the learning process of learners, predicts learner behaviour, evaluates learners' learning status and effects, continues to intervene in learning, and improves learners' learning performance. Scholars such as Gu Xiaoqing have redefined learning analysis, and believe that learning analysis is about the data related to the learner's learning information, using different analysis methods and data models to interpret the data, and exploring the learner's learning process according to the interpretation results. Situation, and discover learning rules; or build a learner's learning performance model based on data, and provide corresponding feedback to promote more effective learning.

As the first classroom teaching mode with thousands of years of development history, it is still an irreplaceable teaching form now and in the foreseeable future. Therefore, how to analyse the first classroom teaching mode and realize personalized learning based on the analysis results Specific applications such as diagnosis, learning path planning, personalized learning plan recommendation, teaching status visualization, and learning intervention have become the development direction and research focus and difficulty of quantitative learning analysis.

The project team focuses on the current blank areas of academic research and the areas that the industry urgently needs to make breakthroughs, and captures the postures of classroom students by using all-round high-definition video capture collectors, distributed pickups and other information-based means of the Smart Education Laboratory built by Xi'an Eurasia College., behaviour and psychological external manifestations, extract the factors that have causality, strong correlation and weak correlation to the teaching scene and behaviour, and conduct a full-process, all-round, fully automatic, and non-perceptual analysis of the first classroom teaching panorama. Information processing and analysis of causal and correlated factors. Using various technologies such as quantitative classroom teaching analysis based on attention analysis and quantitative classroom teaching analysis based on facial recognition, the high-definition video of classroom teaching is recognized frame by frame, and all participants participating in the classroom teaching process are identified. The level of investment in teaching and learning, and generate judgment models to provide benchmarks for further big data analysis.

3 Classroom Quantitative Results Analysis

According to the first three articles on quantitative analysis of classroom teaching, the smart education laboratory built by our school has adopted the quantitative analysis of classroom attention teaching based on stochastic cascade regression and PnP method to realize the visual display of learning attention. Using the quantitative analysis of facial expression recognition in classroom teaching based on FACS and KNN classification algorithm, using Gabor and ULBPHS feature fusion, after PCA + dimensionality reduction, the learning emotion judgment and output are realized. Using the quantitative analysis of teacher attention based on three-dimensional feature point coordinate transformation of face and viewpoint visualization, the intersection of the rays in the classroom coordinate system on the camera plane is calculated first, and then the mapping point coordinates of the intersection in the teacher's coordinate system are calculated. Finally, the viewpoint visualization in classroom teaching is realized. And analyze the data processing results.

From the facial expression area pictures of 64×64 pixels in the JAFFE expression library with exaggerated expressions, it can be seen from the data in the last column that our expression recognition algorithm can obtain very satisfactory expression effects, and the resolution is also The average recognition rate of 64×64 pixel facial expression area pictures can reach 96.67%. For the expression library we built, as shown in Tables 1 and 2, our expression recognition algorithm is difficult to obtain satisfactory expression effect, and the average recognition rate can only reach 79.00%. This shows that in the classroom teaching environment, the lighting, posture, resolution, expression intensity and other conditions of the students' faces are relatively poor. The facial expressions cut out is used in such an environment to build an expression library, and then the traditional feature-based expression recognition algorithm is used. However, limited by the poor feature extraction ability of the shallow processing network, it is difficult to use the traditional facial expression recognition algorithm to recognize the facial expression with high recognition rate in the classroom evaluation. Therefore, in the future, we will use deep learning technology with strong feature extraction ability to recognize the learned expressions to improve the expression recognition rate.

As shown in Fig. 1, we performed facial expression recognition on a certain student in a 15-min classroom video. The results of facial expression analysis showed that in the

Table 1. Expression recognition rate of KNN classification of JAFFE expression library K = 3 (%)

Emoji category	LBP features	ULBPHS(64blocks) features	Gabor features	LGBPHS features
anger	83.33	86.67	96.67	90.00
disgust	80.00	60.00	86.67	90.00
fear	73.33	76.67	90.00	100.00
Happy	80.00	93.33	100.00	100.00
nature	86.67	83.33	100.00	100.00
sad	46.67	76.67	96.67	96.67
surprise	76.67	90.00	100.00	100.00
average value	75.24	80.95	95.71	96.67

Table 2. Self-built library 64*64 K = 3 Euclidean distance-KNN classification expression recognition rate (%)

Emoji category	LBP features	ULBPHS (64blocks) features	Gabor features	LGBPHS features
distracted	55.00	55.00	65.00	67.50
puzzled	70.00	50.00	70.00	80.00
focus	50.00	70.00	82.50	72.50
surprise	50.00	55.00	77.50	82.50
pleasure	87.50	85.00	87.50	92.50
average value	62.50	63.00	76.50	79.00

first 4 to 5 min of classroom teaching, due to the concentration of the mind, for the teaching materials introduced by the teacher, the student showed a good learning expression, and the expression was mainly happy and focused; as the teacher taught new knowledge points, the student showed more confusion and distracted expressions, indicating that the student had difficulty in understanding. Within minutes, the teacher consolidates the teaching of the new knowledge point. The student's confused and distracted expressions are reduced, and more focused, surprised and happy expressions appear, indicating that the student has absorbed and mastered this knowledge point. Therefore, the learning expression analysis can evaluate the students' listening effect, that is, the use of expression recognition technology can automatically judge the students' listening effect in the classroom teaching process.

Through the above data analysis of the whole 15-min classroom teaching, the project team has initially achieved some results under the premise of incomplete data.

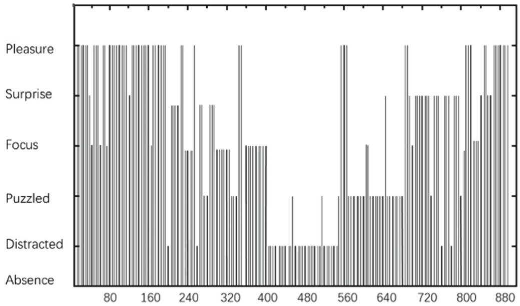

Fig. 1. Analysis results of a student's facial expression 15 min before class teaching

(1) Teachers should flexibly prefabricate some measures to accelerate the emotional involvement of students in the classroom, so as to improve the concentration of all students. For example, the use of pre-class questions, knowledge consolidation, classroom random questions and other means. During the course of the class, measures such as teacher-student interaction and other measures to ease the classroom mood should also be appropriately increased, so as to relieve the fatigue of the students in class and relieve the students' emotional disengagement before get out of class.

(2) The research results can conduct automatic, full-process, non-perceptual teaching effect evaluation for the classroom teaching process, and can assist teachers in decision-making on teaching strategies. If at a certain moment the students' emotional involvement, participation, attention and difficulty in the classroom all decrease, it means that the students' listening status needs to be adjusted in time. At the same time, teachers should be more vigilant, adjust teaching strategies in a timely manner, activate classroom atmosphere, improve teaching efficiency, and improve teaching effects.

(3) According to the data of individual students' classroom emotional involvement, combined with the progress of classroom teaching, highly targeted learning strategies can be provided for students with learning difficulties. Aiming at the basic learning ability of some students in our school, their study habits leading to the loss of most of their emotional input in classroom teaching is unconscious. Therefore, through the analysis of personal emotional data after class, it is possible to put forward personalized learning strategies and suggestions, change learning habits, optimize learning effect, and improve learning level.

4 Conclusions

In short, the quantitative analysis of facial expression recognition in classroom teaching can carry out real-time strategic intervention on the teaching and learning input in the classroom teaching process, and can implement teaching strategy optimization through auxiliary decision-making methods at any time, and at the same time, customize learning strategies for learners, improve learning difficulties, etc. It has obvious positive guiding significance for teachers and students. However, due to the extreme scarcity of current data, the analysis results do not have general statistical properties.

Acknowledgements. In this paper, the research was sponsored by the Social science fund of Shaanxi Province (Project No. 2019Q019), China Higher Education Association Special Project (Project No. 2020XXHYB13) and Shaanxi Provincial Department of Science and Technology Key R&D Program (Project No. 2022GY-317).

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