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Intelligent Learning Platform for Children with Autism: Enhancing Assessment, Training, and Information Management

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Abstract

This research presents an intelligent learning platform designed specifically for children with autism. The platform comprises a capacity evaluation system, a learning and training system, and an information management system. The capacity evaluation and learning systems are client-side components, while the information management system is hosted on either the internet or a local area network server. Data and information sharing between the capacity evaluation and learning systems is achieved through internal storage sharing or file modes, while the network service and information management system facilitate transmission and sharing across the platform. The intelligent learning platform offers scientific, personalized, and systematized services for children with autism, improving parental and specialist involvement and facilitating comprehensive capacity evaluation. By designing and adjusting learning targets based on evaluation results, the platform establishes tailored computer-assisted learning activities. Moreover, the platform enables the management of rehabilitation training records through an information-based approach, allowing convenient long-term tracking of the rehabilitation progress for children with autism.

Keywords: intelligent learning platform, autism, capacity evaluation system, learning and training system, information management system, personalized service, rehabilitation training, computer-assisted learning

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that affects a significant number of children worldwide. It is characterized by persistent deficits in social communication and interaction, as well as restricted and repetitive patterns of behavior, interests, or activities. Children with autism

often face unique challenges in learning and development, requiring specialized educational interventions to support their needs. In recent years, there has been a growing interest in utilizing intelligent learning platforms to enhance the educational experience for children with autism.[1]

The aim of this research is to develop an intelligent learning platform specifically designed for children with autism. This platform integrates various components, including a capacity evaluation system, a learning and training system, and an information management system, to provide scientific, personalized, and systematized services for these children. By leveraging technology and data-driven approaches, the platform seeks to improve the learning outcomes and overall well-being of children with autism.[2,3] The intelligent learning platform consists of three key components: the capacity evaluation system, the learning and training system, and the information management system. The capacity evaluation system plays a crucial role in assessing the cognitive, social, and emotional capacities of children with autism. Through a comprehensive evaluation process, it aims to provide a deeper understanding of each child's strengths and challenges. This evaluation serves as the foundation for designing personalized learning activities and interventions.[5]

The learning and training system within the platform is designed to address the unique needs of children with autism. It creates a tailored learning environment that offers targeted activities and interventions based on the evaluation results. Computer-assisted learning activities are implemented to improve various skills, such as communication, social interaction, and cognitive abilities.[6] These activities are designed to be engaging, interactive, and adaptive to the individual learning styles and preferences of each child.[7] The information management system serves as the backbone of the intelligent learning platform. It facilitates data and information sharing between the capacity evaluation system, learning and training system, and relevant stakeholders involved in the child's development. This centralized system ensures efficient storage, management, and accessibility of data related to the evaluation process and rehabilitation training records. It enables easy tracking of the child's progress over time and provides valuable insights for parents, specialists, and educators.[4]

One of the key advantages of the intelligent learning platform is its ability to provide personalized and systematized services for children with autism. By analyzing evaluation results and understanding the unique needs of each child, specific learning targets can be designed and adjusted purposefully. This personalized approach ensures that interventions are tailored to the individual abilities and challenges of each child, maximizing their learning potential.[8]

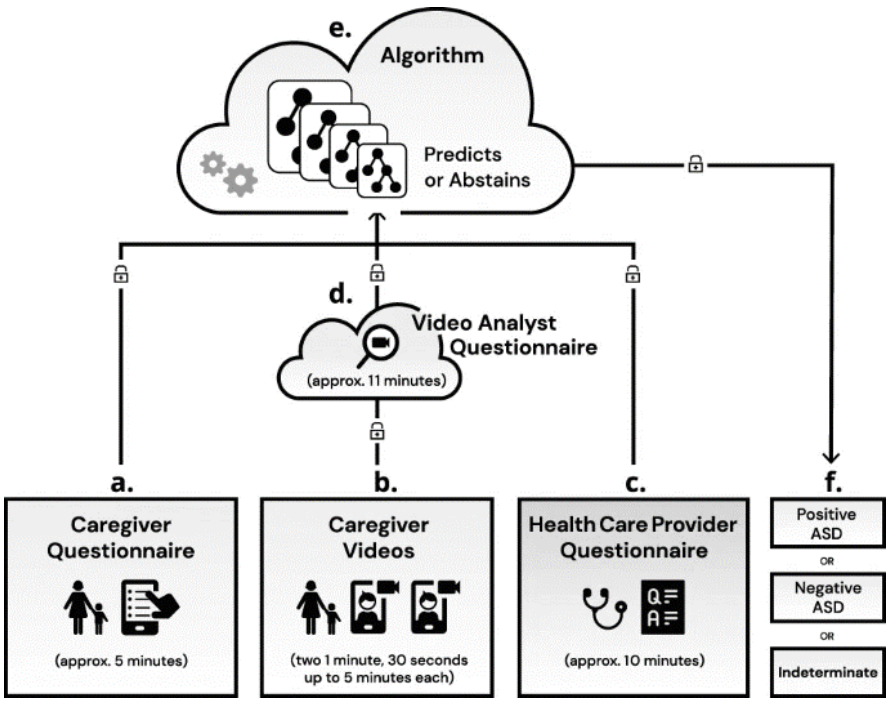
Furthermore, the platform enhances the collaboration and communication between parents, specialists, and educators involved in the child's development. It allows for seamless sharing of information, progress updates, and feedback, promoting a comprehensive and coordinated approach to support the child's educational journey. In conclusion, the development of an intelligent learning platform for children with autism holds great promise for improving their educational experiences and outcomes.

By integrating capacity evaluation, personalized learning activities, and information management, the platform aims to provide a comprehensive and effective solution for addressing the unique needs of children with autism.[2] Using technology and data-driven approaches, this platform has the potential to significantly enhance the learning process, facilitate parental and specialist involvement, and improve long-term tracking of rehabilitation progress. Ultimately, the intelligent learning platform seeks to empower children with autism and provide them with the necessary tools and support to thrive in their educational journey.

Related Work

Childhood autism, also known as autism spectrum disorder (ASD), is a neurodevelopmental disorder that typically manifests in the early stages of a child's life. It is characterized by difficulties in social interaction, communication, and repetitive behavior patterns. Research studies have shown that the prevalence of autism in children is between 0.04% to 0.15%. In China alone, the number of children affected by autism exceeds 800,000 and continues to rise.[2]

Fig. 1: Graphical representation of the Device and its major components.



The Device presents results indicating whether a subject is positive for ASD, negative for ASD, or falls under the category of "indeterminate" (as shown in **Figure 1**). An indeterminate output is generated when the Device's inputs lack the necessary level of detail for the algorithm to provide a highly conclusive outcome. This can occur when a patient exhibits an insufficient number or severity of features, making it challenging for the algorithm to confidently classify them as either ASD negative or ASD positive. The indeterminate output of the Device, also referred to as "abstention" or "no result" output in the literature, is a standard risk control method employed in machine-learning algorithms. In collaboration with the FDA, we established minimum thresholds for positive predictive value (PPV) and negative predictive value (NPV), which served as the primary endpoints for this pivotal study.[7] These threshold values (PPV > 65% and NPV > 85%) were utilized to define the acceptable range of outcomes during the hyperparameter tuning of the model.

Through the process of model hyperparameter tuning on training and testing data, we evaluated various combinations of PPV and NPV that met or exceeded the FDA thresholds, while considering variable abstention rates. Cross-validation was employed to maintain the minimum PPV and NPV requirements and determine the current Device abstention thresholds. The inclusion of abstention in cases with high clinical uncertainty acts as a safeguard against known failure modes in machine-learning, promotes transparency of the model to clinicians, and helps identify instances where additional human expertise or data may be necessary. In the primary care setting, particularly when dealing with neurodevelopmental disorders like ASD, where symptoms manifest along a spectrum and often overlap with multiple phenotypically similar conditions, it is expected that presentations will be ambiguous and complex.

Currently, there is no known cure for childhood autism, and drug treatments are not effective in addressing the core symptoms of the disorder. Long-term educational interventions are the primary approach used to help children with autism improve their functioning and quality of life. Early diagnosis and intervention before the age of 6 are crucial as it is considered the critical period for effective treatment. Developing an effective early intervention training platform for children with autism is a significant challenge in autism research.[8] Awareness and attention towards autism have grown significantly in recent years. The United Nations declared April 2nd as World Autism Awareness Day since 2008. Efforts have been made to establish specialized rehabilitation institutions for children with autism. However, the number of these institutions is still limited, and many children with autism miss out on timely intervention and the opportunity for optimal treatment. Furthermore, these institutions often face challenges such as a shortage of qualified teachers trained in autism education, limited teaching resources, and a lack of professional training mechanisms and tools, including home-based interventions.[3]

Recent studies have demonstrated the effectiveness of computer-aided learning (CAL) for children with autism. Due to difficulties in interpersonal communication, children with autism often find it easier to engage with electronic devices.[9] Computers provide a safe and controlled learning environment that is conducive to repetitive training, which is beneficial for the rehabilitation training of children with autism. By integrating expertise into an intelligent learning platform specifically designed for children with autism, the platform contributes to improving the capabilities of teachers in rehabilitation institutions and enables even families without professional training to carry out rehabilitation training at home to a certain extent. Although some software and systems for rehabilitation training of children with autism have been developed both domestically and internationally, most of them focus on games or learning activities. They do not consider the individual needs and varying abilities of each child with autism.

Moreover, these programs lack systematic planning and management of the rehabilitation progress of participating children. In response to the aforementioned challenges and gaps in existing approaches, the present invention aims to develop a scientifically grounded, personalized, and systematic intelligent learning platform for children with autism. This platform integrates capability comparison, learning training, and information management to provide comprehensive support. By focusing on early intervention, this invention plays a significant role in the treatment and support of a large number of children with autism.[10]

Research Objective

The main objective of this research is to develop an intelligent learning platform to support children with autism. Specific goals include:

1. Designing and implementing a capacity evaluation system: Develop an assessment system to evaluate the cognitive, social, and emotional capacities of children with autism, providing a comprehensive understanding of their strengths and challenges.
2. Creating a learning and training system: Design a personalized learning environment that offers targeted activities and interventions based on the evaluation results. Implement computer-assisted learning activities to improve various skills, such as communication, social interaction, and cognitive abilities.
3. Establishing an information management system: Develop a centralized system for managing and storing data related to the capacity evaluation and rehabilitation training records of children with autism. Enable easy access to historical data for long-term tracking and analysis.
4. Enabling data and information sharing: Implement efficient data and information sharing mechanisms between the capacity evaluation system, learning and training system, and

information management system. Facilitate collaboration and communication between parents, specialists, and educators involved in the child's development.

Intelligent Learning Platform for Children with Autism

The development of an intelligent learning platform for children with autism is aimed at providing a supportive and effective educational tool tailored to their specific needs. This platform consists of three essential components: the capability comparison system, the learning training system, and the information management system. The capability comparison system and learning training system are designed to work together on the child's device, such as a computer or tablet. They are directly accessible to the child and provide interactive learning experiences. On the other hand, the information management system is located on either the internet or a local server, acting as a centralized hub for storing and sharing data and information between the capability comparison and learning training systems. This data sharing can occur through internal memory or file transmission, ensuring that all relevant information is available to support the child's learning journey.

Within the learning training system, various modules play a vital role in assessing and monitoring the child's learning progress. The learning state detection module utilizes a camera and an expression recognition module to observe and interpret the child's facial expressions, providing insights into their engagement and understanding. The notice detection module helps identify when the child may need additional guidance or support during the learning process. Additionally, the eye tracking module tracks the child's eye movements, while the head pose estimation module analyzes their head position. These modules collectively contribute to a comprehensive understanding of the child's learning behaviors and preferences. The intelligent learning platform aims to provide a personalized and effective learning experience for children with autism. By utilizing advanced technologies and incorporating specialized modules, the platform can adapt to the unique abilities and requirements of each child. This adaptability enables the platform to tailor learning activities and interventions to address specific challenges and foster optimal learning outcomes.

Furthermore, the platform's information management system ensures that the child's learning progress and relevant data are organized and easily accessible. This centralized approach enables teachers, parents, and specialized professionals to stay informed and collaborate effectively. The system also allows for long-term tracking and monitoring of the child's rehabilitation progress, enabling continuous evaluation and adjustment of the learning targets and activities. In summary, the intelligent learning platform for children with autism aims to provide a scientifically grounded, personalized, and

systematic approach to their education. By combining various modules, data sharing mechanisms, and adaptive learning strategies, this platform facilitates early intervention, enhances parental involvement, and promotes effective rehabilitation training for children with autism.

Conclusion

The intelligent learning platform developed in this research offers a holistic approach to supporting children with autism. By integrating capacity evaluation, personalized learning, and information management, the platform provides scientific and systematized services tailored to the unique needs of each child. The platform enhances parental and specialist involvement, streamlines the evaluation process, and allows for long-term tracking of rehabilitation progress. With its computer-assisted learning activities and data-driven approach, the platform aims to improve the educational outcomes and overall well-being of children with autism.

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