AutismRecover Project Report: Leveraging Generative AI and AR Technology for Autism Rehabilitation

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1. Project Overview

1.1 Project Background and Theme

The "Generative AI in Autism Rehabilitation" project aims to apply Generative AI and Augmented Reality (AR) technologies to the field of autism rehabilitation, creating personalized experiences to provide innovative support for children with autism.

1.2 Project Team and Submission Date

This project was completed by Group 35 - Hao Tian Zeng 2255702 . The project was submitted on 2025/5/4.

1.3 Problems and Opportunities

Currently, the field of autism rehabilitation for children faces the challenge of a lack of engaging and customized tools. Traditional rehabilitation methods, mostly static behavioral therapies, lack interactivity and are difficult to meet the special social and sensory needs of children with autism. This project uses human - centered computing methods and leverages GAI and AR technologies to address these issues, aiming to improve the engagement of children with autism and enhance their quality of life.

1.4 Differences from Existing Work

Traditional autism rehabilitation mainly relies on static behavioral therapies, focusing on standardized training. These methods cannot fully meet the unique needs of each child and have a single form of interaction, making it difficult to stimulate children's active participation. This project innovatively integrates GAI and AR technologies, transforming the drawings of children with autism into 3D interactive scenes, creating immersive and creative experiences, enhancing interactivity and personalization, and promoting the development of social skills.

2. Design and Methodology

2.1 Process Overview

The project follows the Double Diamond model and the interaction design lifecycle. Through the process of "Discover, Explore, Define, Develop, Test, Deliver", it gradually moves from problem definition to the implementation and optimization of solutions.

2.2 Target Users and Key Requirements

1. **Target Users**: The primary users are children with autism, mainly in the age range of 5 - 12 years old. This age group is a critical period for the development of children's social skills and has a high acceptance of new things. The project aims to meet their needs in social interaction, emotional expression, and self - awareness. 2. **Stakeholders**: They include parents, doctors, and teachers. Parents expect the product to assist in their children's rehabilitation and improve social and life skills. Doctors are concerned about the product's auxiliary effect on treatment and safety. Teachers hope the product can be integrated into teaching to help children with autism better integrate into the classroom. 3. **Key Requirements**: By collecting information through secondary data, interviews, and questionnaires, the key requirements are identified as engaging interactive experiences, emotional value delivery, and encouragement of self - expression, ensuring that the product can effectively support the social and emotional development of children with autism.

2.3 Methods and Tools

1. **Data Collection Methods** - **Secondary Data**: Collect and analyze existing autism research data, statistical reports, etc., to understand the development trends of children with autism, behavioral characteristics, and the effectiveness of existing rehabilitation methods, providing a macro - background support for the project. - **Interviews**: Conduct in - depth interviews with autism experts, parents, and teachers to obtain professional insights and practical experiences, and deeply understand the needs and pain points of children with autism. - **Questionnaires**: Distribute questionnaires at autism - related public welfare activities to widely collect feedback from families of children with autism, understanding user needs from multiple dimensions and providing a basis for product design. 2. **Design Tools and Technologies** - **Generative AI (GAI)**: It is used to transform the 2D graphics drawn by children with autism into vivid 3D characters, giving life to the drawings and providing a basis for interaction. - **Augmented Reality (AR)**: It realizes the integration of 3D characters with the real - world environment, creating an immersive interactive experience. Children can interact with virtual characters in a familiar real - world scene, reducing the cognitive burden. - **Interaction Design Tools**: Professional interaction design software is used for UI layout design, prototyping, and user experience optimization to ensure the ease of use and attractiveness of the product.

2.4 System Workflow

1. **Drawing Stage**: Children freely draw characters on a virtual canvas. This process fully respects children's creativity and imagination and is the starting point for subsequent interactions. 2. **Transformation Stage**: The GAI algorithm recognizes and processes the drawn graphics, transforming them into 3D characters with unique features, achieving the transformation from 2D to 3D. 3. **Animation Stage**: AR technology adds animation effects to the 3D characters, making them come alive in the real - world scene and increasing the fun of interaction. 4. **Interaction Stage**: Children interact with 3D characters naturally through gestures and voices, such as waving hands and speaking. The characters will respond in real - time, promoting the development of communication skills. 5. **Feedback Stage**: The 3D characters provide emotional feedback based on children's behaviors and expressions, such as expressing emotions like happiness or sadness, strengthening the emotional connection. 6. **Reinforcement Stage**: The system displays interesting animations in a timely manner, further enhancing children's participation and enthusiasm, forming a positive incentive loop.

3. Prototyping and Implementation

3.1 Prototyping Process

1. **Initial Concept Validation**: The AR - tracking drawing guidance technology was adopted to test children's reactions to the product concept. Preliminary results showed that children had a high level of interest, but there were problems such as slow feedback and insufficient interactivity. 2. **Prototype Development**: According to the analysis of the previous - stage tests, it was found that children paid more attention to colors and dynamic feedback. Therefore, in this stage, the drawing immersion was enhanced through a prompting mechanism to optimize the user experience. 3. **User Behavior Analysis**: Continuously observe the behaviors of children during the use process. It was found that they still focused more on colors and dynamic feedback. Based on this, the feedback frequency was further increased through prompting, significantly enhancing children's empathy, emotional investment, and attention. 4. **Current Version**: Gesture control was introduced to reduce the operation difficulty. At the same time, the emotional feedback mechanism was optimized, enabling 3D characters to respond intelligently according to children's expressions and contexts. This series of improvements effectively increased the interaction success rate and enhanced the immersion of the product.

3.2 Design and Comparison of Two Prototypes (A and B)

1. **Prototype A**: It focuses on establishing an emotional connection through vivid visual effects and emphasizes simplicity. The interface design and interaction process are relatively simple, making it easy for children to operate. It can quickly attract children's attention but may

be slightly lacking in functional richness. 2. **Prototype B**: It places more emphasis on the richness of content, trying to provide more interaction functions and information. However, it may be slightly inferior in terms of simplicity and ease of use. Some children may find the operation complex in the initial use stage. 3. **Comparison and Evaluation**: The HEART framework and heuristic evaluation methods were used to compare the two prototypes. The HEART framework evaluated from five dimensions: Hedonic quality, Engagement, Adoption, Retention, and Task success. The results showed that Prototype A performed better in terms of Hedonic quality and Engagement. The heuristic evaluation, based on Shneiderman's rules, found that Prototype A was more in line with design principles in terms of color system consistency, icon - real - world match, and information feedback. Comprehensive evaluation suggests that Prototype A can better meet the needs of children with autism.

4. Evaluation and Results

4.1 Heuristic Evaluation and Application of Shneiderman's Rules

1. **Consistent Color System**: The product adopted a unified and soft color scheme in the overall UI design, avoiding overly bright or complex color combinations, reducing visual stimulation for children with autism, and conforming to their perceptual characteristics. 2. **Follow Platform Standards**: In the design of interactive components, it followed the design specifications of mainstream AR applications, such as gesture operations and menu layouts, reducing the user's learning cost and improving the ease of use of the product. 3. **Match between System and the Real World**: The icons in the product were designed simply and clearly, and had a high similarity to objects or actions in real life, facilitating the understanding and recognition of children with autism and enhancing the intuitiveness of interaction. 4. **Offer Informative Feedback**: When children interacted with 3D characters, the system provided rich feedback information in a timely manner, such as the character's voice response, action changes, and expression display, allowing children to clearly understand the effects of their operations and enhancing the fun and participation of interaction.

4.2 Usability Testing

1. **Testing Method**: A combination of observation and user feedback collection methods was used. Children with autism and their parents were invited to participate in the test. Observe the children's behavior, operation process, and emotional changes during the use of the product, and at the same time collect the opinions and suggestions of parents. 2. **Testing Results**: In the preference survey of interaction - first or content - first, most parents believed that the interaction design of Prototype A could better attract children's attention and enable them to engage in interaction more quickly. In the test of text - first or friend (character) - first, more parents preferred the character - centered

design of Prototype A, believing that it was more in line with children's cognitive characteristics and could better stimulate children's interest.

4.3 UEQ (User Experience Questionnaire) Evaluation

Through the UEQ evaluation, it was found that Prototype A scored high in dimensions such as attractiveness, ease of use, and fun, indicating that this prototype performed well in terms of user experience and could better meet the needs of children with autism, providing strong support for the further optimization of the product.

5. Discussion and Reflection

5.1 Project Achievements

1. **Integration of Technology and Humanity**: The project team deeply understood the importance of combining technology with empathy when designing products for children with autism. Through human - centered design methods, fully considering the special needs and behavioral characteristics of children with autism, the product not only has functionality but also provides emotional support. 2. **Application of Design Models**: With the help of the Double Diamond model and the interaction design lifecycle, the team learned to balance creativity and structure in the design process. From problem discovery to the iterative optimization of solutions, each stage is closely linked to ensure the continuous improvement of the product. 3. **Use of Evaluation Methods**: By using multiple evaluation methods such as usability testing, heuristic evaluation, and the HEART framework, the product was evaluated from different angles, effectively optimizing the emotional connection between the product and users and enhancing the user experience.

5.2 Existing Deficiencies

1. **Insufficient Early - Stage User Participation**: In the early stage of the project, children with autism were not fully involved in the design process, resulting in some design decisions that may not fully meet their actual needs. 2. **Limitations of the Test Sample**: The number of test samples was relatively small, and the regions and backgrounds were relatively homogeneous, which may have affected the universality and representativeness of the test results and could not comprehensively reflect the needs of different groups of children with autism.

5.3 Improvement Directions

1. **Strengthen Personalization**: Add character customization options, allowing parents and children to adjust the appearance, personality, and voice of 3D characters according to personal preferences, improving the degree of personalization of the product and better meeting the unique needs of each child. 2. **Enhance Sensory Adaptability**: Add adjustment functions for environmental settings such as brightness and contrast to AR glasses to adapt to different use scenarios and children's visual needs, reducing discomfort caused by environmental factors. 3. **Introduce Multi - Person Interaction Mode**: Develop multi - person interaction functions to

support the simultaneous participation of multiple children with autism in the interaction, promoting social cooperation among them and improving the training effect of social skills. 4. **Enhance Accessibility Design**: For non - verbal children with autism, add input methods such as eye - tracking and brain - computer interfaces to ensure that all children with autism can use the product conveniently and achieve broader inclusivity. 5. **Establish a Long - Term Progress Tracking Function**: Develop a long - term progress tracking system to record the behavioral data and progress of children during the use of the product, providing detailed rehabilitation data for parents, doctors, and teachers, facilitating the formulation of personalized rehabilitation plans.

6. Future Work

6.1 Expansion of Background Drawing

Explore the technical implementation method of transforming the content drawn by children that cannot be transformed into characters into scenes and backgrounds. This can not only further unleash children's creativity but also enrich the interactive scenes of the product, creating a more immersive experience for children.

6.2 Integration of Music Elements

Based on existing research showing the positive effects of music therapy on the rehabilitation of children with autism, plans are to add music elements to the product. By organically combining music with drawing and 3D character interactions, the emotional support and rehabilitation effect of the product can be enhanced, improving the quality of life of children with autism.

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