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## INNOVATIVE VISUALIZATION TECHNIQUES IN DESIGNING CHILDREN'S 3D POP-UP BOOKS

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*The integration of advanced visualization technologies, such as augmented reality (AR), virtual reality (VR), and 3D printing, into children's 3D pop-up books has been investigated. The introduction of these technologies has opened up new avenues for engaging users and enriching the educational experience, particularly in the field of children's literature. Combining these technologies with traditional mechanisms of pop-up books makes it possible to create an immersive and interactive reading experience for young audiences. The introduction of visualization technologies into 3D pop-up books attracts children, which leads to improved learning outcomes and the development of imagination.*

**Key words:** Children's books, 3D pop-up books, Visualization technologies, Augmented reality (AR), Virtual reality (VR), 3D printing.

### INTRODUCTION

Children's books have traditionally served as pivotal tools for literacy development, cognitive stimulation, and emotional growth. As technology advances, the format and functionality of these books are evolving, incorporating digital elements to create more engaging and interactive experiences. Among these innovations, 3D pop-up books stand out for their ability to combine the tactility of physical books with the dynamic visual appeal of digital media. Traditional pop-up books, known for their intricate paper engineering, have long captivated children with their three-dimensional scenes. However, the integration of visualization technologies such as AR, VR, and 3D printing offers opportunities to enhance these experiences further.

### PURPOSE

The aim of the work is to analyze the limitations of traditional children's books in terms of visual presentation and interactivity and to explore innovative visualization techniques in the design of children's 3D pop-up books.

### RESULTS AND DISCUSSION

The 3D pop-up books are a hybrid of traditional book formats and modern technological innovations. They integrate traditional books with modern technology, employing design methods and skilled craftsmanship to present illustrations in three-dimensional visual effects, offering readers a novel reading experience. This books format attracts a wide range of readers due to its visual appeal and fosters



their imagination and creativity, thereby substantially increasing their interest in and engagement with reading [1].

Book visual design, as an important component of modern book binding art, is gradually attracting more and more attention from designers and readers. By presenting complex information in an intuitive and vivid way, book visual design not only enhances the visual effect of books but also greatly improves the reading experience of readers. Unique visual design makes books more attractive in appearance and adds cultural connotations and artistic value to books. This helps to enhance the market competitiveness of books and attract more readers' attention and purchase. The application of visualization technology in children's 3D folding books has brought great changes to children's reading experience. The integration of this technology not only improves the interest and interaction of books, but also greatly enriches the way children acquire knowledge and promotes the cognitive development of children.

3D modeling and rendering technology is one of the important applications of visualization technology in children's 3D fold-out books. Through 3D modeling software, designers can create realistic 3D models and scenes, providing children with a more vivid and graphic reading experience. Meanwhile, rendering technology can also process the models with lighting, materials, and textures, making them more realistic and detailed.

Augmented Reality (AR) technology is a technology that combines virtual information with the real world. In children's 3D fold-out books, AR technology can be used to add virtual interactive elements and animation effects. When children use specific AR devices to scan the books, they can see virtual scenes and animation effects related to the book content on the screen. This immersive reading experience not only attracts children's attention but also helps them better understand the book content and improve learning effectiveness [2].

Virtual Reality (VR) technology is a computer simulation system that can create and experience virtual worlds. Although the application of VR technology in children's 3D fold-out books is relatively rare, its potential cannot be ignored. Through VR technology, children can enter the world depicted in the books in a realistic way, interact with virtual characters, and explore unknown domains. This new reading experience not only stimulates children's curiosity and desire for exploration but also cultivates their spatial cognition ability and logical thinking ability.

By integrating innovative design with visualization technology, children's 3D fold-out books have demonstrated significant advantages in enhancing reading experience and educational value. Improving educational effectiveness, children's 3D fold-out books not only focus on form innovation but also delve deeply into the content. By combining visualization technology, designers can present scientific knowledge, historical stories, etc. to children in a more vivid and graphic way, helping them better understand and remember the learned content. For example, when children encounter difficult knowledge points, they can watch related explanatory videos or animations through AR technology; when children are interested in a certain topic, they can deeply understand the relevant content



through the flip page form. This personalized learning method improves children's learning efficiency and interest.

Promoting parent-child interaction, the interactive design of children's 3D fold-out books also provides more possibilities for parent-child reading. Parents and children can explore the three-dimensional scenes and characters in the books together, complete tasks and challenges together, thereby enhancing the emotional communication and interaction between parents and children. During parent-child reading, parents and children can share their feelings and thoughts, enhancing emotional communication and companionship. This emotional communication and companionship is of great significance for children's growth and development, helping them build confidence, enhance security, and cultivate good interpersonal relationships [2].

Through folded structures and interactive element design, as well as realistic three-dimensional scenes and characters, the children's 3D pop-up books have greatly enhanced the reading interest. The children's 3D pop-up books adopt a unique folding structure. As shown in Fig. 1, the pop-up books and flip pages as demonstrated in "The City of Mountains" Pop-Up Book Project enable the contents in the books to be presented three-dimensionally before the children. This novel form immediately attracts the children's attention and stimulates their curiosity and desire for exploration.



**Fig. 1.** "The City of Mountains", Pop-Up Book Project

To sum up, 3D pop-up books combine the essence of traditional books with modern technological innovations. Through unique design concepts and significant advantages, they bring revolutionary changes in the field of reading. Their visual



design enhances the reading experience and integrates visualization technologies such as 3D modeling, rendering technology, augmented reality (AR), and virtual reality (VR), greatly enriching children's reading experience and educational value. Not only does it improve educational effectiveness, but it also promotes parent-child interaction and enhances children's reading interest and exploration desire.

### **CONCLUSIONS**

The combination of traditional books with modern scientific and technological innovations to create 3D pop-up books was analyzed. It was found that by using advanced visualization technologies such as 3D modeling, visualization, augmented reality (AR) and virtual reality (VR), the design of 3D pop-up books changes the way children interact with and interact with reading materials. It was determined that the use of AR and VR technologies allows designers to add interactive elements to books, making them more attractive and effective learning tools.

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### **ІННОВАЦІЙНІ ТЕХНІКИ ВІЗУАЛІЗАЦІЇ В ДИЗАЙНІ ДИТЯЧИХ 3D ПОР-АП КНИГ**

Досліджено інтеграцію передових технологій візуалізації, таких як доповнена реальність (AR), віртуальна реальність (VR) і 3D-друк, у дитячі 3D пор-ап книги (книжки-«розкладанки»). Впровадження цих технологій відкрило нові шляхи для залучення користувачів і збагачення освітнього досвіду, зокрема у сфері дитячої літератури. Поєднання цих технологій з традиційними механізмами книжок-«розкладанок» дає можливість створити захоплюючий та інтерактивний досвід читання для молодшої аудиторії. Впровадження технологій візуалізації в 3D-спливаючі книжки приваблює дітей, що призводить до покращення результатів навчання та розвитку уваги.

**Ключові слова:** дитячі книги, 3D пор-ап книги, технології візуалізації, доповнена реальність (AR), віртуальна реальність (VR), 3D друк.