Implementation of holographic displays to increase realism in virtual reality through 3D images that simulate being in the environment

Implementación de pantallas holográficas para aumentar el realismo en la realidad virtual a través de imágenes 3D que simulan estar en el entorno

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Keywords

Virtual reality; holography; 3D images; displays; innovation.

Abstract

This paper presents a study on the use of holographic displays in virtual reality. It highlights the significant advances that virtual reality has experienced in recent years and emphasizes the importance of improving realism in the immersive experience. The potential of holographic displays to enhance the quality of virtual reality by generating 3D images that resemble real physical objects is discussed. The current limitations of electro holographic recording due to the pixelated structures used are mentioned. A model for generating digital holograms using holographic displays is described, based on image superposition techniques and convolution with a point spread function. It is concluded that holographic displays have the potential to revolutionize virtual reality by providing high-quality 3D images and increased interactivity.

Palabras clave

Realidad virtual; holografía; imágenes 3D; pantallas; innovación .

Resumen

Este artículo presenta un estudio sobre el uso de pantallas holográficas en la realidad virtual. Se destacan los avances significativos que ha experimentado la realidad virtual en los últimos años y se enfatiza en la importancia de mejorar el realismo en la experiencia de inmersión. Se discute el potencial de las pantallas holográficas para elevar la calidad de la realidad virtual al generar imágenes 3D que parecen objetos físicos reales. Se mencionan las limitaciones actuales de la grabación electro holográfica debido a las estructuras pixeladas utilizadas. Se describe un modelo de generación de hologramas digitales utilizando pantallas holográficas, basado en técnicas de superposición de imágenes y convolución con una función de punto de propagación. Se concluye que las pantallas holográficas tienen el potencial de revolucionar la realidad virtual al brindar imágenes 3D de alta calidad y mayor interactividad.

Introduction

Virtual reality (VR) has been a constantly evolving technology in recent years and has had a great impact on different fields, such as education, industry, entertainment, and health [1]. Despite technological advances, one of the main challenges in VR has been to increase realism in the immersive experience in virtual environments.

Holographic displays are one of the most promising technologies to enhance the virtual reality experience. Unlike traditional flat screens, which display 2D images, holographic displays are capable of generating 3D images that appear to float in the air, as if they were real physical objects. This means that users can move around the images and view them from different angles, increasing the sense of presence and realism in the virtual environment.

Conventional holographic displays are capable of providing full parallax viewing and excellent resolution on the order of thousands of lines/mm. However, the electro-holographic recording has not yet achieved this same resolution due to the limitations of the pixel structures used in this process. These structures are not small enough compared to the wavelength of visible monochromatic light, which limits the number of possible viewing angles. Fortunately, recent advances in high-efficiency liquid crystal devices have provided new tools and possibilities

for electro holographic reconstruction from digital holograms. Several approaches for electro-holographic reconstruction have been reported, with holographic reconstruction using liquid crystal devices as one of the most common methods. [2]

The implementation of holographic displays in virtual reality is still at an early stage, but this technology is expected to advance rapidly in the coming years. With high-resolution, wide field-of-view holographic displays, users will be able to experience more realistic and immersive virtual environments than ever before. In addition, holographic technology is also expected to be used in other fields, such as advertising, medicine, and education.

In this poster, we will explore the implementation of a model similar to that proposed by Xing Yang, HongBo Zhan, and Qiong-Hua Wang.[3] for digital hologram generation using a computational technique of superposition of images projected on a single projection screen, convolved with a point spread function (PSF) to generate the complex amplitude in the holographic plane. However, instead of using a conventional projection screen, a holographic screen is used to generate 3D images that appear to float in the air, as if they were real physical objects.

Materials and methods

In this poster, we will explore the implementation of a model similar to that proposed by Xing Yang, HongBo Zhan, and Qiong-Hua Wang.[3] for digital hologram generation using a computational technique of superposition of images projected on a single projection screen, convolved with a point spread function (PSF) to generate the complex amplitude in the holographic plane. However, instead of using a conventional projection screen, a holographic screen is used to generate 3D images that appear to float in the air, as if they were real physical objects.

Experimental configuration

The experiment will be conducted in a laboratory environment specifically designed for virtual reality research. The experimental setup will consist of a VR room that will provide an immersive space and allow free movement of the user.

The central component of the display system in the VR room will be a high-resolution LEDS-illuminated holographic display placed around the user to generate holograms within the viewing area. As in the experiment of Xing Yang, HongBo Zhan, and Qiong-Hua Wang it is necessary to use two or more holographic displays that function as projection planes to capture the projected rays from the 3D points and form the images according to the required projection angle according to the user's position.

In addition to the holographic display, other devices will be used. A position tracking system as used in the Valve Index will be implemented to track the user's movements in real-time and provide accurate information about the user's location in the virtual space. An eye-tracking system is employed to capture the user's eye movements and enable intuitive interactions with the holograms.

Hologram generation

Hologram generation will be based on a holographic calculation process that consists of the calculation of the complex amplitude distribution in the holographic displays through the convolution of each projected image and its Point Distribution Function (PSF). This step is fundamental to achieving the generation of holograms in real-time. For this step, the model proposed in the experiment of Xing Yang, HongBo Zhan, and Qiong-Hua Wang could be used.

The 3D object used in the experiment will be a virtual representation of an interactive VR environment. Advanced 3D modeling and rendering techniques will be used to create virtual objects and realistic scenes. These projected images will be combined on the holographic plane to form three-dimensional holograms. Accurate and synchronized generation of these images would be essential to achieve a consistent and high-quality holographic representation.

Real-time interaction and visualization

Custom visualization software will be developed to enable real-time interaction and visualization of the generated holograms. The software will be integrated with the position tracking system and eye tracking system to update the holograms according to the user's movements and gaze direction.

Real-time rendering techniques will be implemented to improve the visual quality of the holograms and provide an immersive experience. Lighting, shading, and reflection effects will be used to simulate the interaction of light with virtual objects in the virtual reality environment.

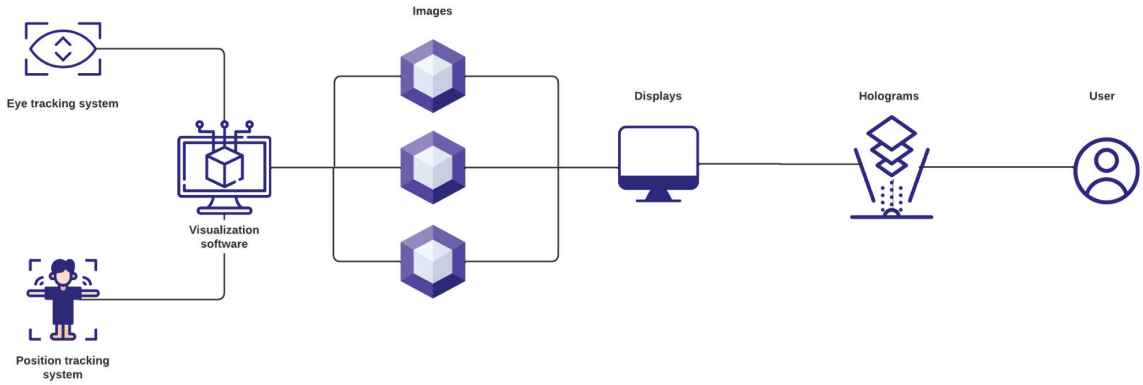

Figure 1. System concept diagram.

System evaluation

Evaluation of the holographic visualization system in the virtual reality room will be conducted in a comprehensive manner to gain a full understanding of its performance and quality. To this end, participants with different levels of virtual reality experience will be recruited to perform specific tasks within the holographic environment and provide feedback on various aspects of the system.

During the evaluations, objective and subjective data will be collected to obtain a complete and accurate assessment. In terms of objective data, performance metrics such as participants' response times in performing specific tasks and eye-tracking accuracy while interacting with the holograms will be recorded. These metrics will provide quantitative information on the efficiency and accuracy of the visualization system.

In addition to objective data, qualitative methods will be used to collect subjective information about the usability, sense of presence, and depth perception of the generated holograms. Questionnaires, interviews, and subjective evaluation scales will be used for participants to express their opinions, sensations, and experiences with the holographic system. This subjective data will be valuable in understanding user satisfaction, immersion in the virtual environment, and the perceived quality of the holograms.

The comprehensive evaluation of the system will identify strengths, weaknesses, and areas for improvement. The data collected during the evaluations will be analyzed and used to make adjustments and optimizations to the holographic display system based on the results and recommendations. The ultimate goal is to improve the visual quality, interaction, and immersive experience in the virtual reality room with the holographic display.

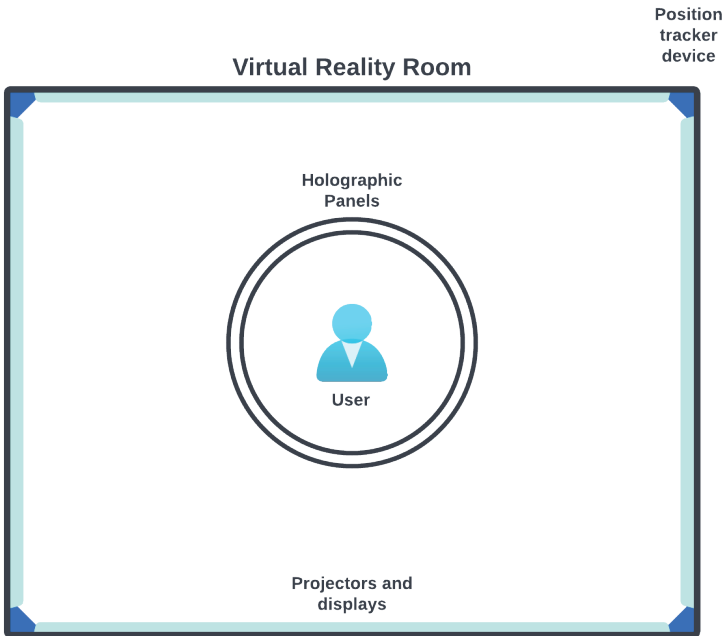

Figure 2. Sketch of the VR room using the holographic system.

Results and discussion

Currently, the project is in its initial phase and the results we expect to see in our system are the real-time values of the system in operation.

Conclusions

The integration of the holographic visualization system in virtual reality rooms can have a substantial technological impact by enabling the generation and projection of holograms within the viewing area. This not only enriches the immersive experience for users but also opens up new possibilities for interaction with the virtual environment. By combining key aspects such as real-time hologram generation and high-quality visualization, the system aims to deliver a realistic and convincing holographic experience. In addition, the comprehensive evaluation of the system through objective and subjective data will provide valuable information to improve visual quality, interaction, and immersion in future implementations, which could further boost the development of holographic technologies in the field of virtual reality.

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Introduction

Virtual reality (VR) has significantly impacted various industries by providing immersive experiences. However, enhancing realism in virtual environments remains a key challenge. This research focuses on holographic displays as a potential solution to overcome this limitation. Holographic displays generate 3D images that appear as if they were real physical objects floating in space, offering a more engaging and realistic experience for users.

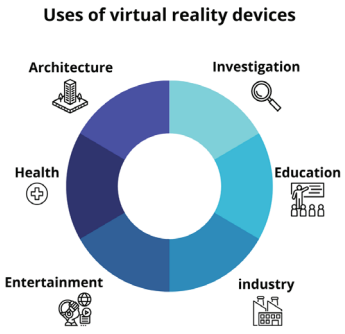

Fig 1. Virtual Reality Devices Applications – Own authory

Materials and Methods

The model is implemented to generate digital holograms using a holographic display in a virtual reality environment. The process involves calculating the complex amplitude distribution in holographic displays by convolving projected images with their Point Distribution Function (PSF). A 3D virtual representation and advanced modeling and rendering techniques are used to create realistic three-dimensional holograms. Real-time interaction and visualization are achieved through customized software and position tracking and eye-tracking systems. In addition, a comprehensive evaluation of the system is conducted in the virtual reality room, collecting objective and subjective data to assess its performance, usability, sense of presence and depth perception.

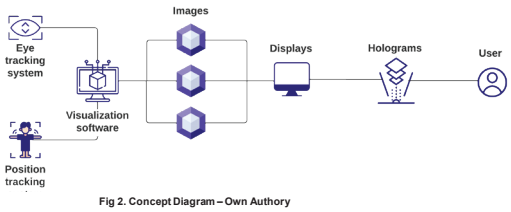

Fig 2. Concept Diagram – Own Authory

The results of the evaluation are used to identify areas for improvement and adjustments and optimizations are made to the holographic visualization system. The main objective of this study is to improve the visual quality, interaction and immersive experience in the virtual reality room through the use of the holographic display. It seeks to provide a more realistic and immersive virtual environment for users, taking advantage of the capabilities of holographic technology and real-time rendering techniques.

Discussion

Currently, the project is in its initial phase and the results we expect to see in our system are the real-time values of the system in operation.

Conclusions

The integration of the holographic visualization system in virtual reality rooms can have a substantial technological impact by enabling the generation and projection of holograms within the viewing area. This not only enriches the immersive experience for users but also opens new possibilities for interaction with the virtual environment. By combining key aspects such as real-time hologram generation and high-quality visualization, the system aims to deliver a realistic and convincing holographic experience. In addition, the comprehensive evaluation of the system through objective and subjective data will provide valuable information to improve visual quality, interaction, and immersion in future implementations, which could further boost the development of holographic technologies in the field of virtual reality.

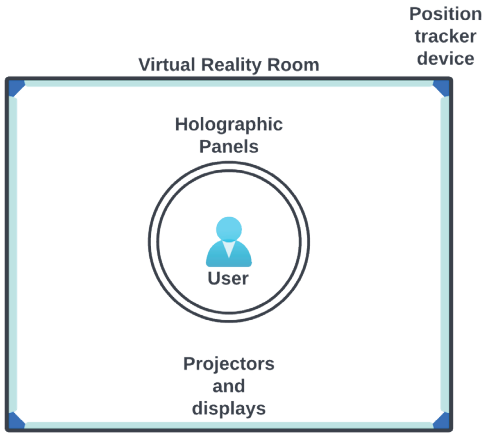

Fig 3. Design Diagram – Own Authory