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The Application of Interactive Design Technology in Digital Intelligent Exhibition Display

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Abstract. Enhancing the exhibition hall's display effect with contemporary digital technology can effectively improve the impact of cultural publicity. Still, in light of AI's advancements and the expanding applications of AI in human-facing fields, further research and creativity are required. Interactive design technologies have greatly influenced exhibition displays in various streams, including technological innovations, art, and more. Better pattern recognition, for instance, has opened up new possibilities and put pressure on developers to incorporate face, object, speech, and language recognition into applications. This article proposed a virtual reality (VR) and augmented reality (AR) based 3D digital exhibition display concept for a museum to raise the standard of cultural and historical propaganda. The article suggests a Polygon Mixed Reality (PMR) technology for VR and AR-based 3D Modeling (IVAR3M) in digital exhibition displays by combining VR and AR 3D modeling using interactive design technology. The technology is capable of digital museum management and clear object display in two- and three-dimensional settings. The model shows that integrating IVR3M within the showroom experience appeals to most customers. Integrating IVR3M with the museum's dynamic picture display is crucial. According to the study's findings, an intelligent digital exhibition display incorporates user satisfaction (80%), information acquisition (72%), and visitor engagement (88%).

Keywords: Human-AI interaction, digital exhibition display, Interactive VR and AR-based 3D modeling, Polygon Mixed Reality technology, visitor engagement, information acquisition, user satisfaction.
DOI: https://doi.org/10.14733/cadaps.2024.S28.296-308

1 INTRODUCTION

The multidisciplinary design field of interaction design concerns how people engage with digital systems, goods, or interfaces. It entails creating user interfaces and experiences for products to make them simple and effective. The method of giving HCI a human-like feel is called interaction design. Interactive digital goods establish this "human" connection by providing users with feedback. The technology known as VR uses computers to generate a three-dimensional, simulated environment that the user may experience up close and personal. Utilizing the user's auditory, visual, and other senses, virtual reality (VR) produces an immersive experience that feels much like the actual world. Virtual reality (VR) is distinguished by its capacity to offer a deep sense of "presence" and "immersion." An advancement of VR called AR technology uses computer vision and other technologies to blend virtual items into the real world. Augmented reality (AR) aims to improve the user's perspective of the real world by fusing virtual and physical aspects. Immersion Museum narrative is greatly enhanced by VR experiences. VR exhibits may layer museum collections, put things in context, make them interactive, and show their entire magnitude. Augmented reality (AR) overlays visuals using a headset, eyewear, phone, or tablet.

The design can entail enhancing paintings with effects, animating historical situations, gamifying exhibitions, superimposing kid-friendly activities over adult displays, and more in a museum context. The public's life is intimately tied to these technology applications. Many industries, including graphics, gaming, engineering, construction, and medical, heavily rely on 3D modeling. Nevertheless, 3D modeling continues to grow more important for Interactive and fully immersive technology such as VR and augmented reality AR. For their future, people must be familiar with the knowledge and abilities of the smart industry.

Nevertheless, since they are too professional, the public cannot readily understand the sophisticated technological phrases and their content using traditional teaching methods. One barrier to disseminating technological and scientific knowledge is the unintelligible content of the smart industry. Developers may now incorporate a range of AI features into user-facing systems thanks to advancements in AI. For instance, there is demand and opportunity to incorporate face recognition, object identification, speech recognition, and translation into applications due to improvements in pattern recognition accuracy. However, because automated inferences are usually carried out imprecisely and frequently result in false positives and false negatives, AI-infused devices might exhibit erratic behaviors that are upsetting, perplexing, unpleasant, or even deadly [1].

Virtual reality (VR) is one of the best tools for giving visitors an interactive and immersive experience with museum exhibitions [7]. Using the four pillars of the experience economy as a guide, let's pretend that absorptive experiences have an effect on immersive experiences, full VR tour experiences at museums, and museum-goers' intentions to visit. These results show how film festival goers' escape experiences are impacted by entertainment, education, and aesthetics. The requirements for preserving and protecting cultural heritage are met by a variety of low-carbon technologies, such as new energy, energy conservation, and information technologies like the Internet of Things [5]. In order to arrive at a detailed conclusion, the data from each sensor will be properly scrutinized and evaluated. Temperature, humidity, focus, pressure, location, velocity, and illumination are only some of the physical attributes that the Internet of Things is able to observe [9]. A number of design elements can be used to bolster the construction of museum information rooms that merge the digital and physical realms. Using case studies of exhibition projects, the research suggested a conceptual tool for integrating various design aspects articulated by relevant areas at various design levels, from the high-level, overarching level of user experience design to the lower-level, more granular level of interface design, information architecture, and interaction design.

The main contributions of the research are,

- To propose an IVAR3M modeling to design intelligent digital exhibition displays.
- Implementing the PMR approach enables the digital management of museums and the clear display of objects in both 2D and 3D spaces.
- To show an intelligent digital exhibition that includes visitor engagement, knowledge acquisition, and user satisfaction.

Section 2 covers previous research evaluations, Section 3 the proposed approach, Section 4 the experimental results, and Section 5 the conclusion and future work. These parts comprise the IVR3M technology research.

2 LITERATURE REVIEW

Manqi Ali Khan et al. [6] observed an AR-assisted mobile integration used in Deep Learning to identify artifacts instantly and obtain multimedia files that are helpful to the users. Convolution neural networks (CNN) were used to identify objects and accurately give the user exact material. The proposed application's relevance is related with outmoded human-guided or unrestricted customer tours using a user-centered questionnaire-based survey. The suggested framework's score shows that it is more significant and beneficial than the conventional approach in fostering greater emotional connection, meaningful experiences, and better engagement with artifacts. The proposed method's usability scores and the knowledge and learning it offers visitors that are on the cusp of relevance compared to the conventional technique are among its shortcomings.

Kai Cao and Mi Huang [2] proposed the university history museum's exhibition space design should be built on the institution's history and culture. It should also be constructed to effectively represent and showcase the institution's cultural and historical significance. At the same time, the University History Museum must keep up with modern trends, incorporate digital technology into the layout of its exhibit space, provide a wider variety of exhibition formats, fully exploit the cultural significance of the University History Museum, and maximize its worth. This article discusses university history museum display design strategies using digital technology. Huiru Wang [12] established digital virtual display methods to determine that museum visitors tend to evaluate modern information technology in museums positively using one-on-one and semi-structured interviews. This study analyzes data to evaluate if visitors can use modern information technology in the museum and if it will improve their experience.

The paper is evident that most people see the employment of visual display technologies in museums favorably. The disadvantage appears to be that some of them imply that new, high-tech applications in museums have higher standards for technology, meaning that cognition is the primary factor affecting the visitor's attitude. Zhen Guo [3] developed a digital display for museums that uses virtual reality and multimedia technologies to increase information about the museum's exhibits and display space. The museum allows the presentation to be multi-dimensional and interactive while meeting the collection's details. Photographic, 3-D laser scanning, modeling, and virtual reality technologies are used extensively in digital display technology. Digital displays produce richer, more realistic details of cultural artifacts or collections, intensifying their sensory effect. The study's shortcoming is that the idea of a real-world workplace was not adequately explained.

Using virtual reality, Wenru Zhao [13] investigated the layout of film museum exhibitions. This article proposed a system that combines virtual reality (VR) with 3D modeling and human-computer interaction (HCI). Virtual reality relies heavily on these two technologies. Artifacts can be displayed in two and three dimensions in digitally operated museums. Of the 80 people who took part in the study, The results showed 40% were highly satisfied with the Chengde Mountain Resort Museum display hall.

On the other hand, 35% were only moderately satisfied. The incorporation of virtual reality technology into the showroom experience is highly attractive to the majority of buyers. As a result, it is essential that the museum incorporate VR technology into its dynamic visual presentation. In their study. The goal was to consider digital technology's role in a smart museum's spatial design and to investigate AI's possible uses in a museum environment. The study sought practical ways to optimize the smart museum's utility while also providing suggestions for improving its spatial architecture. To achieve these objectives, the study used the data heterogeneous network algorithm with the information decision tree approach. The requirements of the digital museum were determined and a blueprint for the smart museum's data distribution architecture was constructed using these techniques. One limitation of this research is that it doesn't take into account how new technologies can change the way exhibitions are presented. The augmented reality technique put out by Wangming Hu et al. [4] enables the digitization and integration of museum information into the user's actual physical surroundings. Additionally, the article suggests blockchain technology as a means to enhance the security of cultural artifact data in digital museums and to hasten the recovery of lost information about such artifacts. Research in this area contrasted the ways in which digital and conventional museums make use of blockchain technology and augmented reality. By combining blockchain with augmented reality, their trial proved that the digital museum significantly increased user engagement. The research may not have been comprehensive enough since it solely considered the impacts on young and elderly people, which is the paper's main flaw. For this reason, adult-oriented museum evaluations must center on both kinds of museums.

Li et al. [8] pointed out that AI is enhancing user engagement with digital environments. Artificial intelligence can anticipate user actions and remove any UI design obstacles by evaluating experience metrics. By doing so, we can bridge the gap between the digital world and its consumers and encourage smarter, more user-friendly design. Wang et al. [11] displayed the goal of the seminars was to get participants to envision a future when AI evolves into II, much like intelligent digital movie theater technology or automatic word-to-video generation. Research and technological advancement in the fields of natural and social sciences would rely on this instead of traditional counterfactual trials. Progress like OpenAI's Sora is simply the tip of the iceberg. Triansyah et al. [10] provided the descriptive bibliometric analysis and the Scopus database, this research examines AI articles in middle school settings. From 9 in 2021 to 20 in 2020, the survey indicated a rise in AI papers, with 2010 being the year most cited. With more articles published on AI research aimed at high school kids than any other country, China dominates this subject. Deep learning and machine learning are among the new topics. Topics such as AI literacy, computer science education, and conception are not immediately related to AI.

3 RESEARCH METHODOLOGY

The uneven visual language and varied content in typical exhibition halls hinder visitors' decision-making. The exhibits' prominent position is overemphasized, and the emotions and feelings of the visitor regarding the surroundings are ignored. Furthermore, the information that only static information displayed through displays, images, and text is what visitors choose to acquire; they can't visually engage with the exhibition area; the bulk of interactions involving single-sensory transmission are presented in a 1D manner; visitors are limited to acting as bystanders; and individuals and the data do not interact in any way.

The benefits of using PMR technology demonstrate such digital show spaces require the application of PMR technology.

3.1 Interactive Design on VR Technology

When actual collections and relevant background content are shown online in an exhibition hall through the use of networks and information technology, this is called a virtual exhibition. Virtual reality refers to the use of computer technology to build simulated environments that offer a rich sensory experience. Virtual reality immerses users in a haptic experience, unlike traditional user interfaces. The 3D environment is far more engaging when visitors actively participate rather than only viewing it on a screen. At the moment, the human-computer interaction module is primarily concerned with the connection between simulations that involve humans and computers. The three modes of engagement are visual, gesture, and touch [14]. Virtual reality technology alters three distinct reference systems: the copy plane's organizing system, the camera's reference scheme, and the real world below.

This study examines how VR interactive design might increase online exhibition visitor participation. The developing technology of VR submerges users in a world of computer-generated, transforming their experience. The human-computer interface research emphasizes touch, visual, and gesture interactions to produce a natural user experience. This research heavily uses coordinate system transformation. The camera's reference system, picture plane coordinates, and real environment must be adjusted. The idea is to maximize these modifications for faster virtual environment movement. Transformation connection ideas are used to map the camera's coordinate system to the physical surroundings. By connecting the virtual environment with user expectations, these principles improve user experience. Interactive design concepts improve user interfaces, visual signals, and gesture-based interactions. The study considers camera location, rotation matrices, and internal properties systemically. This holistic approach ensures seamless integration of interactive elements, creating an immersive and user-friendly virtual presentation. According to the study, VR developers should use interface design. The study optimizes virtual environment-user interactions to improve virtual exhibition quality and engagement. Virtual reality 3D modeling Virtual reality (VR) lets individuals explore future structures and cityscapes in a dynamic, interactive 3D environment. Thanks to this realistic experience, users may examine virtual scenes precisely and from different angles and distances. Sports modes including driving, flying, and strolling can be switched. The tool allows real-time comparisons of construction processes and their environmental impacts, bypassing architectural drawings and 3D animations.

Objects in 3D modeling can be rotated about axes similar to the coordinate axes but in any direction in space. All rotations boil down to a series of adjustments to these axes. To convert a 2D rotation about the z-axis to a 3D one, we employ a rotational process utilizing the cosine and sine of a spinning angle (), transforming elements represented as m' without changing the spatial significance of the z-axis. The three-dimensional spin about the z-axis can be expressed analytically in quadratic coordinates using Equation (1).

$$\begin{pmatrix} m' \\ n' \\ y' \\ 1 \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta & 0 & 1 \\ -\sin\theta & \cos\theta & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix} \tag{1}$$

The rotation of the elements related to y' takes into account the sine and cosine of an angle, which characterizes the pattern of rotation around the other two axes. Next, a particular projection progression mode is shown once the observer is facing the Z-axis at the coordinate system's origin. The optimal choice is a projection plane that is perpendicular to the plane of the reference system. This research presents a novel viewpoint transformation based on homogeneous coordinates. This modification considers specific ratios and combinations of factors. Elements linked to y' are rotated in a way that describes the pattern of rotation along the other two axes, which includes the sine and cosine of a given angle. Next, a particular projection progression mode is shown once the observer is facing the Z-axis at the coordinate system's origin. The optimal choice is a projection plane that is perpendicular to the plane of the reference system. This research presents a novel viewpoint transformation based on homogeneous coordinates. Particular ratios and combinations of elements are considered in this adjustment.

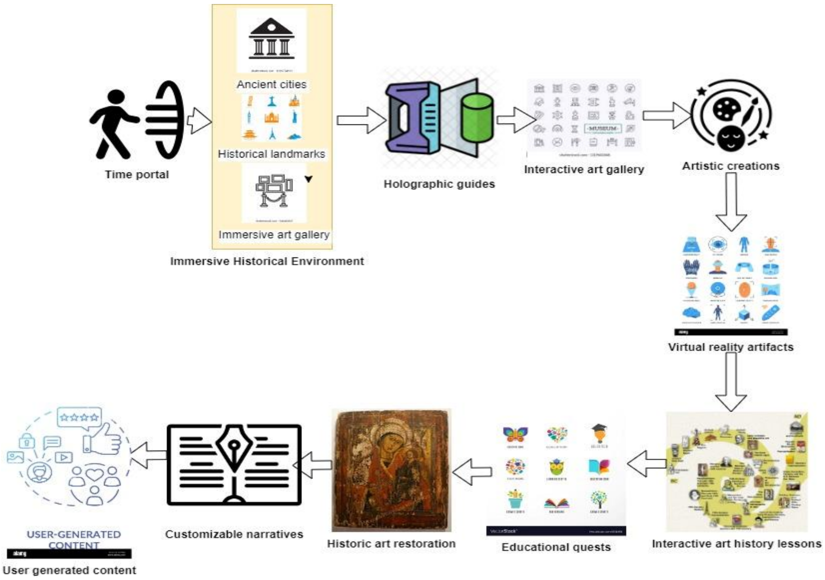

Figure 1: "Immersive Odyssey": A journey through art and history.

It's critical to recognize that changing one's perspective has drawbacks. As mentioned earlier, the formula makes clear that there may be calculation errors when the z-coordinate is zero, so this circumstance needs to be handled differently. When z is negative, negative coordinates result, which presents another difficulty. Ensuring that every z-coordinate is valid, that is, that each corresponds to the 3D model's starting point set, is the only way to solve this issue. To remedy this, the area beneath the observing plane needs to be cropped or eliminated before the change in perspective and occurring transformation.

Figure 1 shows the proposed exhibition theme: "Immersive Odyssey," a museum exhibition that leverages VR-based 3D modeling and interactive design technology to take visitors on an immersive journey through various historical eras and art movements.

3.2 Interactive Design Based on AR Technology

As a subset of the IoTs, augmented reality technology is an example of a vision-based IoT. Augmented reality is able to combine virtual data with actual scenes by using multimedia material, 3D modeling, and intelligent sensing technologies to imitate computer data, which can include images, videos, text, and more. Virtual museums rely heavily on augmented reality technologies to promote and disseminate historical artifacts. Figure 2 shows how digital museums are incorporating augmented reality technologies.

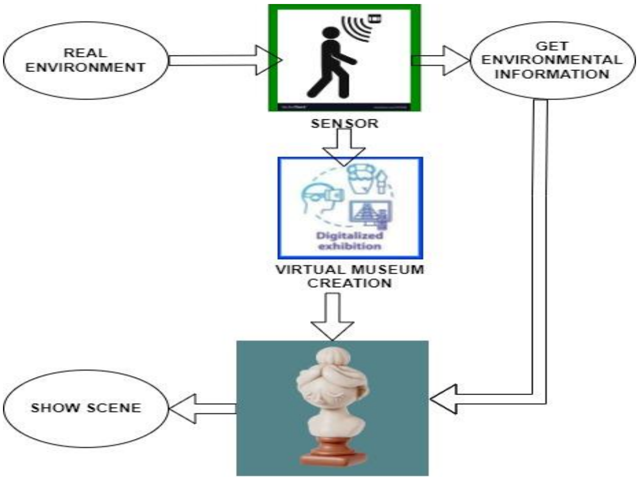

Figure 2: AR technology in a digital museum.

Figure 2 shows the process for creating an online museum that uses augmented reality. Here, viewers can use their senses, such as their phones, to get data about their immediate area in real-time. These sensors collect data, which is subsequently utilized to generate a digital duplicate of artifacts housed at the museum, which may be seamlessly integrated into the physical environment. Incorporating this feature allows visitors to engage with the museum's displays. Utilizing augmented reality technology in virtual museums offers numerous significant advantages. Users are able to experience a range of composite scenarios through real-time interaction with virtual and physical settings, made possible through clever gadgets or alterations to the camera's perspective. The contact between the museum and its visitors is enhanced as a result. Augmented reality creates a three-dimensional matching mode that puts users in the middle of the action by superimposing information about museum displays onto the real surroundings.

This fusion of traditional museums with digital technology improves the transmission of cultural heritage. In conjunction with museums, augmented reality technology offers users interactive, real-time approaches to methodically understanding and appreciating heritage culture. A key feature of this technology is the exact alignment of virtual museum exhibits in augmented reality with the physical world, which requires converting coordinates from camera coordinates to pixel coordinates.

No hard and fast numbers are used to denote where anything is in the camera coordinate system. This spot is where the user is in the physical world. The medium of the camera's external variables establishes the link between the two sets of coordinates. There is a chain of procedures that takes place while moving from camera coordinates to image coordinates. The camera's focal length plays a role in the transformation that yields the final image's coordinates. To make virtual museum exhibitions visually accessible, the picture coordinates must be further translated into pixel coordinates. The parameter that causes this change to occur is the coordinate system of pixels.

3.2.1 3D Modeling design with AR technology

In the context of 3D modeling with augmented reality, these mathematical expressions explain the conversion process converting the globe values to the camera's geographic coordinates, then to the image's locations, and lastly to the pixel values:

Converting word coordinates towards camera coordinates is given by equation (2),

$$Z\begin{pmatrix} A_y \\ B_y \\ C_y \\ 1 \end{pmatrix}^T = \begin{pmatrix} A_x \\ B_x \\ C_x \\ 1 \end{pmatrix}^T \tag{2}$$

Z stands for the camera external variable matrix in this instance. The vector is transposed, as indicated by the T. Converting camera coordinates to image coordinates is shown by equation (3),

$$\left[C_y * \begin{pmatrix} A_k \\ B_k \\ 1 \end{pmatrix}\right]^T = \begin{pmatrix} w & 0 & 0 & 0 \\ 0 & w & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} A_y \\ B_y \\ C_y \\ 1 \end{pmatrix}^T \tag{3}$$

where W denotes the camera's focal length. Visualizing virtual museum displays in an augmented reality scenario requires a multi-step process of mapping points or coordinates from the user's current environment to pixel coordinates. First, a parameter named 'G' facilitates the translation of picture coordinates to pixel coordinates. Then, a matrix operation marked by the letter 'M' transforms the camera coordinates into the pixel coordinates. These mathematical transformations convert camera and picture coordinates to scene pixels. This transformation improves virtual displays in augmented reality with each equation.

3.2.2 Collaborative AR and VR-based 3D Modelling (IVAR3M) with PMR Method

3D modeling uses hardware and software to produce digital images of objects, settings, and characters. Graphics, gaming, engineering, construction, and medicine use 3D modeling. However, 3D modeling is becoming more significant in VR and AR. This study proposes IVAR3M interactive design technology for digital museum exhibition displays. Creating 3D models for VR and AR allows for more creative and realistic concept representation. 3D models can be customized for different purposes, aesthetics, and audiences. Instructional simulations, innovative installations, and fun games can be built with 3D models. Stereoscopic, holographic, and volumetric 3D models can improve VR and AR visual accuracy and depth.

The theoretical framework for interactive picture display in digital exhibition venues using PMR technologies is divided into three stages: resource collecting, 3D simulation, and interactive design (Figure 3). Understanding PMR innovation includes understanding PMR technology, its properties, development process, and required hardware and software.

At the resource-collection stage, the exhibition hall components are hosted. It also examines PMR technology's technological requirements and performance methods. Creating a comprehensive system for sorting exhibition hall contents requires in-person inspection, written documentation, films, and images. The 3D simulation stage addresses the link between virtual and real-world exhibits in physical spaces. The interaction design stage requires correct contour processing and approximate depth estimation for the image interactions system. The dynamic interaction procedure for the altered exhibition hall picture is divided into two components. First, tracking and registration technology gathers exposition hall attributes and displays. Gaze tracking, visual locking, and user movements dominate the second MR image interaction mode part.

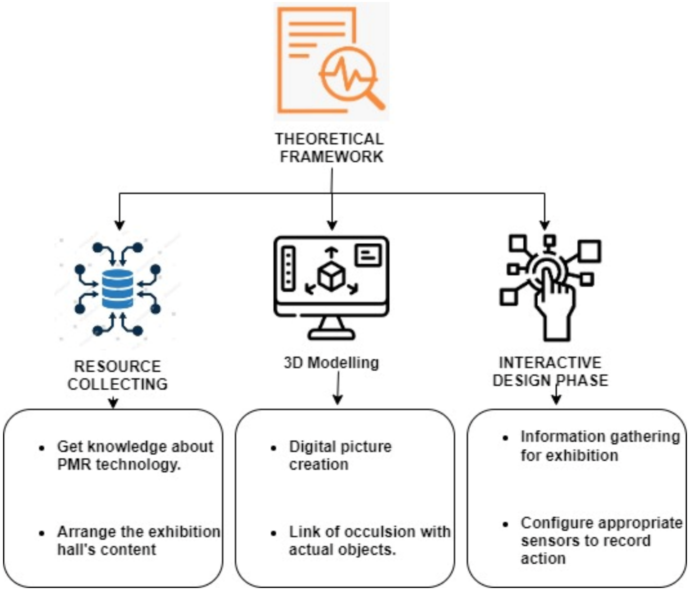

Figure 3: Theoretical framework for interactive display.

The general framework of IVAR3M modeling with PMR technology is illustrated in Figure 4. Pictured in the Figure is the data acquisition layer's principal role: to collect images, audio, and coordinates of the human body; these elements provide the basis for the panorama creation and presentation procedures. Tasks like generating virtual images, recognizing gestures and voice, and tracking targets are all taken care of by the data processing layer. The user interface layer allows for the presentation of panoramic virtual pictures in order to accomplish human-computer interaction (HCI). Digital exhibition halls and other museums might benefit from this theoretical framework for interactive picture presentation in exhibition spaces. In fact, there are a lot of beautiful and historically significant places where it may work. When contrasted with the conventional method of displaying exhibits in a traditional exhibition hall, the innovative, user-friendly, and highly interactive use of PMR advances in a digital exhibition space is stark.

3.2.3 PMR technology in 3D modeling

With 3D holograms, actual and digital elements can interact in mixed reality. The term "polygon mixed reality" refers to an immersive technology that enables users to interact with the digital and physical worlds through 3D holograms. The PMR technology provides advantages in various fields such as enhancing fans' immersion in entertainment and sports, cooperating and working from a distance, adding a social component to video games, and enhancing e-learning security and knowledge retention.

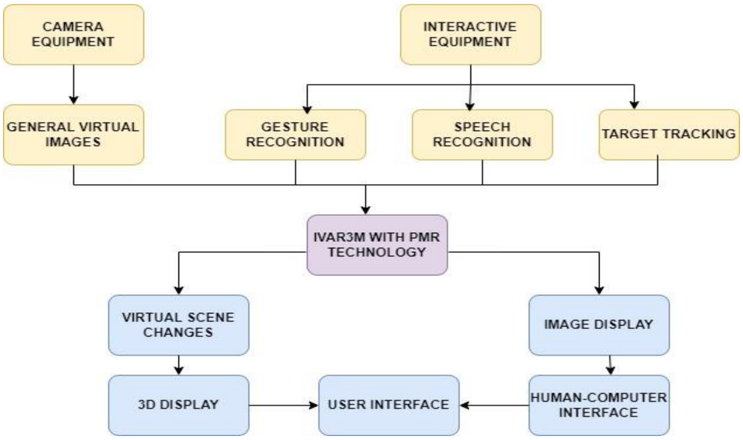

Figure 4: Overall structure of the IVAR3M modeling.

PMR technology-based IVAR3M modeling includes transforming coordinates through steps, resulting in a single 3D equation. The first transformation maps the world's coordinate system to the camera's frame of reference. Transforming camera coordinates into picture coordinates guarantees accurate alignment and projection while rendering an image. The final transformation translates picture coordinates to pixel coordinates, utilizing the parameter 'G' to show spatial information as pixel values. These procedures define the order of transformations necessary for IVAR3M modeling based on PMR technology, which aids in mapping spatial coordinates at various phases and culminates in visualizing virtual elements in an augmented reality setting. Equation (4) can be used to convert between camera coordinates and pixel coordinates.

$$\left[C_y * \begin{pmatrix} g \\ h \\ 1 \end{pmatrix} \right]^T = M * \begin{pmatrix} A_y \\ B_y \\ C_y \\ 1 \end{pmatrix}^T \tag{4}$$

In this case, the ambiguous matrix C_y, represents the camera's internal parameters, including focus length and sensitivity. The G component of the pixel coordinates stands for the horizontal dimension. The h-coordinate represents the vertical position of the image's pixels. The coordinates of a point in three-dimensional space are $A_y, B_y, and\ C_y$, which the camera coordinates are. The matrix M represents the camera's internal settings. Converting from camera coordinates to pixel coordinates relies on this matrix, which contains features linked to the camera's inherent qualities. The equation describes the translation from camera coordinates to pixel coordinates. The equation has two sides, the left representing the transformed pixel coordinates (g, h), and the right involving the multiplication of the internal parameter matrix M with the camera coordinates $(A_y, B_y, C_y, 1)$. In augmented reality, this change is crucial for seeing digital components. In the framework of 3D modeling, AR, and VR technologies, these equations together reflect the whole process from global coordinates to pixel coordinates, enabling the precise rendering and projection of 3D objects in AR and VR settings.

4 EXPERIMENTS AND RESULTS

4.1 Digital Source of Digital Exhibition Museum

The ability of a digital museum to interact with visitors is its main feature. This study surveyed 500 visitors to a museum to fully understand and meet the interactive expectations of users in digital museums. The main goal was to determine what visitors expected from interactive digital museum features. The idea of being "audience-centered" can help the museum eliminate the meaningless status quo by breaking the initial imbalance between the audience and the exhibition and reducing the gap between them. It is important to remember that subjective factors could impact the survey results. The results of the questionnaire survey, which describe the interactive digital museum's anticipated functions based on consumers' perspectives, are summarized in Table 1.

S. No	*Functions*	*No. of responses*	*Percentage (%)*
1	*Animated presentations of cultural artifacts*	*95*	*19*
2	*Engaging games*	*110*	*22*
3	*Authentic Journey*	*150*	*30*
4	*Image and written description*	*86*	*17*
5	*Digital engagements with historical items*	*190*	*38*

Table 1: The function within the museum that the users anticipate to be interactive.

An overview of the interactive features users expect from a digital museum is provided in Table 1. Five anticipated functionalities in all were found. Out of all of them, the digital engagements with historical items had the best representation function, accounting for 38% of the predicted value. The feature that made the games engaging accounted for 22% of the total, while the image and written description had the lowest representation at 17%. The high percentages linked to these five survey functions indicate that people are eager for interactive interaction with cultural artifacts in digital museums. They value the entertaining element of interactive games when it comes to improving their entire museum experience.

To better preserve and distribute cultural material, digital museums use information technology. This project utilized IVAR3M technology to protect digital museum data through the seamless integration of virtual and real worlds through augmented reality. Two hundred museum communicators were sent a survey to determine how effective digital museum interactive design is. We looked at it from their point of view, with an emphasis on how digital museums evaluate the success of interactive design. There was a significant difference between the 500 randomly chosen tourists from the previous group and the 200 museum communicators. The survey was designed to be filled out in an open-ended manner. Museum communicators are invaluable resources for assessing interactive design due to their extensive understanding of visitors' interactions with displays. It is possible to see the criteria for judging the success of digital museum interactive design in Table 2.

S. No	*Indicators*	*No. of responses*	*(%)*
1	*User satisfaction*	*150*	*75*
2	*Information acquisition*	*130*	*65*
3	*Visitor engagement*	*160*	*80*

Table 2: Indicators for assessing the impact of IVAR3M in digital museums.

Table 2 describes the indicators for assessing the impact of IVAR3M in digital museum exhibition displays. Three indicators are analyzed, of which the highest percentage of visitor engagement is 80%, where user satisfaction is 75%, and the lowest percentage of information acquisition is 65%.

4.2 Comparative Results

4.2.1 User satisfaction

User Satisfaction refers to the outcomes of intelligent digital exhibition displays. User satisfaction is compared with the interactivity of museums and tourists using three different technologies. The initially proposed VR technology shows low user satisfaction compared with the next proposed AR technology. AR technology has limitations in applying 3D modeling and gives comparatively less satisfaction to users.

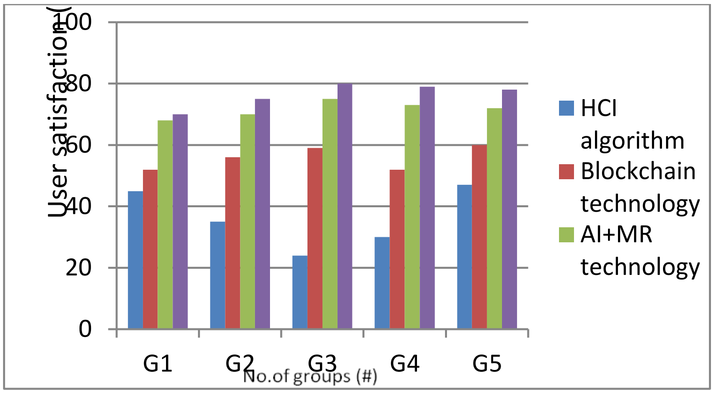

Figure 5: Comparison of user satisfaction with interactive digital display.

This paper proposes an IVAR3M, fusing both VR and AR technologies and 3D modeling, and gives better user satisfaction in displaying digital museum exhibition displays. Figure. 5 shows the comparative analysis of user satisfaction for five groups; each group has 200 tourist participants. The Figure shows improved user satisfaction with IVAR3M compared with traditional VR and AR technologies.

4.2.2 Data Acquisition

The first step in processing an image is acquiring the image. This part is commonly called pre-treatment in the field of picture processing. The first step is to acquire the image from a source, usually one that relies on hardware.

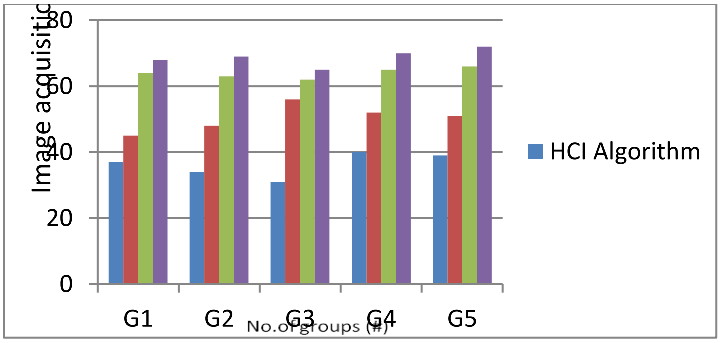

Figure 6: Comparison of information acquisition of interactive digital display.

Figure 6 shows the comparative analysis of information acquisition for five groups of people; each group has 200 tourist participants. The Figure shows the improved information acquisition (so that digital data will be well immersive in the display in the museum) with IVAR3M compared with traditional VR and AR technologies.

4.2.3 Visitor engagement

Audience engagement aims to take a fresh look at museums and concentrate on how they engage with their patrons. It seeks to provide audiences with various enjoyable and engaging experiences throughout their stay and all the ancillary aspects that follow, such as comprehending pre- with post-visit experiences and ways to guarantee repeat business.

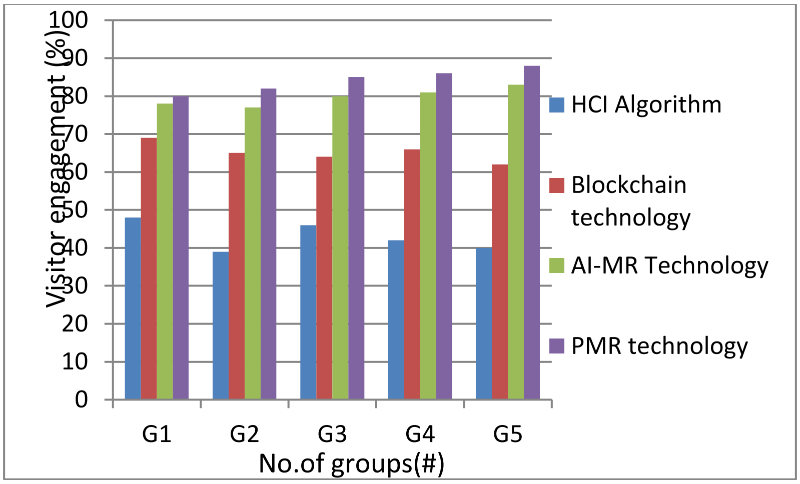

Figure 7: Comparison of visitor engagement in interactive digital display.

Figure 7 shows the comparative analysis of traditional VR and AR technologies and the proposed IVAR3M technology. It can be seen that among the five groups of people (each with 200 participants), the visitors are always engaged, with nearly 80% using the proposed 3D modeling.

5 CONCLUSIONS

The exhibition at the museum seeks to inspire people's creativity and imagination. Various display formats are closely related to museum exhibits, and various display objects have varying needs. Museums can remain sustainable by continuously developing new exhibition techniques, including virtual and augmented reality technology. The paper proposes VR-based 3D modeling and AR-based 3D modeling to develop a PMR technology-based IVAR3M modeling. The proposed technology is capable of digital museum management and clear object display in two- and three-dimensional settings. AR is further realized through VR, which satisfies people's desire for natural involvement with the virtual and physical worlds. The fast advancement of the HCI approach has rendered conventional visitors obsolete.

Consequently, this study uses a 3D modeling method and HCI to explain the fundamentals of VR and AR technology. Lastly, the experiment examines how VR and AR technology and museums have evolved recently and how satisfied individuals are with museums. People seem to prefer using IVAR3M technology for dynamic museum image design. Future work involving 3D analysis will be further extended to various technologies and applications. Also, interactive design with VR technology is expensive, and thus, in the future, the selection of technology with more powerful tools for various applications is recommended.

6 ACKNOWLEDGEMENT

This work was supported by the Liaoning Social Science Planning Fund Project, Project number L21CKG002

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