Immersive services in libraries: perspectives and views of library professionals

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The paper aims to determine whether AR and VR library services are useful and, if so, what are the associated opportunities and challenges. Based on the literature review, 40 libraries that have implemented augmented virtual reality services were identified. An online survey of library professionals belonging to the 40 identified libraries was conducted. Sixty-nine percent of libraries use HTC Vive as their preferred VR headset device. Further, 54 percent of the respondents stated the circulation of VR devices as a new service. Findings show that libraries are offering new services such as 3D Model Gallery, 3D Scanning, 3D Printing, and Data Visualization. SWOT analysis of immersive services in libraries identified VR content archiving, copyrighting of 3D content, and constructing metadata schemas for virtual content as the challenging areas that need further research. The study will be useful to library professionals who plan to introduce or experiment with augmented virtual reality services.

Introduction

The immersive library environment[1] is a 3D virtual environment that facilitates the library users to get immersed in a simulated artificial ecosystem. Today, the most popular immersive technologies include augmented, virtual, mixed, and extended reality. Immersive services are both hardware and software-centric. A head-mounted device (HMD) is needed to experience VR content[2], while an augmented reality (AR) app superimposes the information onto the real physical world. The virtual reality technology displays immersive content on the VR headset.

According to Frost, virtual reality makes learning very easy and enjoyable[3]. Mixed Reality (MR), on the other hand, combines both the physical and virtual worlds[4]. Here, the user wears various controllers and haptic devices that facilitate real-time interaction with the virtual environment. Extended reality (XR) is a universal set that includes all AR/VR/MR technologies (Fig. 1). CAVE[TM] and immersive walls are used to display 3D images using projectors and HD screens. The only drawback of implementing the CAVE[TM] facility is that it needs enormous funds and technological expertise. The study reveals that very few libraries have immersive wall facilities.

Virtual Reality (VR) is a computer-generated virtual world that is accessed via a headset. Ivan Sutherland (1968) revealed the first head-mounted device (HMD). Today, several such devices are available in the market, such as HTC Vive, Oculus Go/Quest, and Samsung Gear. Augmented Reality (AR) provides an interactive experience of the real world in a computer-generated environment. Jaron Lanier (1987) coined the term virtual reality, and Tom Caudell (1990), a Boeing engineer, first coined the term augmented reality[5]. The virtual and augmented reality offered using web technologies is called web-based AR/VR. Mandal et al (2019) explained that library portals use web 2.0 tools to provide interactive solutions to their users[6]. The
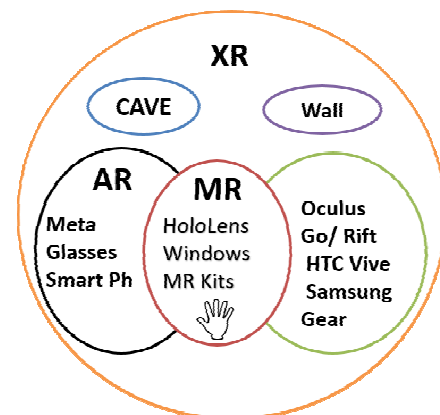

Fig. 1 — Immersive technologies

J. Willard Marriott Library offers various VR services utilizing an interactive software to create an active and immersive classroom[7].

Huber (2020) suggested that libraries that wish to implement VR services may start with a small budget and use open-source software to create virtual tours, panoramic photo galleries, and 360-degree video galleries[8]. Such augmented virtual reality (AVR) space would facilitate interdisciplinary partnerships among the users, educators, and librarians for collaborative learning. LeMire shows how AR programming can be leveraged to provide virtual library tours. The author also testifies to an increase in user motivation and immersion with AR activities. Libr-AR-y Tours increase user engagement and open a new avenue for staff training, user orientation, and dissemination of visual information[9].

The review of literature brings to light some of the practical uses of AR/VR, such as:

- The Cornell University's Albert R. Mann Library's virtual tour is a web-based walk-through of the library collections[10].

- Library Virtual Tour/ 360° Tours is an internet-based service that uses a simulated environment to offer real-time library tours in virtual settings. Edith Garland Dupré Library of the University of Louisiana at Lafayette creates virtual tours that serve as a virtual point of access for information, instruction, and library services[11].

- The University of North Florida (UNF) Carpenter Library opened its Virtual Learning Center (VLC) in March 2021 to support its students and faculty members in using virtual reality[12].

- The University of British Columbia, the library, faculty members, and the MLIS students demonstrates the use of AR for library literacy using the Aurasma[TM] AR app[13]. The research finding demonstrates AR implementation for displaying the library's collection information and building awareness.

- The virtual library cloud space is also an innovative way to provide virtual services online. The Second Life online platform is used to provide such services. Swanson (2008) mentions that the Second Life platform provides virtual space on the Internet. Users can log in as Avatars and visit the library virtually[14].

Immersive technological innovations have changed how we deliver/display information in the digital age.

The literature review shows the adoption of AR/VR services in the library. However, we note a significant gap in opportunities and challenges present with AR/VR services in an academic library setup.

Objectives of the study
- To find out the type of immersive services offered by libraries;
- To examine reports of any health hazards while using the VR devices; and
- To identify the opportunities and challenges present with AR/VR services in the library.

Methods

The present study used Scopus and Google search to identify the scholarly literature based on identified keywords. Our search presented us with 208 published articles. These articles were examined further to generate the final acceptable list for the study (Fig. 2).

The study aims to find the opportunities and challenges of immersive services in academic libraries. The study includes 30 published articles for the literature study and identifies 40 libraries offering AR/VR services. The authors approached the identified academic libraries that had implemented AVR facilities to seek their expert opinions. Five library professionals' responses were rejected as they were incomplete.

We prepared a questionnaire using the Google form. The questionnaire (Annexure I) was divided into four parts (a) Personal information: this part captures the personal and demographic information about the participants; (b) Technology implementation: it is aimed to collect data on the immersive technology implemented in their respective libraries; (c) Library user information: this section aimed to capture the library users details, as observed by the library staff; and (d) Library services: this section aimed to capture the various services offered by the immersive space. The study conducts the quantitative analysis using MS Excel.

Analysis

Types of immersive services offered by the libraries

To the question, "Does your library allow its users to borrow immersive VR devices?" it is found that 54% of the participants replied in the affirmative (Fig. 3). However, 28% of the respondents mentioned that their library has high-end VR devices like Microsoft HoloLens that the users do not borrow.

To the question, "Does your library provide any service for Second Life in the virtual world online platform?", only one library (2.8%) responded that it provides the service. The study finds that the virtual world in the Second Life platform is currently showing a declining trend.

To the question, "Does your library have a digital repository to preserve 360-degree video or 3D image/objects?" it was found that 34% of the LIS professionals mentioned that their library has a digital repository to archive 3D object files. Three libraries mentioned using D space, seven libraries use custom-made software, and two libraries use data verse and be press.

To the question, "Does your library provide any AR services to the library users?", 42% responded in
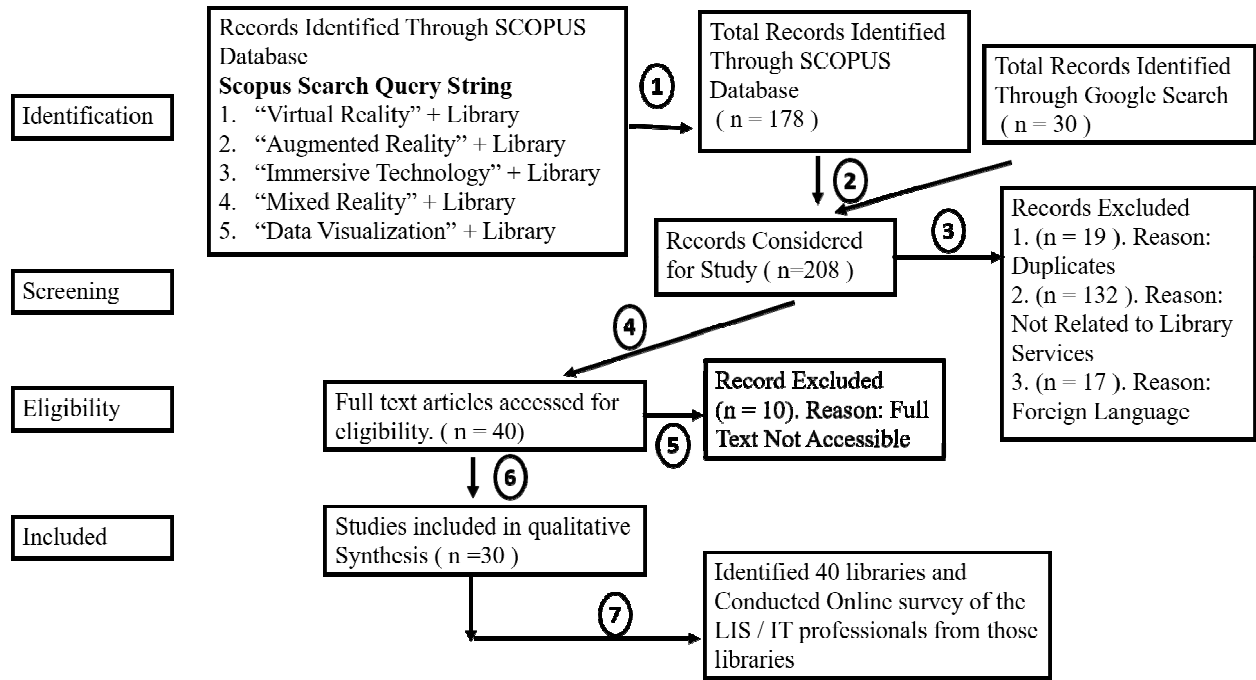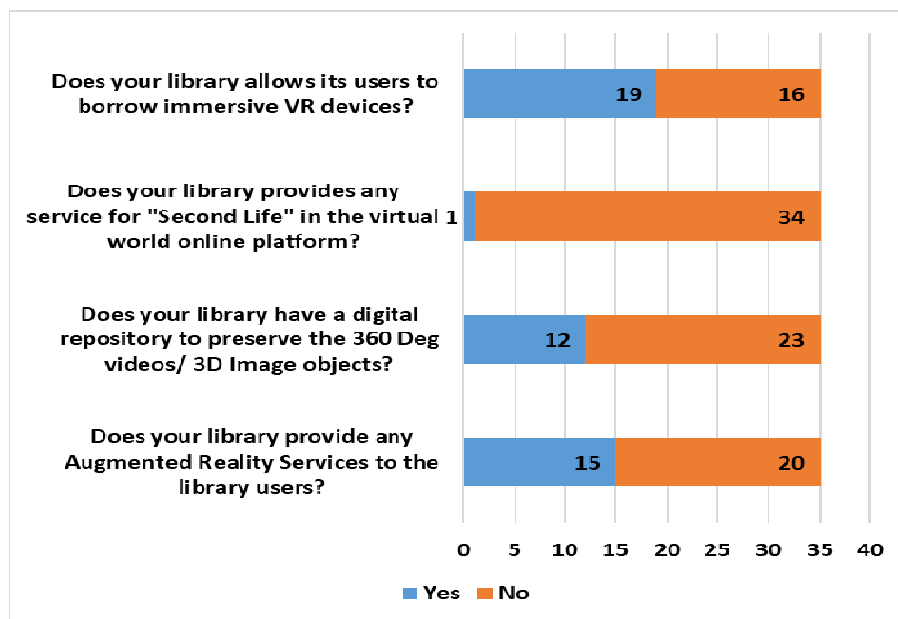
Fig. 2 — Steps for literature review

Fig. 3 — Immersive services in libraries

the affirmative. The survey data shows that two professionals mentioned using A Frame open source software to develop AR experiences, and 13 libraries use subscription-based AR platforms for the service.

Usability of the immersive services

The present study tries to understand what age group of users frequently use the immersive services. In this regard, the professionals mention that the younger users are frequent visitors. However, data analysis shows that library users older than 40 are more apprehensive about using immersive devices (Fig. 4). We found that 77% of library professionals mention that 21-30 year-old users are the most frequent visitors. Seven libraries mentioned providing VR services to the children as an awareness campaign.

To the questions, 'What types of VR devices are more preferred by their library?', the respondents mentioned that HTC Vive and Oculus Rift were the devices of choice. Our survey showed that 69 percent of libraries used HTC Vive, and 57 percent had Oculus Rift.

The respondents mentioned that the AVR space shows a substantial increase in user footfalls. As to 'How many users regularly access the VR devices/immersive service every week?', it was revealed that that 42% of library professionals mention that 10-20 number of users access the VR systems every week (Fig. 5). Two libraries, namely the North Carolina State University library and the Merrill-Cazier library of Utah State University, highlight that their VR space is accessed by more than 41 users every week.

The effect of VR headsets on user health

The study aims to determine the possible impact of an immersive environment on users' health. Twenty-five percent of the professionals responded that users "rarely or sometimes" develop some health issue (Fig. 6).

The study also investigated the types of illness the users generally report while using the VR headsets.

The respondents who mentioned that they observed users with some health issues were told to select the type of problem users generally reported (Fig. 7). They mentioned that sweating and disorientation were the most prevalent issues; however, no serious health problems had been reported. Few participants also suggested that the extended use could put a strain on the eyes, leading to vision problems, eye fatigue, or headaches.

Future immersive services in libraries

Technological advances, such as gigabit networks, artificial intelligence, robotics, and AR/VR have opened opportunities for libraries to create immersive environments and offer new value-added services. In the future, many wearable devices like Google Glass will use AR technology to deliver information. However, AR glasses are in the developmental phase, and today we can experience AR on smart phones. Avila (2017) mentions that libraries need to create their own AR content to enhance library services and advocacy[15]. Roy & Kanjilal (2021) find augmented reality useful in quick information delivery. Their study shows that web-based AR programs execute on mobile browsers, and users do not need to install any AR app[16].

On the other hand, a study shows that virtual reality is used in higher education, lab practice, entertainment, virtual tour, and training[17]. The immersive services greatly enhance the end-user experience in the libraries. As these technologies continue to evolve, they will significantly add to the
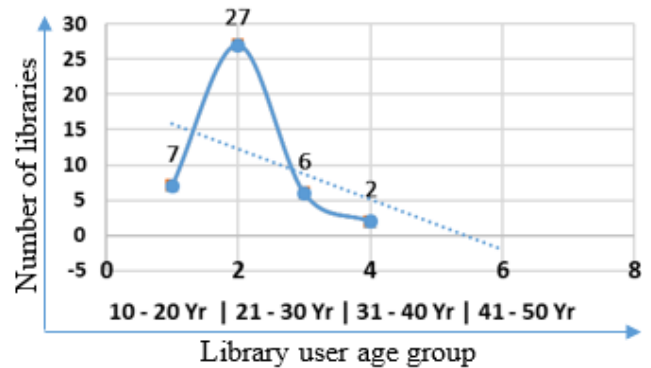

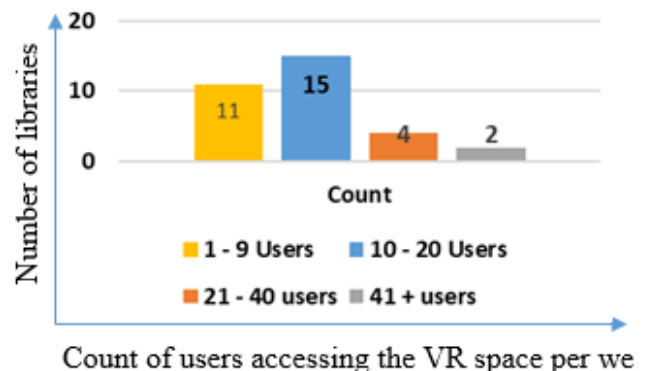Fig. 4 — The user age group accessing immersive services in the library

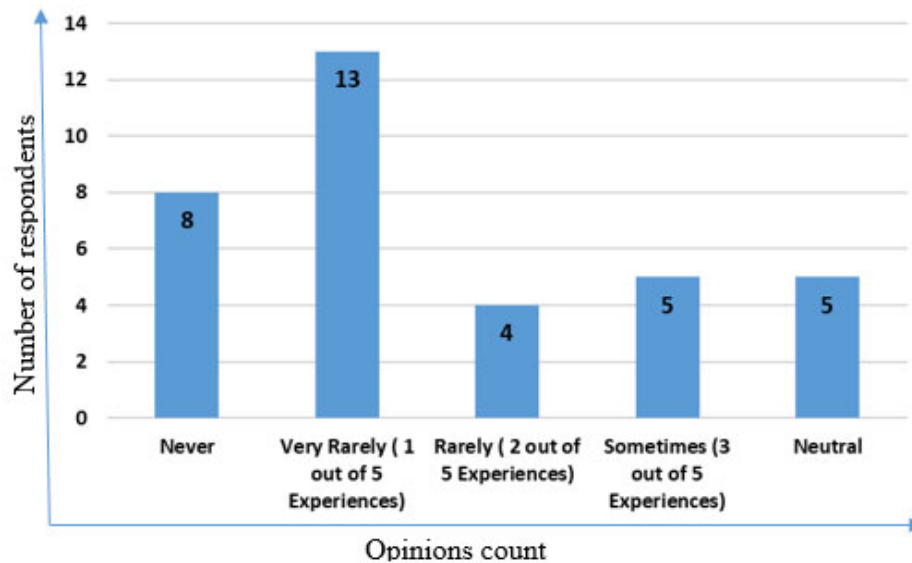Fig. 5 — Usage statistics of the immersive facility

Fig. 6 — Library staff observations of user-health using the Likert scale (count)
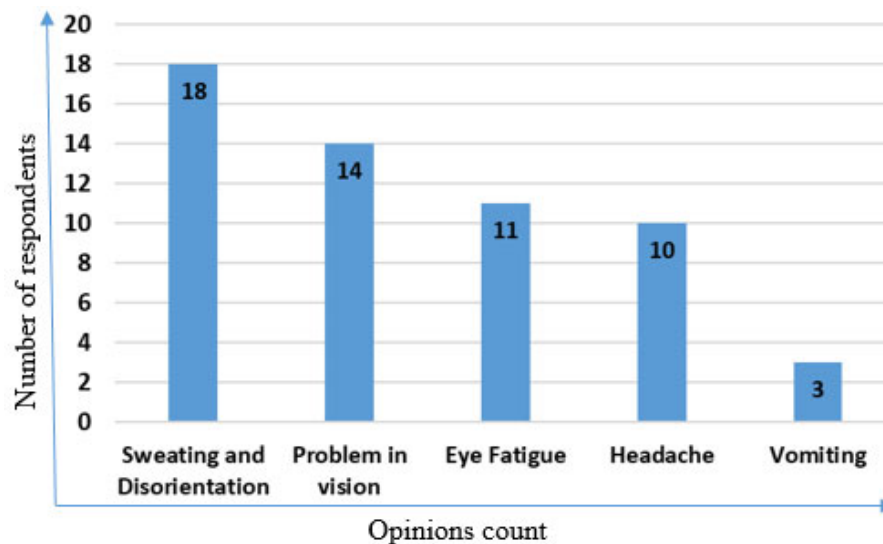

Fig. 7 — Types of health issues

user experience and bring infinite opportunities for library professionals. Library 4.0 applications are redefining library services in tune with the evolving technologies, such as immersive storytelling, context-aware technology, visualizations, and AR/VR services[18].

Opportunities and challenges

The SWOT analysis for immersive services in libraries is compiled using the survey and literature review data (Fig. 8). The survey data shows that 60% of the selected library receives more than ten users weekly. The results indicate that both users and libraries are gradually embracing AR/VR services.

Adoption of AR/VR in ARL member libraries is attracting users[19]. Similarly, the data visualization space is a collaborative visual learning room, which is more comfortable and enjoyable for learning[20]. The emerging immersive technologies are the strength to provide a virtual reality experience to the user.

Immersive services bring about a change in the roles and responsibilities of the librarians. For instance, the new roles could be visualization coordinator, visualization librarian, VR manager, and studio manager. In the coming years, library staff needs to develop new IT skills with more technical knowledge[21]. The author mentions that "on-demand"

Strength

- Emerging Technology
- Innovative Services
- Learning Becomes Enjoyable
- Increases User Footfall
- Collaborative Learning

Weakness

- High Budget
- Data Reuse & Copyright Issues
- Health Related Issues
- Services Depends on Hardware
  & Software

Opportunities

- New Roles
- New Responsibilities
- Development of 3D Content
- Low Cost Training
- New Infrastructure Development

Threats

- Data Privacy Issues in VR
- Device Damage/ Repair
- Rapid Technological Change
- Low Availability of Contents
- Still a Growing Technology

Fig. 8—SWOT analysis of immersive services

digital access, VR-based MOOCs, and virtual spaces will transform academic library services. Libraries provide a variety of VR-based services in education and training. For example, Suen (2020) suggested that virtual lab learning is safer for students as it is risk-free from accidental mishaps[22]. Immersive technology is still in its development phase. There are threats and weaknesses. Such as data privacy, device damage/repair, rapid technological change, and low availability of VR content are significant threats. Repairing damaged VR headsets, 3D/VR collection development, reusing virtual content, and data security in the virtual world are some issues librarians are concerned with[23]. The present study identifies high budgets, copyright issues, 3D data reuse/ preservation, and the impact of VR on users' health as key weaknesses of immersive services.

Discussion

The study suggests three challenges libraries must address: VR content creation, preservation, and user satisfaction. VR research, pedagogy, and 3D content creation require extensive collaboration among peer researchers[24]. So, libraries must create immersive spaces for their users that enable them to collaborate with their peers. For instance, Penn Libraries (UoP, US)[25] has implemented the CAVE[TM] visualization studio. The visualization studio overcomes the limitations of head-mounted displays (HMDs), and many users can collaborate by sharing similar VR experiences. The older researchers and faculty members use the studios and the immersive wall to conduct 1-to-1 interactions. However, the present study found that children and the younger generation are more interested in using VR headsets.

Another challenge is the preservation of students' 3D research data. We found that only 34% of the respondents from the selected libraries mentioned having repositories to preserve 3D content. Hardesty et al (2020) suggest that the collection management for 3D/VR models is challenging, but libraries may follow the LIB3DVR project recommendations[26]. A similar effort is the Community Standards for 3D Data Preservation project (CS3DP), which focuses on developing collaborative standards for preserving and disseminating 3D data[27]. In light of this, libraries can play a pivotal role in creating and archiving students' 3D/VR content under an OA initiative. Finally, the library should focus on users' accessibility and comfort to achieve higher user satisfaction with the immersive services. Roy & Kanjilal (2022) found in their research that 90% of the users are satisfied accessing virtual reality, and few are apprehensive due to health issues[28].

Conclusion

The study found virtual tours, VR-based user orientation, data visualization, 3D galleries, AR services, and 3D scanning/printing as new services offered by the selected libraries. Such initiatives

would increase user engagement and footfall. There is gradual acceptance of the new technologies by libraries and users. VR does not seem to have harmful impact on users' health. However, minor issues like disorientation and sweating may be observed. Immersive services in libraries are beneficial from several perspectives, but face some challenges in the context of archiving. We suggest that libraries heed the recommendations of the LIB3DVR project and work together to create more innovations.

Acknowledgments

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Annexure I

Survey questionnaire for the library professionals

Sl No	Questionnaire	Option Details
1	**Personal Information:**	Essential information
	University Name, Library Name, Immersive Portal URL, Country, Contact Details (Email id, Name, Designation)	
2	**Technology Implementation:**	
	• Name the VR devices that the library procured for use?	Name the Devices
	• Name the AR Software App or AR SDK that the library implemented for its AR services?	Name AR Software
	• Does your library have a digital repository to preserve the 360 Degree videos/ 3D Image object files?	Yes/ No
	• Name the software used to build the digital repository to store the 3D objects or AR/ VR Contents.	Software Name
	• Does the digital repository follow any metadata schema for indexing the VR contents?	If yes, then Mention Metadata Schema
3	**Library User Information:**	
	• How many users access the VR devices every week?	User Range
	• Which age group of users uses the VR service more often?	Age Group
	• How frequently do the users report health issues while using VR devices?	Frequency Group
	○ What type of health issues are reported by the users while using the VR headset?	Sickness Type
4	**Library Services:**	
	• List the type of immersive services your library provides to its users.	Name the services
	• Does your library allow its users to borrow immersive VR devices?	Yes/ No
	• Does your library offer any Second Life Virtual World Platform?	Yes/ No
	• Does your library offer AR Services?	Yes/ No