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IMMERSIVE TECHNOLOGIES IN THE LIBRARY: ORGANIZATION OF INNOVATIVE SERVICE FOR SCIENCE AND EDUCATION

Introduction. *The need to raise the efficiency of scholarly research and to create conditions for the production of new knowledge and its exchange actualizes the study of the cognitive potential of immersive technologies.*

Problem Statement. *The research deals with issues related to unlocking the potential of immersive technologies for the organization of an innovative library and information service to promote the development of science and education.*

Purpose. *The purpose is to substantiate the need to introduce immersive technologies in the practice of scientific libraries in order to provide information and technological support for research and educational activities, to develop theoretical and methodological approaches to the organization of library services based on immersive technologies.*

Materials and methods. *The study is based on information of scientific library websites, thematic resources (MIT Media Lab Research portal, websites of software development corporations and official virtual reality hackathon websites), professional publications covering the specifics of immersive technologies, experience in their use in scholarly research and library practice. Systemic, functional methods, methods of observation, hypotheses in combination with the social communication method have been used.*

Results. *The expediency of introduction of immersive technologies into the practice of scientific libraries as an innovative tool of information and technological support of science and education development has been shown. The cognitive potential of immersive technologies has been emphasized. Theoretical and methodological frameworks for organization of complex library and information service based on immersive technologies have been developed. Case studies of efficient use of these frameworks by scientific libraries have been given.*

Conclusions. *The positive effect of using the cognitive potential of extended reality in educational practice and research actualizes the development of strategies for organizing a comprehensive library and information service in scientific libraries to provide access to immersive technologies.*

Keywords: virtual reality, augmented reality, immersive technologies, extended reality technologies, scientific libraries, library service, and innovation.

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Technologies That Expand Reality

Internet technologies have caused revolutionary changes in various spheres of public life, including the transformations in the system of government, economy, social structure of society, art, ways of communication and perception of information. The space itself and our conceptions of it are changing: it is about the emergence of the phenomena of virtual, augmented, and mixed reality (VR, AR, and MR). Accordingly, the effective use of new technologies and the introduction of innovations developed on their basis in practical scholarly research and educational activities have been actualized. Virtual, mixed, and augmented reality technologies (immersive technologies, extended reality technologies) are among the latest achievements, the importance and potential of which have not been yet fully understood. In particular, this applies to the library industry, especially, scientific libraries, one of the tasks of which is library and information support of research and educational process. The understudy and insufficient use of the potential of extended reality technologies by libraries has been discussed at the discussion panel *Tech Trends* of the Library and Information Technology Association, in the winter of 2019 [1]. Although virtual reality has been identified by the American Library Association as one of the 10 leading trends in library technology in the future, as of July 10, 2019, the main search in the scientometric database of *Web of Science* by keywords "Augmented Reality in Academic Libraries" and "Virtual Reality in Academic Libraries" gave 5 and 24 results, respectively.

Recently, the issues related to the development and the use of extended reality technologies have been in focus of domestic and foreign researchers.

Different types of extended reality have been compared by M. Speicher, B.D. Hall, M. Nebeling [2], S. Mann, T. Furness, Y. Yuan, J. Iorio, Z. Wang [3], D. Bowman, C. Wingrave, D. Hix, B. McIntyre, M. Mine, D. Schmalstieg [4], and others.

The use of immersive technologies in the educational process has been considered by K.-T. Huang, C. Ball, J. Francis, R. Ratan, J. Bowmis, J. Fordham [5], J. Johnson [6], V. Klimnyuk [7], Yu. Trach [8], and others.

R.L.S. Silva, P.S. Rodriguez, J.C. Oliveira, G. Giraldy [9], V. Gopalan, J.A.A. Bakar, A.N. Zulkifli, A. Alwi [10], M. Shabrov and M. Kurikov [11], and others have substantiated the potential of extended reality for analysis and visualization of research results.

The possibilities of effective use of augmented and virtual reality technologies by scientific libraries have been discussed by B.E. Massis [12], A. A. Oelyude [13], S. Avila [14], D. Khan, Ch.-M. Chen and E.-N. Tzai, A. Boyadjian, E. Humphreys, D. Hawkins [15], and by others who focus on the technologies and their prospects for expanding the range of library services. The potential of virtual reality technology for creating virtual reading rooms with open access in order to support browsing by analogy with hardcopies has been studied by M. Cook [16].

In recent years, there have been attempts to generalize the existing experience of libraries in the use of extended reality technologies at the monographic level [17, 18]. However, such monographs focus mainly on the experience of individual U.S. libraries and the applied aspects of individual projects (room selection, engagement, user instructions, equipment placement, etc.). They do not cover issues related to developing a conceptual model or library service organization system based on the use of extended reality technologies. On the other hand, I. Joiner in his monograph [19] that deals with emerging library technologies as a whole, while considering such innovative technologies as artificial intelligence, robotics, drones, driverless cars, big data analysis and so on, very briefly touches on extended reality technologies as promising and does not justify the feasibility of systematic implementation of these technologies in scientific libraries.

Thus, despite a large massif of scholarly research literature on extended reality, in particular, its implementation in library practice, the authors have not generalized the existing experien-

ce of scientific libraries in using extended reality technologies to provide information support for research.

Therefore, **the purpose** of this research is to determine promising areas of implementation of immersive technologies in the practice of scientific libraries from the standpoint of substantiation of the research potential of extended and, especially, virtual reality and to suggest methodological approaches to the organization of library service based on immersive technologies, proceeding from the analysis of recent professional publications and current experience of library institutions.

The main source base of the research is websites of scientific libraries (having studied their content, the authors analyzed the activities of library institutions and the level of immersive technologies implementation); special thematic resources, such as the *MIT Media Lab Research* portal and the official virtual reality hackathon websites; websites of corporations involved in the development, manufacture, and distribution of virtual reality headsets and content, training in the use of extended reality technologies; and professional literature: 1) publications that deal with the specifics of immersive technologies as such; 2) publications that highlight the experience of using immersive technologies in research; 3) publications that show the experience of using immersive technologies in libraries.

The have used several methods to achieve this purpose. In particular, solving the problem of developing methodological principles for organizing library services with the use of extended reality technologies requires the system method, because the library service based on immersive technologies operates in a system that includes components such as library space (the real space that houses the necessary hardware and users, and the "extended" one that is an artificially created product based on computer technology, which might be tested by users), a set of technical and technological support (hardware and software), users and librarians (managers, marketers, extended reality curators). The addition of the functional method to the system one has led to the definition of the functions of such employees. The observation method has been used to study the experience of virtual, mixed, and augmented reality technologies in the practice of individual libraries. The method of hypothesis in combination with the social communication method has allowed to assume the expediency of introducing immersive technologies into library practice in the context of information technology support of scholarly research and educational process by libraries.

Extended Reality for Scholarly Research

Today, the most developed among immersive technologies are virtual and augmented reality technologies. For comparison: as of July 10, 2019, "*virtual reality*," "*augmented reality*," and "*mixed reality*" keyword search in *Web of Science Core Collection* scientometric database showed 41,518, 15,396, and 5,449 scholarly research publications, respectively. Therefore, first of all, we consider the possibilities of applying these technologies in the practice of scientific libraries to support research.

First of all, let us talk about the advantages of using immersive technologies in research and education: their visibility, security, opportunities to attract and to focus audience [8], relative affordability, and cognitive potential. In particular, experts from the *Fluid Interfaces Group* of the *MIT Media Lab* (Massachusetts Institute of Technology) have found that with augmented reality technology, the accuracy of long-term retention of a sequence of objects in memory is tripled as compared with the memorizing information from paper [20].

Moreover, some studies cannot be conducted unless with the use of these technologies (for example, studies of changes in the behavior of a human who has long been under the influence of virtual reality, or related to the study of digital art, etc.). Prospects for the use of extended reality technologies to solve research problems in various fields of science, including cosmology, medicine, biology, chemistry, engineering, archeology, history, art

history, and so on, are definitely promising [11, 21–23]. Specific narrow-field tasks even necessitate the development of special software, such as *InViewR* in the field of biology. This necessity results in the specialization of software development corporations [24].

Virtual reality space might be used for social interaction in general and in the field of scholarly research, in particular. According to *Springer Nature* Senior Semantic Data Manager M. Kaindl, virtual reality is a collaborative environment that allows researchers to work together in a created space thereby enriching each other through sharing experiences and knowledge, while implementing joint projects, and visualizing the data in a unique new way [25].

In order to explore the potential of virtual reality, in 2016, leading manufacturers and universities launched the *VRFirst* initiative that is a global program that combines business, university, and academic science. The partner of the program is the Institute of Electrical and Electronics Engineers (IEEE). The program aims at promoting the creation of laboratories and centers of virtual reality. As of January 2020, more than 50 *VRFirst* laboratories have been launched [26]. Another international structure created to develop cooperation between innovative companies and researchers in the VR and AR ecosystem is VR/AR Association (VRARA) that focuses on stimulating research and education in the field of VR/AR and development of industry standards, as well as on consolidating member organizations and promoting services and products based on immersive technologies [27]. At the European level, *EuroVR* has been operating since 2010. It is an international non-profit association, a network of stakeholders for studying VR and AR [28].

On November 7–9, 2018, to explore the potential of augmented and mixed reality for research, the academic publishing house *Springer Nature* for the first ever time organized a hackathon of mixed reality that took place in San Francisco [23].

It should be noted that in Ukraine the first hackathon *X REALITY HACK* (http://xrhack.com/) that gathered participants for finding ways to implement their ideas for business, entertainment, cultural and social projects was held a year earlier upon the initiative of the organizers of *Sensorama Lab,* a virtual and augmented reality laboratory that develops projects using immersive technologies and interactive media, teaches AR/VR, and supports the development of new ideas and product development in this area.

The prospect for widespread introduction of immersive technologies in the practice of research and education in Ukraine opens new horizons for domestic science and education. Given the relative novelty of technology, Ukrainian researchers who join the pool of scientists studying the phenomenon of extended reality and the possibilities of its use in various spheres of public life will contribute to the formation of a positive image of Ukrainian science at both national and international levels and secure its place among world research leaders. The use of immersive technologies becomes an additional factor for strengthening and establishing scientific communication, being involved in relevant international research projects, and growing scientific capital. The introduction of immersive technologies in scholarly research practice enables implementing studies for which, nowadays, Ukraine has no favorable financial or security conditions in real space. In its wider application, the use of extended reality technologies is an effective tool for bridging the gap between theory and practice, education and industry, for improving the quality of training, given the requirements of employers and a rapid development of innovative technologies.

Given the prospects for immersive technologies in modern domestic science and education, the leading higher educational establishments in Ukraine have launched appropriate laboratories. In particular, almost simultaneously (in the late 2019 — the early 2020) virtual reality laboratories were opened at Sumy State University and Taras Shevchenko National University of Kyiv.

However, the immersive technologies in science and education are associated not only with advantages, but also with certain risks that should be outlined.

First, there appear problems related to intellectual property and copyright, from the acquisition, registration, and use of extended reality hardware and software to the creation of new content/product by users with the help of immersive technologies.

Second, the use of immersive technologies creates a risk of widening the digital divide in society in general and in science and education in particular. Given that not every institution in Ukraine can afford to purchase appropriate equipment and software, there arises the problem of providing students and researchers with equal access to information and technology and the formation of competencies necessary for working with extended reality technologies.

Third, the problem of adequate security for users (given the potential health risks), equipment (given possible damage or theft), and content (given possible copyright infringement or loss) is exacerbated. Special equipment and software being developed by foreign companies today, the reliability of data storage and protection becomes more and more important, especially when it comes to the use of immersive technologies in science.

Fourth, the further introduction of immersive technologies will increase the amount of extended reality content, so the need for its systematization and creation of conditions for its effective use is actualized. It is about the need to form a SMART-space as an organic combination of high technology, software, intelligence, creativity, and engagement.

Is library Smart-Space Possible? Yes, It Is Real!

Working with immersive technologies requires the use of special equipment and software. *Oculus Rift* and *HTC Vive* are leading players in the virtual reality software and headset market today. In addition, *Samsung Gear VR*, *XIAOMI MI VR*, *Huawei VR*, etc. are also available in Ukraine. Extended reality can be created with the use of a regular smartphone or tablet by downloading the appropriate application. As for mixed reality, *Microsoft* has developed a special product, *HoloLens* that is software and headset in the form of special glasses that allow users to interact with virtual elements of mixed reality while complementing them with real objects [29].

Nowadays, extended reality technologies are not so widespread and cheap to be available for every user. In such circumstances, libraries that provide the necessary software and headsets and give recommendations on available content might become a place where everyone can get acquainted with extended reality. Paula MacKinnon Executive Director, CALIFA, defines the focus, "Libraries are the perfect community space to provide access to new technologies and the wealth of educational VR content that is getting published today. Whether it's exploring the endocrine system of a shark or traveling back in time or to Mars — Libraries are great social places that curate large collections of content and the means to experience it — for fun, for learning and for free." [30].

In the domestic realities, the situation is somewhat similar to that in the late 90s—early 2000s with provision of users with access to the Internet. At that time, the Ukrainian Library Association, with the support of the U.S. Embassy in Ukraine, implemented a large-scale project *Internet for Public Library Readers* (LEAP), in which the U.S. government allocated more than USD 1.5 million to provide citizens of Ukraine with free access to the Internet through opening 147 Internet centers in public libraries of Ukraine. Thanks to the program funding, the libraries had the opportunity to purchase the necessary equipment, software, and trainings for staff. Today, this experience can be used to create a network of SMART-centers in scientific libraries throughout the country.

The California libraries in the United States followed this path. In 2016, in partnership with

Oculus, 90 California libraries installed virtual reality systems. Subsequent to *Oculus*, *HTC* announced in 2018 the *Vive Libraries Program* aiming at installing virtual reality systems in 110 libraries in California and Nevada.

Considering library as a catalyst for interaction between the community and the content developers, *Califa*[1], in partnership with *New Media Learning* and the California State Library, pursuant to the Library Services and Technology Act that allows libraries to win federal grants through public libraries of their states, has launched a pilot project to enable California public libraries to install a fully loaded virtual reality system completed with a computer/software/ educational media catalog and an *Oculus RIFT* with touch sensors or a *HTC VIVE* headset [31].

Today, the libraries involved in the program have established centers, laboratories, and virtual reality studios, which allow visitors to test immersive technologies.

Earlier, from 2014—2015, U.S. university libraries started providing access to immersive technologies. The libraries of Oklahoma, Pennsylvania, and North Carolina State Universities, the Universities of Western Michigan, Miami, Adelaide, Clemson, Arizona, the *DeLaMare* Science & Engineering Library of the University of Nevada, Reno, and many others have organized spaces for students and teachers to access virtual reality technology and resources that could help staff and students create content for this new media format. Such laboratories meet the purpose of scientific libraries of higher education institutions in terms of providing information on education and research.

To support the functioning of such studios, libraries introduce a special position: library manager, special or research librarian who provides the necessary advice to those teachers who are interested in integrating immersive technologies into their courses and necessary project-specific instructions for small student groups, as well as help generate ideas for smart digital media space or gain virtual reality experience. Equipment and premises are booked in advance (on average, 3 days before the event), for a period of several hours to several days.

In addition to the hardware, users get access to a collection of software products from leading corporations, developers of such software. In particular, *HTC Vive Libraries* provides access to 35 free educational products that have been developed and made available to *VIVE Studios* in geography, art and culture, history, design and health care, based on *VIVEPORT*, the official application store and *HTC Vive* content platform [30].

Among the programs available through university libraries are *Apollo 11 VR Experience* (ability to control a command module, land a lunar shuttle, and to explore the moon's surface by experiments), *Star Chart* (to study the solar system, to view constellations and meteorite showers,). constellations and meteor showers, to explore Mars, etc.), Athenian Acropolis (to visit the recreated Acropolis of Athens, every detail of which corresponds to the available archaeological data), *Quill* (VR illustration tool designed to enhance the capabilities of artists), *Google Earth VR* (to explore the Earth in cyberspace: to fly over cities, to climb mountain peaks, etc.), *3DOrganonVR Anatomy* (3D anatomical atlas showing various human body systems with more than 4,000 realistic images of anatomical structures and organs, which can be enlarged and studied from different angles, and additional and descriptive information on the topic), etc.

There are also programs for developing one's own innovative media projects: *3dsMax 2018* (software for modeling, rendering, and creating 3D animation), *Adobe Creative Cloud* (services for de-

[1] *Califa* (https://califa.org/) is a non-profit library consortium representing 230 libraries in California. Engaged in brokerage activities and facilitates procurement for libraries at reasonable prices, cooperates with the California State Library in the management of several national projects. With many years of experience and a network of professional contacts, *Califa* has become effective in the development, implementation, and management of grant programs.

sign, processing of photos, videos and web content), *Blender* (free and open source 3D animation software that supports each stage: modeling, rigging, animation, simulation, rendering, compositing, and motion tracking, video editing and game creation), *Unity3D* (cross-platform tool for developing 2D and 3D applications and games), *Unreal Engine* (a set of software tools to create content for extended reality).

Collections of VR/AR products in different libraries are not standard and constantly change depending on library's capabilities.

In addition, in order to facilitate scientific communication, special software systems are being created. They allow many distributed users to manipulate virtual 3D objects from different fields of research. An example of such systems is the *OVAL* (*Oklahoma Virtual Academic Laboratory*) platform implemented in the University of Oklahoma Library that supports the operation of a kind of virtual class *Portals*, within which students, teachers, and specialists in various subjects: up to 20 users per session can jointly conduct research in virtual reality environment. For example, that way, the inner part of the cave system of Arizona (in particular, pieces of early archaic cave art) and the ruins of Palmyra have been studied [32].

In addition to US university libraries, although on a much smaller scale, extended reality access services are now offered in specially equipped laboratories or centers by research libraries in higher education institutions of Denmark (e.g. the DTU Library *Media Lab* of the Technical University of Denmark); Canada (*Lab NEXT Library* of the University of Calgary, *Experience Lab* of Library of Mount Royal University); Netherlands (*VR Zone New Media Center Library* of Delft University of Technology); Hong Kong (*Creative LabVR-AR-Media Production Center* of the Library of the Educational University of Hong Kong, *i-Space* Library of the Hong Kong Polytechnic University, *Tech @ Ingenium* Library space of the University of Hong Kong , and others.

Although the new technology has many advantages, D. Greene and M. Groenendyk have drawn attention to the possible difficulties of its promotion in the university library: the need to ensure the preservation of equipment and to prevent theft, to hire backstopping staff, to update hardware and content, to encourage users to further use of technologies [33].

At the same time, the favorable prospects for integrating extended reality technologies into the library information service have been evidenced by the fact that having collaborated with California libraries and sponsored virtual reality research programs at U.S. universities, including the Massachusetts Institute of Technology and Harvard, *Oculus* announced the launch of pilot programs for implementing immersive technologies in educational institutions of Japan and Taiwan. Moreover, in the case of Taiwan, in cooperation with the Taiwan Association of Internet and E-Commerce, it is planned to attract VR-products to the collection of public libraries and museums across the country. Among prospective recipients of the *Oculus Rift* and *Go* headsets, there are Kaohsiung Main Public Library, National Central Library, New Taipei City Library, and Taipei Public Library.

In Ukraine, access to immersive technologies has been provided within several individual libraries: the library of Sumy State University, the scientific library of the National University of Trade and Economics, Lviv Regional Library for Children, institutions of Ivano-Frankivsk city centralized library system through grant support of UAH 14,810 from the *Teple Misto* platform [35] and some others. However, in order to support research and teaching and to ensure equal access to technology, it would be appropriate to arrange VR/AR space on the basis of Vernadsky National Library of Ukraine (VNLU) as a methodological center of academic libraries. Given the national status of the library, the creation of such a laboratory on its basis will expand the range of potential users and provide access to equipment and content to researchers from different fields of knowledge and research institutions of various subordination.

The analysis of the existing theoretical achievements of both librarians and researchers of immersive technologies, as well as the study and review of practical experience in the use of extended reality technologies in library practice have allowed the following conclusions on the promising areas of library involvement in production, access to, and use of VR/AR products:

- First, given the growing number of ready-made products, it is very important to provide information about available products and libraries of VR/AR content and to assist in navigating resources, i.e. to form special guides or indexes with the help of which users may navigate through the existing VR/AR products, as well as learn about the necessary software with which a product might be used. Seminars and lectures organized by libraries may also be in demand. Such activities, in addition to introducing a new technology, may also contribute to the formation and development of the concerned community and the environment for the exchange and production of new knowledge;
- Second, for the success of the innovative service of access to immersive technologies, the systematization and preservation of content, creation of collections of relevant products and software that will be used along with the technology, as well as their maintenance with a detailed description are essential. In the case of scientific libraries, the formation of such a collection shall give priority to the acquisition of software that has cognitive and research potential;
- Third, the involvement on a partnership basis in the development of new VR/AR products and in the implementation of research in collaboration with other institutions and organizations, in particular by creating digital content based on digitization of library collections (e.g. maps, drawings, illustrations, etc.) contributes to simulate virtual spaces;
- Fourth, the development of own products and realization of own media projects on the basis of, for example, *3dsMax2018*, *Unity3D*, etc. As a result of increasing amount of digital content, including e-books, the creation virtual card and book catalogs, VR/AR libraries, by analogy to those in the paper form, can help users navigate across the existing stock by 3D visualization. The study has shown the navigational benefits of such products that take into account the psychological characteristics of human search [15, 16, 19, 36]. It is telling that *Springer Nature* has introduced the first prototype of spatial reading, which allows users to view and to read books in virtual reality [21]. Moreover, it has been suggested that by examining the user behavior in virtual library simulator space, namely, changes in the vector of his/her view, librarians may understand the possibilities of improving the operation of the real library space to more effectively represent the library. The possibility for librarians to create their own VR or AR products has been substantiated by B. Massis who, by the example of *EON Reality* and *Aurasma* software products, concludes that now it is not really necessary to have programmer knowledge and skills in order to develop a content. The ease of using these products allows even a librarian or a teacher to create original content, regardless of his/her previous experience [12];
- Fifth, purchasing the appropriate equipment, including *Oculus Rift*, *HTC Vive*, *Microsoft Hololens*, *Google Cardboard* enables creating one's own SMART-space that can be used to develop IT solutions that allow the use of virtual and augmented reality for teaching and research (including the organization of scientific interaction in cyberspace following the example of OVAL University of Oklahoma Library). Nowadays, in the post-Soviet countries, the leaders in the organization of such spaces are business structures and higher education institutions. However, the creation of library-based VR/AR laboratories will help democratize access to immersive technologies. Such a space makes it possible to acquaint users with new technology and to form their corresponding com-

petences, in particular, to allow use of VR/AR equipment and related software for the creation and use of VR in library space and to conduct consultations and trainings.

The analysis of experience has shown that depending on the scale of implementation of the extended reality library service, the backstopping team needs from one to several members: VR/AR content marketer (for studying the institution's involvement in projects related to extended reality technologies, media support of relevant products and services); VR/AR content curator (for providing assistance and advice to users on the use of certain products), research librarian (library specialist involved in the implementation of research projects), VR/AR space manager (for supporting and organizing access of researchers to headsets and laboratories, conducting trainings, seminars, inviting specialists).

It is also important to purchase quality equipment. The costs might be reimbursed from various sources: applications to manufacturers who are interested in expanding the market; interaction with relevant business structures (such as the domestic corporation *Sensorama*); participation in grant project competitions; corporate acquisition; and crowdfunding.

Therefore, given the prospects of using extended reality technologies to solve research and educational problems, it is advisable for scientific libraries to organize a comprehensive library and information service to provide access to immersive technologies and products and services based on them.

The key components of such a service are as follows:

- software and hardware — SMART-space created in the library;
- a set of products, starting with the content (both library's own and provided by manufacturers and partners) and ending with guides and navigators of resources created by library, as well as a range of services with a detailed description of these services;
- librarians: marketer, curator, content manager, and special librarian;
- users: researchers, students, the general public.

Promising directions for the introduction of immersive technologies in the practice of scientific libraries to provide information technology support for research are to facilitate the navigation across finished VR/AR products, to create appropriate guides and navigators, to systematize and to preserve the existing content, to create one's own and to contribute to developing new VR/AR products, to organize library VR/AR space, to allow the use of VR/AR equipment, to organize and to hold consultations, seminars, lectures, and trainings.

Actual tasks related to the implementation of organizing the comprehensive library and information service to provide access to immersive technologies and products and services based on them are to train specialists (because specialized higher education institutions have not yet introduced courses on extended reality technologies in their educational programs; also, this component is missing in the programs of advanced training of librarians), to organize (to allocate and to arrange premises) space, and to ensure security measures (control over the content downloaded to the device or created, observance of intellectual property rights, property damage prevention etc).

Having solved these problems enables the modernization of the existing library and information service in accordance with the needs of the scholarly research and educational market and facilitates the transformation of libraries into modern information and communication hubs.

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ІМЕРСИВНІ ТЕХНОЛОГІЇ В БІБЛІОТЕЦІ: ОРГАНІЗАЦІЯ ІННОВАЦІЙНОГО СЕРВІСУ ДЛЯ НАУКИ ТА ОСВІТИ

Вступ. Необхідність підвищення ефективності наукової діяльності, створення умов для продукування нових знань і обміну ними актуалізують вивчення когнітивного потенціалу імерсивних технологій.

Проблематика. Розкриття потенціалу імерсивних технологій для організації інноваційного бібліотечно-інформаційного сервісу сприяння розвитку науки і освіти.

Мета. Обґрунтування необхідності впровадження в практику наукових бібліотек імерсивних технологій з метою забезпечення інформаційно-технологічної підтримки наукових досліджень і освітньої діяльності, розробка теоретико-методологічних підходів до організації бібліотечного сервісу, побудованого на основі імерсивних технологій.

Матеріали й методи. Джерельну базу дослідження склали вебсайти наукових бібліотек, тематичні ресурси (портал Масачусетського технологічного інституту MIT Media Lab Research, сайти компаній-розробників програмного забезпечення та офіційні веб-сайти хакатонів віртуальної реальності), фахові публікації, що висвітлюють специфіку імерсивних технологій, досвід їх використання в наукових дослідженнях та в бібліотечній практиці. Використано системний, функціональний методи, методи спостереження, гіпотези в поєднанні з соціальнокомунікаційним методом.

Результати. Показано доцільність впровадження в практику наукових бібліотек імерсивних технологій як інноваційного інструменту інформаційно-технологічного забезпечення розвитку науки і освіти, акцентовано когнітивний потенціал імерсивних технологій, розроблено теоретико-методологічні засади організації комплексного бібліотечно-інформаційного сервісу, побудованого на використанні імерсивних технологій, висвітлено приклади ефективного використання останніх науковими бібліотеками.

Висновки. Позитивний ефект використання когнітивного потенціалу розширеної реальності в освітній практиці й наукових дослідженнях актуалізує розробку стратегій організації в наукових бібліотеках комплексного бібліотечно-інформаційного сервісу з надання доступу до імерсивних технологій

Ключові слова: віртуальна реальність, доповнена реальність, імерсивні технології, технології розширеної реальності, наукові бібліотеки, бібліотечний сервіс, інновації.