Immersive Health Monitoring: Harnessing Virtual Reality for Advanced Healthcare Solutions

Monu Sharma
University Institute of Film & Visual Art
Chandigarh University
Kharar, India
mannan.sharma487@gmail.com

Pradeep Kumar
University Institute of Film & Visual Art
Chandigarh University
Kharar, India
pradeep.sthr@gmail.com

Deepak Kumar Singh
University Institute of Film & Visual Art
Chandigarh University
Kharar, India
dksqwerty@gmail.com

2023 International Conference on Artificial Intelligence for Innovations in Healthcare Industries (ICAIIHI) | 979-8-3503-3091-5/23/$31.00 ©2023 IEEE | DOI: 10.1109/ICAIIHI57871.2023.10489108

Abstract— **Virtual reality (VR) technology has emerged as a transformative tool in healthcare, revolutionizing the way we monitor, manage, and enhance patient well-being. This abstract provides an overview of the potential and significance of using VR in health monitoring and its impact on advanced healthcare solutions for the patients. Through Bibliometric analysis, the last 10 years of data has been analyzed in this paper which depicts that the use of VR in healthcare and health monitoring has been consistently growing in the field of medical. The positive and negative effects of VR on user health have been discussed in this paper. The finding of this study shedding light on the use of virtual reality in the medical practice.**

Keywords— ***virtual reality (VR), health monitoring or healthcare, computer graphics,***

I. Introduction

Virtual reality (VR) integrates computer applications, multimedia, information technology, and simulation techniques. Its applications span diverse fields, including advertising, sports, game design, and film production. Furthermore, VR exhibits promise in enhancing health-related knowledge and influencing behavior positively [1]. The virtual reality technology's involvement in healthcare represents a promising transformation for patient care and medical students. VR is a very sophisticated technology that is employed in the simulation, education, and entrainment sectors. It is highly recommended that people in other fields must try VR as part of their research. VR has been utilized in medical therapy, rehabilitation, and education, offering a simulated environment to support these objectives [2][3].

VR has been employed to train healthcare professionals in the delivery of difficult news, demonstrating positive effects on learning and fostering patient-centered approaches [4]. The old healthcare system has long relied on conventional techniques for training, diagnosis, and treatment; however, with the advent of virtual reality technology, learning has become easier and modern technology is being used in the field of medial.

Both patients and healthcare professionals stand to benefit greatly from the diverse ways VR technology is being utilized in health monitoring and healthcare. In this paper, a thorough summary of these applications will be provided to offer insight into the comprehensive advantages they afford. VR has surfaced as a promising instrument for monitoring health and conducting diagnoses [5]. Potential for revolutionizing healthcare has been shown by a study with VR technology at its forefront. With this technology, innovative solutions for therapy, medical training, health monitoring and patient care could be provided. Using information from VR helps us understand how people behave and predict when someone might start facing mental health issues. This can then help create special VR experiences to make therapy better [6]. The integration of VR into healthcare systems helps to reduce the overall burden on resources while also improving patient outcomes and medical education. VR technology is helpful in healthcare for things like teaching patients, training medical professionals, and doing medical appointments online. This helps make patients better, keeps them more interested, and makes medical training more effective [7][8]. In healthcare and health monitoring, VR is a versatile player that provides several benefits, such as enhancing patient care, healthcare delivery, and medical training. Its multifaceted nature allows for diverse applications. The VR application can be used by medical professionals such as nurses and doctors for immersive health consultation [9]. VR has found a new use in pain management that doesn't require drugs. In fact, VR's immersive environments have been quite effective at distracting patients from unpleasant sensations brought on by medical procedures, like wound dressings, injections, and dental work. By transporting patients to a virtual world, they can perceive less pain, anxiety, and general discomfort. This system includes a machine learning model that predicts changes in health conditions and provides alerts based on the patient's previous medical records and vitals. The monitor and ventilator parameters are sent to the headset via the laptop, to get useful information [10]. Head mounted display (HMD) equipment is used and light in weight, demonstrating significant benefits from the seamless integration of digital data with healthcare practitioners' and patients' experiences [11][12]. In order to maximize the efficacy and success of implementing new technology for patient benefit, researchers have looked into a number of factors. Information technology can help hospitals when creating or modifying new service protocols. Health care facilities can improve their service innovation processes by analyzing and identifying patient needs and preferences through the use of information and communication technology applications [13]. VR technology is used in serious gaming to heal the patient's mental health symptoms. Serious games can be used in various aspects of health care, such as educating patients, their families, and the public about a disease or a medical/surgical procedure and VR helps the medical trainer and professional to enhance learning experiences in the medial industry [14][15]. The use of VR in medical education is very useful and following factors can be considered:

Virtual Reality for Stress Management: With the intention of reducing stress and promoting relaxation, VR environments are created and can be utilized at a healthcare facility or at home to assist patients in coping with stress and anxiety-related ailments. To enhance relaxation and mental health, instructed VR mindfulness and meditation lessons can be an effective tool.

Exposure Therapy: VR has demonstrated usefulness in the treatment of phobias, post-traumatic stress disorder (PTSD), and anxiety disorders through the use of exposure therapy. Exposure therapy can be done in a way that patients would experience their fears gradually and safely by creating virtual environments. In so doing, they face and overcome their fears.

Physical Rehabilitation and Therapy: Patients recovering from operations or injuries can benefit from VR-based rehabilitation exercises. These workouts can be tailored to meet the needs and skill levels of everyone. VR has been shown to be particularly useful for physical therapy in stroke rehabilitation, traumatic brain injury, and other diseases because it helps enhance motor skills, balance, and mobility.

II. Positive and Negative effects of VR in healthcare and health monitoring

A. *Positive Effects:*

Enhanced Patient Engagement: Patients' motivation to engage in therapy, rehabilitation, and health monitoring activities can be increased by providing them with realistic and captivating experiences through virtual reality. It can add some fun and interaction to the healthcare procedure.

Pain Management and Stress Reduction: Virtual reality (VR) offers a non-pharmacological approach to stress relief and pain management. During medical operations, it helps patients relax and divert their attention from pain and suffering, which may lessen the need for painkillers.

Improved Rehabilitation Outcomes: VR-based rehabilitation exercises are intended to be more entertaining and engaging than conventional workouts, which may improve patient compliance and hasten their recuperation.

Remote Patient Monitoring: VR can facilitate remote patient monitoring, which lets medical professionals keep tabs on patients' vital signs and health issues in real time. This can lessen the need for frequent in-person visits and increase access to care.

Medical Training and Education: VR is a useful technology for medical education because it provides accurate simulations that allow medical professionals and students to perform surgery and diagnose challenging cases. This may result in medical professionals who are more prepared.

Access to Specialized Care: VR can give patients access to specialist medical services that might not be nearby. Telemedicine enables patients to consult with global experts.

B. *Negative Effects:*

High Costs: It can be costly to use VR technology in healthcare; large expenditures in hardware, software, and training are necessary. The expense could prevent widespread use.

Technical Challenges: Due to its complexity, virtual reality technology may present technical difficulties such software and hardware incompatibilities, malfunctions, and upkeep needs that could interfere with patient treatment.

Ethical and Privacy Concerns: VR applications in healthcare give rise to ethical and privacy problems, particularly with relation to patient data collecting and security. Ensuring data security and safeguarding patient privacy are critical.

Potential Overreliance: There is a risk that healthcare providers and patients may become overly reliant on VR technology, potentially neglecting other essential aspects of patient care, such as the human touch and interpersonal interactions.

Limited Accessibility: Virtual reality technology might not be appropriate for all medical illnesses or age groups, nor be accessible to all patients, particularly those with physical or cognitive disabilities.

Regulatory and Legal Issues: VR integration in the healthcare industry may present legal and regulatory obstacles, such as issues with medical negligence, liability, and licensing.

In conclusion, virtual reality, or VR, has been used in healthcare and health monitoring to provide accurate data digitally. However, there are risks associated with VR that should be CONSIDERED for future considerations. VR has the potential to improve patient health, but it must be used properly to achieve the best potential outcomes.

III. Growth of Virtual reality system in medical stream

VR was introduced to the world a decade ago. The use of VR technology nowadays is becoming a part of each sector either its educational, simulation, training and development, aviation or medical education and technology.

Virtual reality transformed many facets of healthcare by providing pain management, stress reduction, and mental health therapy to patients which helps the patient to recover from the surgeries and illness. VR is an excellent tool for medical professionals to practice or experience VR technology before applying it to a real patient. It gives an opportunity to healthcare workers to practice and understand the use of VR technology in patient health situations. VR has also enhanced patient satisfaction as compared to traditional healthcare systems. As VR continues to evolve, it promises to enhance patient engagement, revolutionize medical training, and optimize healthcare processes, ultimately leading to improved healthcare delivery and patient outcomes. The growth of VR in medicine reflects its potential to redefine the future of healthcare.

A. *Problem Statement*

Patient Standardization and Regulation: There is no proper policies and procedures to follow the VR technology application in the medical field which makes it difficult to ensure that the VR technology meets the standards in the field of medical and patient safety.

Patient Acceptance and Accessibility: Virtual reality is a immersive and amazing instrument but not all patient are ready to wear and experience the same. Some are the factors that patient don’t able to experience the VR technology such as elderly people or those who are not mentally prepared to experience the VR and it’s not widely available in all medical facilitation centers.

Healthcare Workforce Training: The use of VR technology has significantly increased in many sectors such as education, simulation, training and development. In the medical stream it plays a vital role, but without proper training to the doctors, nurses and healthcare professionals, the use of VR on patient can be dangerous.

B. Significance of study

VR has become a game-changing technology that has enormous implications for monitoring and providing healthcare. The use of VR in medical education and training is one of the most noteworthy uses of VR in healthcare. Today, medical professionals can practice complex surgeries and procedures by immersing themselves in realistic, simulated scenarios. This reduces risks to real patients while improving skills and confidence. VR also provides a potent tool for therapy and pain management. During a variety of medical procedures, patients can be taken to serene and immersive virtual environments, which can help them feel less pain and anxiety.

Beyond teaching and managing pain, virtual reality is essential to psychological treatment. It offers a secure and regulated setting for exposure therapy, which is especially helpful in treating anxiety disorders, phobias, and post-traumatic stress disorder (PTSD). VR also makes telemedicine and remote consultations possible. This makes healthcare more efficient and accessible, particularly in remote areas, by enabling medical professionals to monitor and assess patients' conditions from a distance.
VR is also very helpful for patient rehabilitation. Personalized VR exercises are a vital component of physical therapy and the recuperation process following an injury or surgery, as they can help restore motor functions, cognitive abilities, and balance. These applications showcase the profound significance of VR in healthcare, as it enhances medical training, patient comfort, therapy options, and remote care, ultimately contributing to improved health outcomes and the overall well-being of individuals.

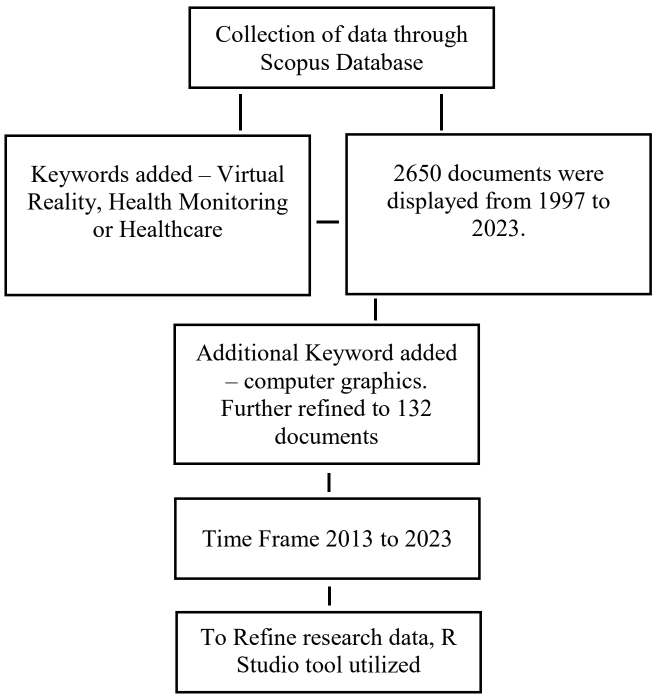
C. Methodology

This research paper's data was methodically taken from the Scopus database, which is a well-known collection of academic literature from a variety of academic fields. A thorough search was carried out with the keywords "Virtual Reality" "Healthcare or Health monitoring Engagement”. After the data was refined, 2650 documents from 1997 to 2023 were displayed. An additional keyword search, "computer graphics," further limited the number of documents to 132 for the same years. This set of keywords was selected to guarantee a thorough retrieval of current and pertinent research delving into the application of VR technology in healthcare and health monitoring settings. The study period, which spans ten years from 2013 to 2023, was chosen.

The chosen duration was chosen to encompass groundbreaking research as well as the most recent developments in the field of VR integration in education. To improve the accuracy and legitimacy of the information gathered, the search results were restricted to peer-reviewed journal articles, conference papers, and scholarly publications.

A comprehensive evaluation of the chosen publications was part of the data collection procedure that followed. The title, abstract, and keywords of each publication were carefully considered in order to determine how well it aligned with the goals of the research. The impact of virtual reality on medical fields like patient healthcare and health monitoring has only been studied in detail.

R Studio, a potent data analysis and visualization tool, was used to further refine the data. To extract useful insights and patterns from the abundance of data acquired from Scopus, the extracted data points were sorted, cleaned, and put through the necessary statistical analyses. The accuracy and resilience of the ensuing conclusions were guaranteed using R Studio.



D. Results and Findings

With the help of R Studio's analytical tools and the integration of data from Scopus, a compelling story about the use of VR technology in education is revealed. Analysis of research from 2013 to 2023 repeatedly highlights how VR patients have a transformative effect on healthcare.

VR integration has continuously demonstrated potential to improve medical stream output. Patients can focus on something other than their pain thanks to virtual reality's immersive qualities. VR has demonstrated promise in the treatment of phobias and anxiety-related mental health issues. VR is integrated with health monitoring devices which is very helpful for the healthcare professionals to monitor the updated health sign of patients. Finding shows that the VR platform has potential to give more accurate data rather than the traditional method of health care system.

E. Figures and Table

TABLE I. SCOPUS DATA 2013 TO 2023

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2013:2023
Sources (Journals, Books, etc)	71
Documents	92
Annual Growth Rate %	-6.7
Document Average Age	5.04
Average citations per doc	12.23
References	2946
DOCUMENT CONTENTS	
Keywords Plus (ID)	968
Author's Keywords (DE)	313
Articles	22
Conference Paper	56
Conference review	4

Table I. above provides an overview of the data insights obtained from the careful examination carried out in R Studio. The main conclusions and patterns that were derived from the thorough analysis of the papers, authors, references, sources, and the designated time frame are summarized in this visualization. The graph is evidence of R Studio's analytical ability to combine complex data into logical and understandable visual representations.

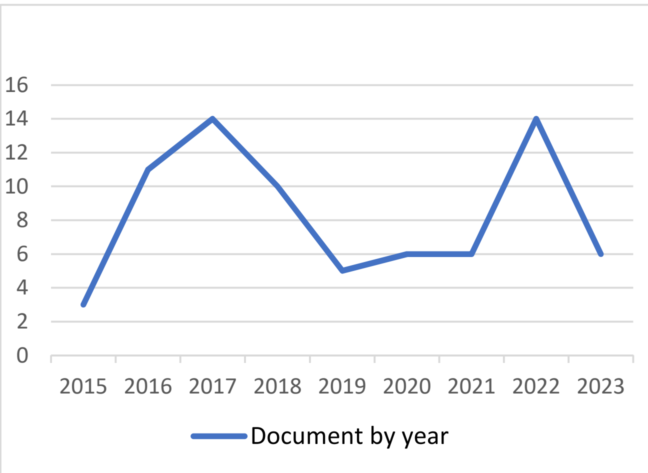


Fig. 1. Distribution of document by year.

For the years 2013 to 2023, the visualization in Fig. 1. offers a thorough summary of the academic landscape regarding the application of virtual reality (VR) technology in healthcare and health monitoring. The graph provides a clear visual representation of the frequency of documents published over the specified time period, highlighting changing trends and areas of interest for research in the field. The years 2022 and 2017 saw the highest number of publications published during the entire period. The graph shows that 2015 saw the fewest documents published.

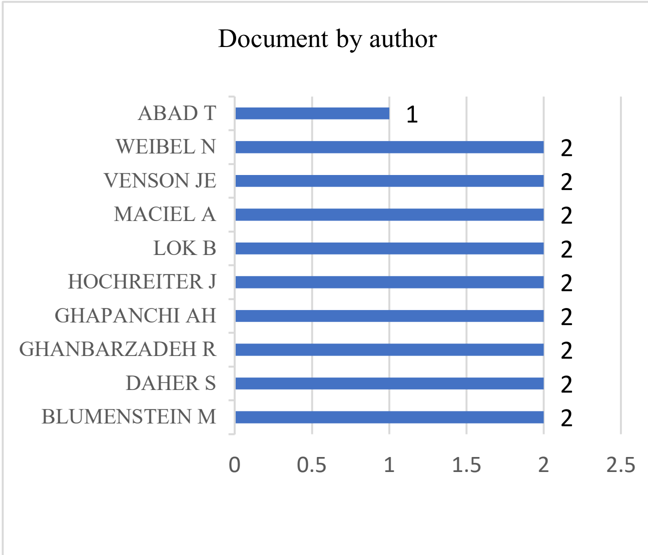


Fig. 2. Documents by authors.

An overview of the major writers' contributions to VR healthcare and health monitoring is given in this graphic Fig. 2. The influence of specific authors and researchers is shown in this graph. The graph's data set spans from 2013 to 2023. The authors who have published the most papers on VR healthcare and health monitoring are Blumenstein, Daher, and Ghanbarzader, among others. The majority of the authors have written two publications.

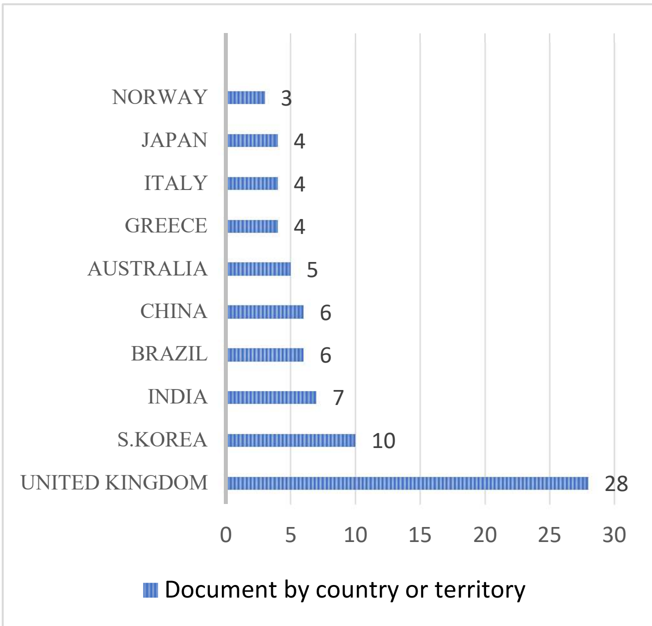


Fig. 3. Documents by country/territory.

The visualization is presented in Fig. 3. presents a compelling global picture of the involvement of different nations in the field of VR health monitoring and healthcare research from

2013 to 2023. In addition to highlighting the geographic distribution of research efforts, the graph identifies the nations that submit the greatest number of documents. About 28 articles from the United Kingdom were submitted, the most being from South Korea (10 papers), India (7), Brazil and China (6), Australia (5), and Japan Italy, Greece, and Norway each submitted three papers.

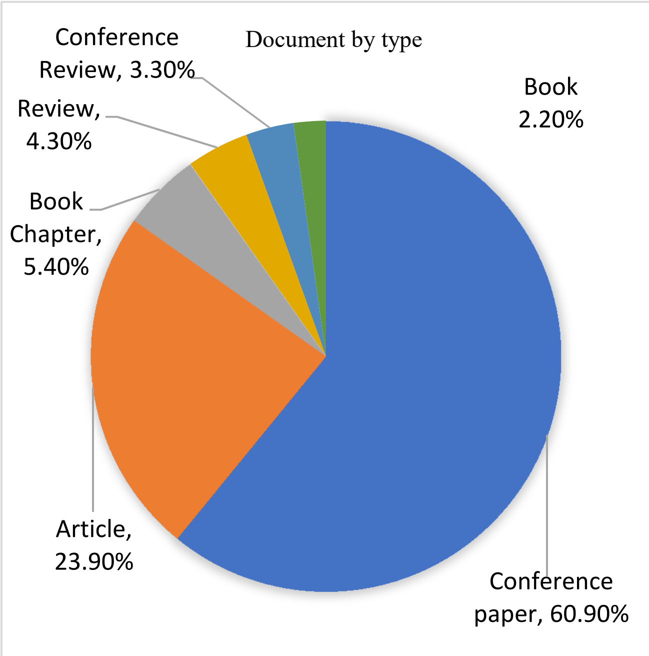


Fig. 4. Documents by type.

Fig. 4. shown a detailed analysis of the distribution of publication types in the field of VR healthcare and health monitoring research from 2013 to 2023 is presented in Figure 4. The graph provides a visual depiction of the variety of scholarly output and the formats in which researchers prefer to submit their work. Conference papers make up the majority of publications in the field of VR healthcare and health monitoring research, making up roughly 60.90% of all publications. As a result, articles make up about 23.90% of publications, book chapters make up 5.40%, review papers only 4.30%, conference reviews make up roughly 3.30%, and books make up roughly 2.20% of publications.

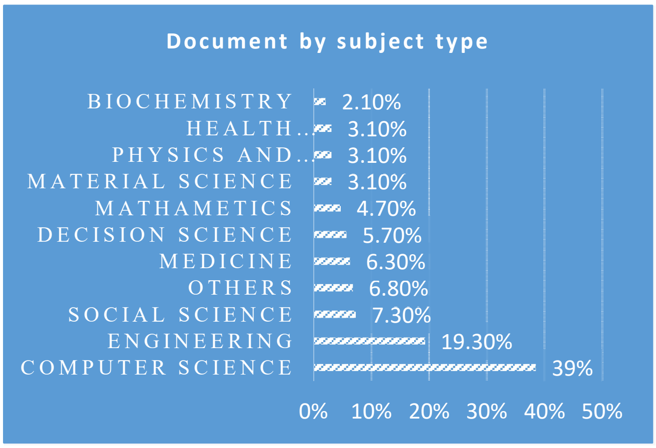


Fig. 5. Documents by subject type.

A thorough breakdown of the distribution of papers published in a range of academic subjects related to VR health monitoring and healthcare research is presented in Fig. 5. This graph, which spans the years 2013 to 2023, provides insights into the various disciplinary lenses that researchers use to examine the incorporation of VR technology into education. The graph clearly shows that, at about 39% of all published papers, Computer Science is the subject with the greatest number of publications. Engineering claims the second-highest share, at roughly 19.30%, after computer science. The graph also shows that biochemistry is the least represented subject, accounting for only about 2.10% of the published papers.

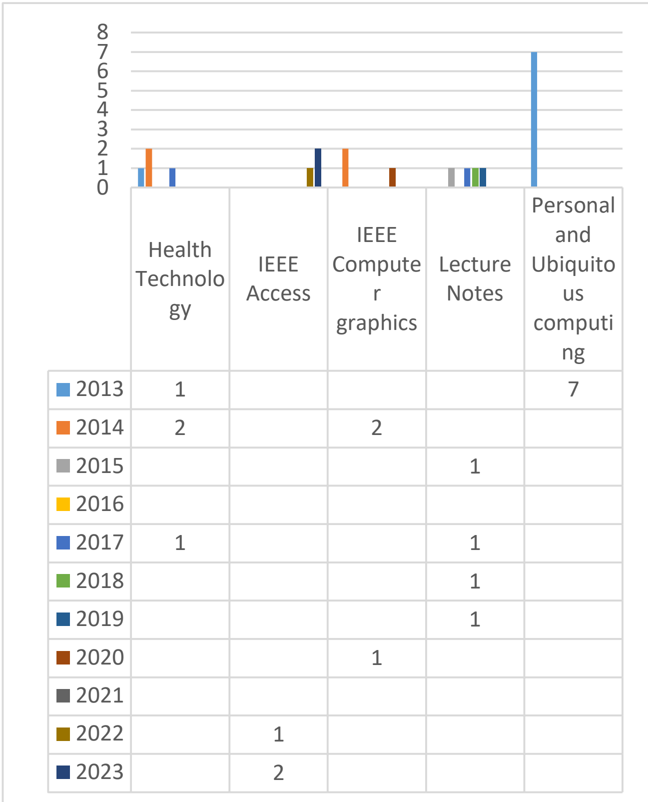


Fig. 6. Documents by source

A perceptive illustration of the citation trends in the field of VR health care and health monitoring research from 2013 to 2023 can be found in Fig. 6. The line graph provides a dynamic snapshot of the impact and recognition gained over time and functions as a visual representation of the document by source by research papers. 2013 stands out as a year of particular interest, with the highest document count (7 sources) in the areas of personal and ubiquitous computing, and the lowest document count (1 source) in the areas of bioinformatics lecture notes and IEEE access in 2015, 2018, 2019, and 2022.

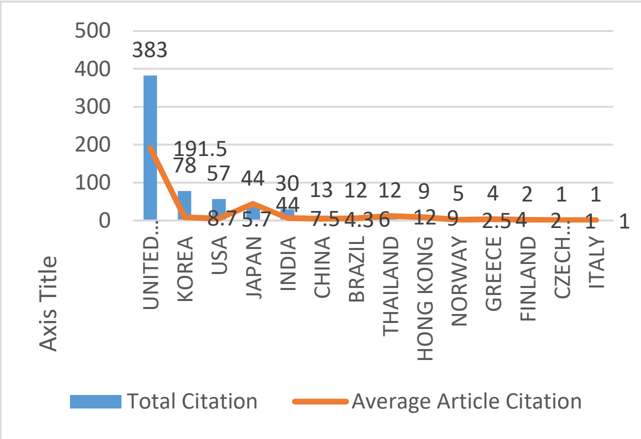


Fig. 7. Documents by most citation by countries.

Fig. 7. provides a thorough overview of the citation environment in the field of VR health care and health monitoring research, broken down by nation. This graphic illustrates the total effect and meaning that each country's contributions have brought about, providing insight into the international significance of the study carried out in this area. The United Kingdom is a prominent leader, with the most citations overall (roughly 383) but a comparatively low average citation rate of one. Despite having 78 total citations, Korea stands out for having a dynamic and an average citation count of 8.7 research outputs. Conversely, with roughly 1 citation each, the Czech Republic and Italy show the lowest overall citation counts one only.

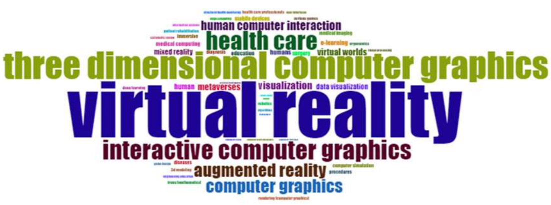


Fig. 8. Documents by most relevant keywords.

The most pertinent and recurring themes that have surfaced in research on VR health care and health monitoring are shown graphically in Fig. 8. This word cloud summarizes the main ideas and subjects that scholars have looked into in this ever-evolving field. These terms, which include "computer graphics," "health monitoring or healthcare," and "virtual reality," sum up the main concepts that researchers have studied over the years.

CONCLUSION

In conclusion, studies show that the incorporation of virtual reality technology has become commonplace globally and, by providing immersive and interactive experiences, has
W

revolutionized medical practices. When combined with appropriate treatment, VR has the potential to improve patient outcomes. Lastly, even though cutting-edge VR technology has the potential to replace conventional medical systems, the majority of the healthcare and health monitoring sectors have not included immersive VR in their medical instrumentation because of cost and lack of awareness. VR technology has been used in other fields, including engineering, aviation, training and development, and education. This is a sign that more new tools will be added to help with data collection and exploration.

REFERENCES

[1] M. Fink, D. Sosa, V. Eisenlauer, and B. Ertl, " *Authenticity and interest in virtual reality: Findings from an experiment including educational virtual environments created with 3D modeling and photogrammetry*," doi: 10.562. 38/alookdevelopv1-187, 2023.

[2] D. Kaminska, G. Zwolinski, A. Laska-Lesniewicz, and L. Coelho, "*Virtual Reality in Healthcare: A Survey,*" IRMA International, doi: 10.1007/11418337_3, 2023.

[3] D. Oswald, A. Reichmann, and M. M. Bock, *"Virtual Reality Interventions for Mental Health,"* Current Topics in Behavioral Neurosciences, doi: 10.1007/7854_2023_419, 2023.

[4] S. van Ginkel, I. Blauw, B. Sichterman, and A. Klarenbeek, *"Virtual reality training of bad news delivery in health care,"* Patient Education and Counseling, doi: 10.1016/j.pec.2022.10.297, 2023.

[5] F. Ferreira-Brito, H. Gjoreski, O. Mayora, M. Lustrek, E. kizhevska, J. Guerreiro, K. Gerling, S. B. Badia, and T. Guerreiro, *"Virtual Reality for Health and Wellbeing,"* doi: 10.1145/3568444.3568560, 2022.

[6] V. Chitale, D. Playne, H. N. Liang and N. Baghaei, *"Virtual Reality Data for Predicting Mental Health Conditions,"* IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct), Singapore, pp. 6-8, 2022.

[7] A. Hassan and S. Aziz, *"Virtual Reality Programs Applications in Healthcare,"* Journal of Health and Medical Informatics, doi: 10.4172/2157-7420.1000305, 2018.

[8] S. Anitha, Pillai, and S. Mathew, *"Impact of Virtual Reality in Healthcare: A Review,"* doi: 10.4018/978-1-5225-7168-1.CH002, 2019.

[9] C. Sik-Lanyi, *"Virtual reality healthcare system could be a potential future of health consultations,"* in 2017 IEEE 30th Neumann Colloquium (NC), pp. 000015– 000020, IEEE, 2017.

[10] C.-J. Liang, C. Start, H. Boley, V. R. Kamat, C. C. Menassa, and M. Aebersold, *"Enhancing stroke assessment simulation experience in clinical training using augmented reality,"* Virtual Reality, vol. 25, no. 3, pp. 575–584, 2021.

[11] M. R. Desselle, R. A. Brown, A. R. James, M. J. Midwinter, S. K. Powell, and M. A. Woodruff, *"Augmented and virtual reality in surgery,"* Computing in Science, 12(14), 6890; https://doi.org/10.3390/app12146890, 2022.

[12] Kleanthis, Manolakis., George, Papagiannakis. (2022). *"Virtual Reality simulation streamlines medical training for healthcare professionals".* Journal of Dentistry, doi: 10.1016/j.jdent.2022.103987

[13] A. I. Stoumpos, F. Kitsios, and M. A. Talias, *"Digital Transformation in Healthcare: Technology Acceptance and its Applications,"* International Journal of Environmental Research and Public Health, vol. 20, no. 4, p. 3407, 2023, doi: https://doi.org/10.3390/ijerph20043407.

[14] Michael, F. Wagner, P. Urbauer, A. Balz, and Mathias Forjan, *"Extended Reality Solutions in Medical Context and Educational Approaches,"* Studies in health technology and informatics, Jun. 2023, doi: https://doi.org/10.3233/shti230548.

[15] S. Chakraborty, H. Chopra, S. Akash, C. Chakraborty, and K. Dhama, *"Advances in artificial intelligence (AI)-based diagnosis in clinical practice—correspondence,"* Annals of Medicine and Surgery, vol. 85, no. 7, pp. 3757–3758, Jun. 2023, doi: https://doi.org/10.1097/MS9.0000000000000095.