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The Opportunities and Limitations of Human Computer Interaction in Virtual and Augmented Reality

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Abstract*— Virtual Reality, Augmented Reality and other such immersive environments have gained popularity with the increase in technological trends in the past decade. As they became widely used, the human computer interface design and the designing criteria emerges as a challenging task. Virtual and Augmented Reality provide a wide range of applications ranging from a primitive level like improving learning, education experiences to complex industrial and medical operations. Virtual reality is a viable alternative that can be focussed on, in the future interface design development because it can remove existing generic and complex physical interfaces and replace them with an alternative sensory relayed input form. It provides a natural and efficient mode of interaction, that the users can work with.Virtual and Augmented reality eradicates the need for development of different acceptable standards for user interfaces as it can provide a whole and generic interface to accommodate the work setting.In this paper, we investigated various prospects of applications for user interaction in Virtual and Augemnted realities and the limitations in the respective domains. The paper provides an outline on how the new era of human computer interaction leading to cognition-based communications, and how Virtual and Augmented realities can tailor the user needs and address the future demands which replaces the need for command-based interaction between the humans and computers.

Keywords: Augmented Reality, User Experience, User Interfaces, Virtual Reality.

I. INTRODUCTION

The advancements in the technological fields in the past few decades have brought about noticeable changes to the aspect of life and how we perceive interaction with things. There has been a constant evolution of user interface design ever since the production of commercial computer systems towards the latter half of the 19th century.

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But there has been increasing trend towards the focus on user interaction rather than the hardware and software capabilities to increase the cognitive capabilities.

As the focus shifts, the necessity for easily approachable and accessible standards of design became a cause of concern. In the initial stages of computer systems, only the programers and engineers had the access to the computers and had the necessary skills to do so. The focus was on improving the software capability and not much on the graphical interface. But, as the applications began to be developed for groups and individuals, the existing design criteria became inadmissible as the input needed to be generalized to accommodate users with minimal experience and not just experienced programmers. Thus, there was a need to evaluate and improve the standard of design standards to improve the user interface. With the rapid technological advancements in the past two decades, Immersive environments have been a focus as part of trend in interface design. Virtual and Augmented realities provide the user enhanced experience of using the application. They would be able to perceive and manipulate information through sensory relayed inputs. This would eradicate the need for the users to have a prior experience about the system, as the elements of computation are perceived as real-world experiences.

II. METHODOLOGY

We reviewed and reserched relevant published and posted research papers to provide an outline on how the new era of human computer interaction leading to cognitive info communications that can tailor the application to the user's specific needs and address the future demands which replaces the need for command-based interaction between the humans and computers .

Since the inception of Immersive environments as a design standard there have been various instances of such environments which include Virutal Reality (VR), Augmented Reality (AR), Mixed Reality (MR) etc. But there has always been a misconception about the different types of realities listed before, by the common audience and the increasing attention due to the rapid and still increasing trend requires for detailed information regarding these.

III. KEY CHALLENGES &CONSIDERATION

A. *FOR USER TASKS*

Virtual Reality (VR) is a computer-simulated recreation of real-life environment or a situation. The sensory relayed inputs mimic the user movement to give them an immersive feel of experiencing the simulation directly. It is developed by a coding language known as VRML (Virtual Reality Modelling Language) which simualates a series of images to recreate a situation and specifies the possible interactions in that instant. Augmented Reality (AR) is a technology that utilizes an existing reality and adds a layer of computer-generated enhancements to make it more meaningful to interact with. AR involves

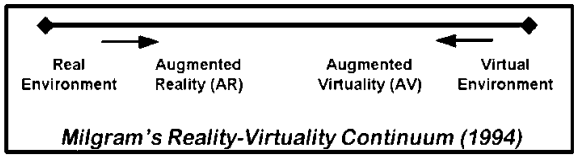

Fig. 1. Depiction of the difference between Virtual and Augmented Realities according to the Milgram's Reality-Virtuality Continuum.

applications involving mobile devices to implement the digital concepts as a real-world experience in such that they are compatible and enhance each other, can also de differentitated easily. AR Technoogy is used to display overlays and in the concept of holograms and other motion-based commands.

Virtual and Augmented realities are infact quite opposite to each other in the mechasims they use and the deliverables they try to accomplish. Virtual reality focuses on being able to offer a digital recreation of a real-life situation. Whereas, Augmented Reality offers virtual elements as an overlay to the real-life examples. However, Augmented and Virtual realities utilize the same kind of technology and try to attain the common goal of hance uing user experience. Various inputs like sensory relays based on gestures, voice and speech recognition can be used in this spectrum as inputs.

These inputs replicate being in a real or imagined environment and perform tasks desired by the user. Inputs are recorded and relayed through sensory relays based on gestures, voice and speech recognition or any other form of the provided spectrum of inputs. These inputs replicate being in a real or imagined environment and perform tasks desired by the user. Virtual and Augmented reality eradicates the need for development of different acceptable standards for user interfaces as it capable of providing a whole and generic interface to accommodate the work setting.

However, even while the immersive environments provide an enhanced user experience, it is difficult to monitor the user activities for improving real-time experience. The actions need to be monitored (see Table 1) and the application might need to be recalibrated based on the performance later, after the analysis. There are numerous examples where the user tasks comprise of the major action input for the immersive environment and it being the sole reason for the need of improved user interface in that domain.

Virtual reality and Augment reality provide a wide range of applications ranging from primitive examples like improving learning and educational experiences to complex engineering, industrial and medical operations.Virtual and Augmented realities simulate the actions in an alternate reality, which remove the need for user presence and mimic the user actions to get the tasks done, without their presence although they are present virtually. Table 1 shows the user tasks which have been identified in our study. There have been numerous examples discussed in the research papers where Virtual or Augmented reality was used to replicate human actions in conditions inhospitable to humans [12][16]. The

TABLE 1

Summary Table of User Tasks:

Research Paper Reference Number	User Tasks									
	Activity monitoring	Manual Work Application i.e. Human Participation	Task Planning and Diagnostics	Monitoring Tasks	Creation and Analysis of Visualizations	Simulation	Calibration	Monitoring Feedback	Pre-Processing	Movement Tracking
1	*	*			*			*		
2			*		*					
3		*			*					
4		*			*	*				*
5	*						*			
6		*		*		*				*
7					*		*	*		*
8		*				*	*		*	*
9	*						*			*
10	*									
11		*	*	*	*		*			
12	*				*	*				*
13		*					*			*
14			*		*			*		
15				*						*
16						*	*			*
17	*				*		*			*
18						*			*	*
19		*	*				*			*
20		*	*		*		*			*

equipment is programmed in a way to mimic the user actions and perform the required tasks. VR/AR provide the technology to perceive computational elements and objects in real world experience including structures and machinery [9] to perform complex activities, while performing the tasks through mere gestures and speech. However, there are various user tasks need to be performed to enable the necessary operations in immersive reality. Activity monitoring is necessary in the field of education [14]. In such situations, it enables the instructor to observe the VR users in a scale using AR, where the gazes of VR users and improve the awareness of the person monitoring the tasks. Task planning and diagnostics is another such user task which is incorporated in the field of constructions along with the previously discussed tasks. Designing proper tachnologies for safety enhancement involves numerous technology trade-offs. It requires precise calibration and simulations, while monitoring the tasks being performed to analyse the performance. Based on the feedback, the application needs to be diagnosed and calibrated again to improve the efficiency.

B. *For Interface Design Considerations*

We considered the various design interfaces we were able to identify from the examples. Virtual and Augmented reality were the basic criteria and the most popular as the topic is built around them. The sensor relayed input is used to eliminate the generic and complex physical interfaces and replace them. The sensors relay the motions and gestures of the user to the system, which mimics these actions in the virtual environment. The equipment needs to be calibrated prior to the operation to be able to recognize the gestures, speech or any other motion movement. The design criteria are categorized as Expert centered and User centered, to normalize the ope

ratios involved in the performing the tasks desired by the user. 3D and Depth sensing [2][7] are used in medical field-oriented operations to assist in the complex tasks involved and enable the user to multitask simultaneously. There are certain applications that are web application oriented, majorly in augemented reality. It provides graphic overlays to mobile devices to enhance the user experience. Teleoperation and use of holograms are some advanced uses of virtual environment which are still in development and is supposed to be viable in near future.

C. *For Analysis of Tasks*

Certain specific standardized and some explicit criteria were used to analyze the tasks being performed in the examples we considered. Evaluation of taxonomy and heuristic evaluation were used to determine the efficiency of tasks in some certain operations. Statistical Analysis was deployed in some cases [7][11], which is a generalized standard for computing the efficiency. There were some cases where the researchers deployed some advanced metrics like Computational Fluid Analysis [12] and Building Information Model [14], which were specific to construction and some mechanical task-oriented operations. Acoustic property estimation was considered to pinpoint the accuracy of sensory relays. The Compatibility rating and feedback based on framework was analyzed as a diagnostic to calibrate the application for proficiency of performance. Error analysis was employed in some cases as analysis of the design concept [19][20].

IV. Result Analysis

VR/AR provide the technology to perceive computational elements and objects in real world experience including structures and machinery to perform complex activities, while performing the tasks through mere gestures and speech. Such technology enables inte

TABLE 2

Summary Table of Interface Design Considerations:

Research Paper Reference Number	Interface Design Considerations									
	Virtual Reality	Augmented Reality	3D Sensing	Sensory Relays	Expert Centred Approach	Learner Centred Approach	Web Application	Depth Sensing	Teleoperation	Gesture & Speech Recognition
1	*		*	*						*
2	*	*	*			*				
3	*	*		*						*
4	*		*	*						*
5	*			*						*
6	*	*	*	*						*
7	*	*	*	*		*		*	*	*
8	*	*	*					*	*	*
9	*					*				
10	*	*			*	*	*			
11	*	*			*	*				
12	*	*		*					*	*
13	*	*	*	*				*		
14	*	*	*	*						
15	*	*					*		*	
16	*	*	*	*				*		*
17	*	*		*	*	*				
18	*	*	*					*		*
19		*								*
20		*	*	*	*				*	

TABLE 3

Summary Table of Computation & Analysis:

Research Paper Reference Number	Computation & Analysis												
	Evaluation of Taxonomy	Integrating the features into a profile	Framework for evaluation	Compatibility Rating	Ergonomic Analysis	Heuristic Evaluation	Computational Fluid Analysis (CFD)	Error Analysis	Statistical Analysis	Building Information Model (BIM)	Rendering Analysis	Acoustic Property Estimation	Semantic Segmentation
1			*								*		
2											*		
3					*				*			*	
4						*		*				*	
5					*				*				*
6			*	*									
7					*			*	*				
8					*			*	*				
9												*	
10	*	*	*	*					*				
11					*	*			*				
12							*	*	*	*			
13													
14	*				*					*			
15	*												
16					*	*							
17	*				*						*		
18					*						*	*	*
19	*							*					
20					*	*		*			*		

ractions like repairing equipment in machinery [26] which would be otherwise unreachable, performing scans ultrasound scans simultaneously while performing a surgery, analyzing hazards before directly confronting them. It also has the provision of surveillance and reconnaissance which provides necessary military provisions. It supports iterative actions and in real time efficiently. It enables the user to multitask with ease. Various examples show how, virtual environment can be employed in sectors that require manpower and are yet have dangerous working conditions. The design concepts of Head mounted headsets and Extended-limb operation through a custom developed chipset are some design models to mimic the actions and viable for future development as a model. There have been some research going on in some of the tech giants like Google, Samsung and Samsung [7] who were intrigued by the concept of immersive environment to enhance user interaction. They have made some significant strides in the field have developed some devices that are already deployed and in use. Occulus by facebook is a VR headset which supports various applications on mobile devices. Some specific applications for the device have also been developed to promote and market the product. The HTC Vive is a headset that lets the user experience virtual reality through various applications based on gestures and movement. The physical movements are relayed through sensors that replicate the actions performed in a virtual reality experience. The major application of the product is VR Gaming. It involves capturing eye tracking, gesture control, simplified input and navigation and visual collaboration. The product also has commercial clients that are focussed on simulations to improve insights and processing. Google Lens is a virtual assistant developed by Google, which is powered by an AI technology. It enables the user to learn about something, when they point at it. Bixby used by Samsung is also similar in that aspect. Both the products utilize deep machine learning to detect the object and understand it, offer actions based on the result. The applications involve Smart Text selection and search based on user input.

V. CONCLUSION

The difference between these products and my envisioned user interface is the range of application. The user interface I desire, will be more evolved in the sense and scope of utility. These products are limited to the processing power and capabilities regarding cognitive functionality. By implementing higher cognitive functions, problem solving and involving machine learning to anticipate and meet the user's needs [5]. It is possible to provide a more natural and efficient way for user interaction. Existing technology is not capable of the processing power and is not scalable to process the tasks in the operations required. The rapid advancements in the technological and the trend make this a viability in the coming decade or so. Our vision for the evolution of Human Computer Interaction for future is to be around Virtual and Augmented Reality because of the prospect of its scalability. Immersive reality has a wide range of application ranging from enhancing learning experiences in primary and elementary level of student education to complex medical study, Professional Telepresence that improve quality of life in various fields, which the user might be associated with.

Our vision being involved with Virtual reality, is because it is a viable platform that is capable of removing generic and complex physical interfaces and replacing them with sensory relayed input form, which is capable of accommodating a large base of users easily as it does not require much prior training or knowledge either about the peripherals or the software accommodations. The Virtual or Augmented reality is expected to provide more natural and efficient way to interact with.

Our vision is based on the "Fourth and Fifth foci of interface development" from the research paper by Jonathan Grudi which was assigned to us as part of the first assignment. The fourth focus of Interface development is focussed on the interface at the Interface Dialogue, the author discusses about the perpetual-motor and cognitive results based on incorporating sense and a deeper cognitive focus. It included work about user's interfaces being modelled per user's requirements and to be able to interact with the user and adapting accordingly to be able to develop the sense of a dialogue with the user. It was assumed that interfaces would be modelled according to user and utilize machine learning to anticipate and accommodate the user's needs [37]. Various inputs like sensory relays based on gestures, voice and speech recognition can be used in this spectrum as inputs. These inputs replicate being in a real or imagined environment and perform tasks desired by the user. The Fifth focus of Interface development is to accommodate the interface at the work setting. The author estimated that since work occurs in a social context, the computers and user interfaces will have to be able to viable in a social and organizational sense. The Hardware and software components should account for supporting people from various backgrounds with different roles, preferences and skills for the role. Virtual and Augmented reality eradicates the need for development of different acceptable standards for user interfaces as it capable of providing a whole and generic interface to accommodate the work setting. Future Applications of VR in a work setting involve Medical and Healthcare prospects that involve treatment for Stress disorders and anxieties [30]. Virtual reality is also capable of supporting complex tasks like surgery, equipment. Telepresence [24] is a major standout as an interface in the work setting. VR and AR also have prospective aspects in the entertainment field like Cinema, Music and Gaming. TourismPromotion can also be accommodated with certain advancements.

The problems that exist with the existing standards of user interfaces is that they are designed to accommodate users that are likely trained or knowledgeable about the interface standard in order to work with it. The GUI implementation has made computers viable for computer use, but it still is not generic enough to be able to accommodate everyone. In a work setting, the design choices regarding the infrastructure and interface might affect the user experience and even slight changes give rise to undesirable user experiences. With the existing interface design, the users must interact directly with the physical terminals to accomplish their tasks.In the case of a generalized design standard for immersive environments like VR/AR, the need for design inputs is mitigated by the way of self calibration of the sensor and the field of relay. Virtual and Augmented realities simulate the actions in an alternate reality, which remove the need for user presence and mimic the user actions to get the tasks done, without their presence although they are present virtually.

REFERENCES

1. Hanson, K. and Shelton, B.E., 2008. Design and development of virtual reality: analysis of challenges faced by educators. *Journal of Educational Technology & Society*, *11*(1), pp.118-131.
2. Encarnacao, I.M., Barton, R.J., Bimber, O. and Schmalstieg, D., 2000. Walk-up VR: virtual reality beyond projection screens. *IEEE Computer Graphics and Applications*, *20*(6), pp.19-23.
3. Voit, A., Mayer, S., Schwind, V. and Henze, N., 2019, April. Online, VR, AR, Lab, and In-Situ: Comparison of Research Methods to Evaluate Smart Artifacts. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (p. 507). ACM.
4. Gandhi, R.D. and Patel, D.S., 2018. Virtual reality–opportunities and challenges. *Virtual Reality*, *5*(01).
5. Powell, W., Rizzo, A., Sharkey, P. and Merrick, J., 2018. Innovations and challenges in the use of virtual reality technologies for rehabilitation. *Journal of Alternative Medicine Research*, *10*(1).
6. Batmaz, A.U., Machuca, M.D.B., Pham, D.M. and Stuerzlinger, W., 2019, March. Do head-mounted display stereo deficiencies affect 3D pointing tasks in AR and VR? In *2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)* (pp. 585-592). IEEE.
7. Ardiny, H. and Khanmirza, E., 2018, October. The Role of AR and VR Technologies in Education Developments: Opportunities and Challenges. In *2018 6th RSI International Conference on Robotics and Mechatronics (IcRoM)* (pp. 482-487). IEEE.
8. Micelli, L., Acosta, D., Uribe-Quevedo, A., Lamberti, F. and Kapralos, B., 2018, July. Extending Upper Limb User Interactions in AR, VR and MR Headsets Employing a Custom-Made Wearable Device. In *2018 9th International Conference on Information, Intelligence, Systems and Applications (IISA)* (pp. 1-4). IEEE.
9. Bastug, E., Bennis, M., Médard, M. and Debbah, M., 2017. Toward interconnected virtual reality: Opportunities, challenges, and enablers. *IEEE Communications Magazine*, *55*(6), pp.110-117.
10. Kurilovas, E., 2016. Evaluation of quality and personalisation of VR/AR/MR learning systems. *Behaviour & Information Technology*, *35*(11), pp.998-1007.
11. Liston, P.M., Kay, A., Cromie, S., Leva, C., D'Cruz, M., Patel, H., Langley, A., Sharples, S. and Aromaa, S., 2012. Evaluating the iterative development of VR/AR human factors tools for manual work. Work, 41(Supplement 1), pp.2208-2215.
12. Malkawi, A.M. and Srinivasan, R.S., 2005. A new paradigm for Human-Building Interaction: the use of CFD and Augmented Reality. *Automation in Construction*, *14*(1), pp.71-84.
13. Milanović, V., Kasturi, A., Yang, J. and Hu, F., 2017, February. A fast single-pixel laser imager for VR/AR headset tracking. In *MOEMS and Miniaturized Systems XVI* (Vol. 10116, p. 101160E). International Society for Optics and Photonics.
14. Li, X., Yi, W., Chi, H.L., Wang, X. and Chan, A.P., 2018. A critical review of virtual and augmented reality (VR/AR) applications in construction safety. *Automation in Construction*, *86*, pp.150-162.

15. Domingues, C., Otmane, S., Davesne, F. and Mallem, M., 2009. A distributed software architecture for collaborative teleoperation based on a vr platform and web application interoperability. *arXiv preprint arXiv:0904.2096*.
16. Van Krevelen, D.W.F. and Poelman, R., 2010. A survey of augmented reality technologies, applications and limitations. *International journal of virtual reality*, *9*(2), pp.1-20.
17. Eagleson, R. and de Ribaupierre, S., 2018. 6 Visual Perception and Human–Computer Interaction in Surgical Augmented and Virtual Reality Environments. In *Mixed and Augmented Reality in Medicine* (pp. 83-98). CRC Press.
18. Kim, H., Remaggi, L., Jackson, P. and Hilton, A., 2019. Immersive Spatial Audio Reproduction for VR/AR Using Room Acoustic Modelling from 360° Images. *Proceedings IEEE VR2019*.
19. Neumann, U. and Majoros, A., 1998, March. Cognitive, performance, and systems issues for augmented reality applications in manufacturing and maintenance. In *Proceedings. IEEE 1998 Virtual Reality Annual International Symposium (Cat. No. 98CB36180)* (pp. 4-11). IEEE.
20. Henderson, S. and Feiner, S., 2010. Exploring the benefits of augmented reality documentation for maintenance and repair. *IEEE transactions on visualization and computer graphics*, *17*(10), pp.1355-1368.
21. Regenbrecht, H., Meng, K., Reepen, A., Beck, S. and Langlotz, T., 2017, October. Mixed voxel reality: Presence and embodiment in low fidelity, visually coherent, mixed reality environments. In 2017 IEEE International Symposium on Mixed and Augmented Reality (ISMAR) (pp. 90-99). IEEE.
22. Chang, K.E., Zhang, J. and Liu, T.C., 2017, October. Workshop on Virtual, Augmented and Mixed Reality in Education (VAMrE 2017) Summary. In 2017 IEEE International Symposium on Mixed and Augmented Reality (ISMAR-Adjunct) (pp. 293-293). IEEE.
23. Cidota, M.A., Lukosch, S.G., Bank, P.J. and Ouwehand, P.W., 2017, October. Towards engaging upper extremity motor dysfunction assessment using augmented reality games. In 2017 IEEE International Symposium on Mixed and Augmented Reality (ISMAR-Adjunct) (pp. 275-278). IEEE.
24. Lenz, L., Janssen, D. and Stehling, V., 2017, June. Mixed reality voice training for lecturers. In 2017 4th Experiment@ International Conference (exp. at'17) (pp. 107-108). IEEE.
25. Bastug, E., Bennis, M., Médard, M. and Debbah, M., 2017. Toward interconnected virtual reality: Opportunities, challenges, and enablers. IEEE Communications Magazine, 55(6), pp.110-117.
26. Kang, H.J., 2017, March. Designing next generation marketplace: The effect of 3D VR store interface design on shopping behavior. In 2017 IEEE Virtual Reality (VR) (pp. 411-412). IEEE.
27. Tamura, H., Saito, H., Shibata, F. and Kameda, Y., 2015, September. Diminished Reality as Challenging Issue in Mixed and Augmented Reality (IWDR2015) Summary. In 2015 IEEE International Symposium on Mixed and Augmented Reality Workshops (pp. 25-25). IEEE.
28. Issartel, P., Guéniat, F., Coquillart, S. and Ammi, M., 2015, March. Perceiving mass in mixed reality through pseudo-haptic rendering of Newton's third law. In 2015 IEEE Virtual Reality (VR) (pp. 41-46). IEEE.
29. Chandramouli, M. and Heffron, J., 2015, March. A desktop vr-based hci framework for programming instruction. In 2015 IEEE Integrated STEM Education Conference (pp. 129-134). IEEE.
30. Satava, R., 2013, March. Keynote speaker: Virtual reality: Current uses in medical simulation and future opportunities & medical technologies that VR can exploit in education and training. In 2013 IEEE Virtual Reality (VR) (pp. xviii-xviii). IEEE.
31. Sherman, W.R., 2012, March. VR 2012 tutorial proposal title: An in-depth introduction to virtual reality programming. In 2012 IEEE Virtual Reality Workshops (VRW) (pp. 1-2). IEEE.
32. Hurwitz, A. and Jeffs, A., 2009, October. EYEPLY: Baseball proof of concept—Mobile augmentation for entertainment and shopping venues. In 2009 IEEE International Symposium on Mixed and Augmented Reality-Arts, Media and Humanities (pp. 55-56). IEEE.
33. Mekni, M. and Lemieux, A., 2014. Augmented reality: Applications, challenges and future trends. Applied Computational Science, pp.205-214.
34. Graham, K., Dhanda, A., Tousant, K., Weigert, A. and Fai, S., 2017. The VR Kiosk How observant passive VR storytelling enhanced the physical tour of parliament hill and disseminated the rehabilitation project. In 2017 23rd International Conference on Virtual System & Multimedia (VSMM) (pp. 1-7). IEEE.
35. Krishna, M.P., Mehta, S., Verma, S. and Rane, S., 2018, December. Mixed Reality in Smart Computing Education System. In 2018 International Conference on Smart Systems and Inventive Technology (ICSSIT) (pp. 72-75). IEEE.
36. Cheng, K. and Furusawa, I., 2018, October. The Deployment of a Mixed Reality Experience for a Small-Scale Exhibition in the Wild. In 2018 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct) (pp. 214-215). IEEE.
37. Prilla, M. and Rühmann, L.M., 2018, October. An Analysis Tool for Cooperative Mixed Reality Scenarios. In 2018 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct) (pp. 31-35). IEEE.
38. Rumiński, D. and Klinker, G., 2018, October. Augmenting Mixed Reality Applications with the Vibro Motors Wearable. In 2018 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct) (pp. 401-402). IEEE.
39. Dey, A., Billinghurst, M., Welch, G. and Rojas-Muñoz, E., 2018, October. 3rd Virtual and Augmented Reality for Good (VAR4Good) Workshop. In 2018 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct) (pp. 364-364). IEEE.
40. Nebeling, M. and Speicher, M., 2018, October. The Trouble with Augmented Reality/Virtual Reality Authoring Tools. In 2018 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct) (pp. 333-337). IEEE.
41. Horst, R. and Dörner, R., 2018, October. Opportunities for Virtual and Mixed Reality Knowledge Demonstration. In 2018 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct) (pp. 381-385). IEEE.
42. Horst, R. and Dörner, R., 2018, October. Opportunities for Virtual and Mixed Reality Knowledge Demonstration. In 2018 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct) (pp. 381-385). IEEE.
43. See, Z.S., Lee, X.S., Brimo, A., Thwaites, H. and Goodman, L., 2018, August. MOOC for AR VR Training. In 2018 IEEE Games, Entertainment, Media Conference (GEM) (pp. 1-9). IEEE.
44. Cognard, T.E., Goncharov, A., Devaney, N., Dainty, C. and Corcoran, P., 2018, August. A Review of Resolution Losses for AR/VR Foveated Imaging Applications. In 2018 IEEE Games, Entertainment, Media Conference (GEM) (pp. 1-9). IEEE.
45. Karakottas, A., Papachristou, A., Doumanoqlou, A., Zioulis, N., Zarpalas, D. and Daras, P., 2018, March. Augmented VR. In 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR) (pp. 1-1). IEEE.
46. Huang, W., 2018, March. Evaluating the Effectiveness of Head-Mounted Display Virtual Reality (HMD VR) Environment on Students' Learning for a Virtual Collaborative Engineering Assembly Task. In 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR) (pp. 827-829). IEEE.
47. Handosa, M., Schulze, H., Gracanin, D., Tucker, M. and Manuel, M., 2018, March. An Approach to Embodiment and Interactions with Digital Entities in Mixed-Reality Environments. In 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR) (pp. 569-570). IEEE.
48. Zhang, Z., Cao, B., Weng, D., Liu, Y., Wang, Y. and Huang, H., 2018, March. Evaluation of Hand-Based Interaction for Near-Field Mixed Reality with Optical See-Through Head-Mounted Displays. In 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR) (pp. 739-740). IEEE.

49. Ghrairi, N., Kpodjedo, S., Barrak, A., Petrillo, F. and Khomh, F., 2018, July. The State of Practice on Virtual Reality (VR) Applications: An Exploratory Study on Github and Stack Overflow. In 2018 IEEE International Conference on Software Quality, Reliability and Security (QRS) (pp. 356-366). IEEE.
50. Obrist, M., Velasco, C., Vi, C., Ranasinghe, N., Israr, A., Cheok, A.D., Spence, C. and Gopalakrishnakone, P., 2016. Sensing the future of HCI: touch, taste, and smell user interfaces. interactions, 23(5), pp.40-49.

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