COMPLETE SYSTEMETIC REVIEW ON CHALLENGES OF COLLABORATIVE VIRTUAL REALITY ENVIRONMENT

Muhammad Sheraz Arshad Malik[1], Qoseen Zahra[2], Naila Batool[3]

Department of Information Technology, Government College University, Faisalabad,
e-mails: sheraz_awan@gcuf.edu.pk[1], qoseenzahra@gmail.com[2],
nailabatool93@gmail.com[3]
Pakistan

Abstract: The Collaborative Virtual Reality Environment (CVRE) facilitates distributed cooperated activities. CVRE provides the graphically digital environment for multiple user interface to interact with each other. Mostly virtual reality systems are developed for the individuals. Therefore, CVRE faces the technical and systematic challenges. In this paper we discuss the existing challenges of CVRE. First part highlights the nature of the virtual reality, collaboration and virtual reality activities, in contrast of the challenges of CVRE. Following this, we discuss the future research directions.

Key words: Collaborative virtual reality, computer supported cooperated work, virtual reality environment.

1. INTRODUCTION

Virtual reality (VR) become popular from its first development in sixties [1]. According to Professor Fred Brooks, virtual environment (VE) research has got a point where it "hardly works".

Technology has become advanced and it has face many problems regarding hardware, software, and other related to algorithms, security, issues etc. With the development in the field of computer technology becomes more advance day by day but there are still inadequacies which causes the prevention of its applications in the real world. VR mostly works with the individuals. VR offers the more potential in the representation of data and mostly individuals do it. Individuals may utilize the 3-dimension graphical representation of data and may be 2 dimensions of flat data. Now trend in VR shifts towards the "Collaboration".

Tasks are mostly completed in informal cooperation to generate ideas, and it is compared with formal collaboration and this is mostly related to confirm the designs and this come up to the meetings. All the members of team not collaborate with each other in effective and efficient way because they are at distributed places. VR collaboration is proposed to resolve this issue. All the participants using the modern technology able to communicate with each other and share their experiences virtually.

Collaborative virtual reality environment (CVRE) are the systems which allow the multiple users to interact with each other. CVRE main purpose is to interaction of multiple people at the same time graphically to share the information and able to do different activities.

Virtual Collaboration (VC) can be enhanced using the advanced virtual reality (VR) technology. Existing virtual reality based collaborative system are not suitable for all scale industries. All the systems experience the different challenges. System and technology challenges are most considerable. In the development of CVRE systems hardware, software, algorithms development and modification, graphical representations problems are experience. Dedicated functionalities are difficult to customize according to the real time conditions. Dedicated functionalities are the chunk of the systems which are targeted to assist the specific industry.

1.1. Virtual Reality and Virtual Collaboration

Virtual Reality (VR) is 3-Dimenssional environment that is formed with a combination of collaborating hardware and software [8]. The use of VR spread rapidly in every field. An example of this increasing use of VR is the wide range of VR research papers. When VR systems becomes popular in the different fields it changes the research trends. Researchers focuses on the different aspects of VR. According to survey results, clear increasing trend can be examined in the three areas (1) VR with medicine, (2) VR with computer science, (3) VR with engineering (fig.1).

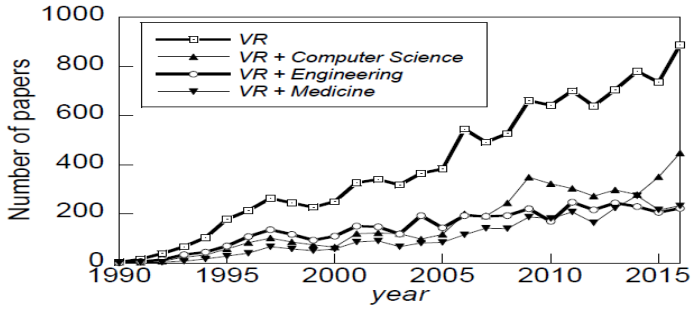

Fig. 1. Title Number of research papers indexed in SCOPUS related with the virtual reality [2].

Virtual Collaboration (VC) is a technique of technology communication for collaboration of different virtual team members [9]. VC provides opportunities for team members to join projects where their knowledge can be useful [10]. VC is very inexpensive as compared to face-to-face meetings of members which are at far places. VC faces many challenges regarding communication, network connections and to adoption of latest devices. VC trend increases very rapidly and adopted by many companies for multi purpose.

2. CHALLENGES OF COLLABORATIVE VIRTUAL REALITY ENVIRONMENT

Finding a solution for a real-life problem involves that various thoughts and explanations be shared in some way. Formerly virtual reality can move from a research-based subject into typical applications, ways must be originating to assimilate philosophies from the contributing disciplines into an intelligible architectural context, intended to support

systematic application development. The expansion of any system targeted at extensive use must also take due interpretation of the very varied necessities of its users.

According to the computer supported cooperative work (CSCW) community CVRE is a technology that supports the features of collaborative communication not readily put up by technologies [6]. The joint virtual places provided by CVRE may found corresponding means for tele-communication. CVRE have the possibility to sustenance cramped online conditions where many contributors transfer societal appointment by randomly creating sub groups. CVRE may allow contributors to deliberate and operate shared 3-Dimensional representations and imaginations, such system can accept their specific viewpoint and can logically show to others where they express and point. We discuss here several key challenges for collaborative virtual reality systems and research.

2.1. The Dispersed Intelligible City

CVRE permit contributors to be alert of each other, in a way possibly far closer to our everyday participation in a shared environment than can be accomplished by other systems of human-computer interaction. A CVRE is relatively changed from using an Internet browser, in which one is basically uninformed of others allocation of the resources. If the collaborative environment is sufficient, there is the opportunity of using the situation for global social interaction and discussion, relatively than just task-specific claims. This collaborative social environment for the global inhabitant is at the heart of many CVRE study, which is one purpose why the discipline extents graphics, tutoring, broadcasting, entertainment and administration. Attaining such goals increases challenges for our thoughts of social interaction, but also impulses the limitations of our system architecture competences, including as it does instantaneous collaboration for physically isolated members in complex virtual environments.

There are supplementary architectural challenges in management the circulation of the model and sustaining management in the face of real-time collaborative demands. If contributors are physically dispersed, then there are growing concerns in managing with the perceptually disturbing effects of communication. On a demonstration, such gaps may be acceptable, but in the deep environment where the VE constitutes the entirety of the user's involvement, such defects cannot simply be overlooked, and can reduce the system unusable.

2.2. A Complicated Real-World Application

The design of complicated development plants, such as petrochemical installations and offshore drilling platforms. Such fixings are complex – both geometrically and in terms of building and functioning. A representative offshore installation absorbs over 40 person-years of design effort, requiring the management of a huge team of engineers, safety experts and operations staff. CAD tools are regularly used for design, and the output of these provender into mechanical engineering, development engineering, resources arrangement, building scheduling and development, and security assessment.

The role of the CVRE is to provision result creation during the design development, to help collaboration between specialists from different professional areas, and to permit the working influence of other designs to be evaluated. Tasks to be reinforced consist of editing the models, simulating creation processes, and simulating succeeding working aspects, including security, demanding that users can cooperate with the prototypical and with each other. A specific example is seen in Fig. 2, which displays a simulation of two users carrying

wounded person on a stretcher from the place of an accident to a helicopter landing pad. Such simulations pose main challenges to the designer of a CVRE software system.

2.3. Scalability and Interest Managing

The need to maintenance instantaneous collaboration among huge number of instantaneous contributors dispersed over a WAN makes CVRE a challenging function, particularly with measure. The scalability of CVRE is discuss to the visuals and interactive complication of simulated worlds and their insides, specially symbols, furthermore the number of real-time contributors that can be maintained. Restrictions on scalability rise from the diversity of structure blockages.

Huge numbers of vigorous contributors make great capacities for system traffic, particularly drive updates and auditory packages. Servers on the system may develop the data, for illustration, in processing a reliable replica of the world from numerous apprise communications. Even if the central system and server accommodates can bear a CVRE, the "last mile" system linking to every contributor's device can simply develop a blockage. Lastly, if the data can be distributed to contributors, their confined systems must be intelligent to develop it and reduce the collaborative computer-generated world at a suitable value while upholding an adequately fast reply to the contributors' activities and former actions.

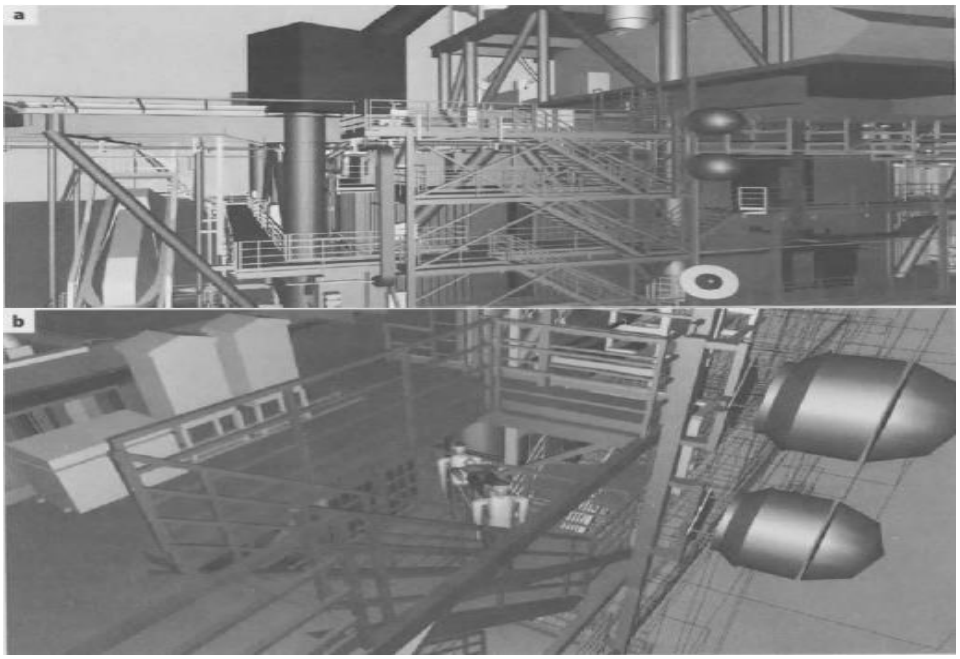

Fig. 2. Carrying a stretcher during an emergency on an offshore gas platform

Person perceptual and intellectual boundaries deliver a substantial influence in evolving replies to the issues of scale. Through positioning the simulated platforms so every contributor is not burdened to understands and catches "enough" of the creation but no additional difficulties of scale can be reduced. At this situation "sufficient" is clear in conditions of curiosity in the domain and its insides, it may be controlled by landscapes like hard limitations. For instance, a member need not to take auditory packages from substances

at distant to be caught or update communications from substances behind the close partition or that thought to boring. Though, contributors' attentions will vigorously variate as they discover a domain. Thus, challenge for CVRE inventers is to plan elastic and lively attention managing schemes [4]. The best-known instances describe interest concluded the partition of simulated space.

2.4. Distributed Architectures

CVRE help variable numbers of physically dispersed clients and possess contributors current with fluctuations in the domain and other methods of message and collaboration. Supporting these manipulators characterizes a major challenge, and CVRE structures fluctuate suggestively in the techniques in which they hold the problems of sharing [7]. Basically, three fundamental architectures are developed by CVREs:

- Client/server: Individual contributor's purpose to connects merely with a mutual server instruction that is accountable for passing communications on to other customers as suitable. Client/server method is also the standard for shared Internet CVRE, as the server can adapt its message to contest the system and device competences of every client. For illustration, SPLINE maintains the dial-up handlers concluded dedicated servers that attach them to the central technique over a compacted and augmented application procedure.
- Peer-to-peer unicast: Every specific client instruction directs data precisely to add user instructions, as suitable. Generally, it is the maximum bandwidth demanding of the three methods, however it evades insertion of extra burden on specific and server machines, frequently presents lower system interruptions.
- Peer-to-peer multicast: Like to peer-to-peer unicast, these used the usually a bandwidth effective system. It is similarly used for audial in numerous schemes, with SPLINE, just as a client/server technique is exploited for graphical data. Multi-casting is not at present accessible on entire systems or networks, and large area accessibility is mainly restricted. Therefore, a few systems now contain use of specific multicast linking and proxying servers, which shorten service over large area and non-multicast networks.

Though we have existing these as substitutions, a single CVRE system can merge multiple methods—for diverse media, different phases of contribution or for distinctive clusters of contributors. A main subject of research is discovering innovative approaches of joining these architectures to successfully reinforce a variety of applications and media over diverse structures.

2.5. Migrating Lesson From 2D Interface to CSCW

The leading method to collaborate in CVRE undertakes every member understands the similar content, although from another perception However, the practice of the CSCW assistance in creating cooperative 2D graphical user interfaces proposes this kind of method really delay individuals' capability to cooperate. Initial practices of joint interface systems grounded on the principle of "What You See Is What I See" (WYSIWIS) directed to a reconsideration for certain principles of distribution and the essential for shared and private interfaces and diverse opinions on collective data.

Certain of these initial lessons about the landscape of collaboration have been wandered to CVRE and structures now suggest users "particular" views on joint worlds. These individual opinions can reproduce the modified interests and characters that users living collective domains may have. For instance, contributors inward a 3-D architectural prototypical may understand different intersections for connecting, sanitation, and

networking; the simulated cameras used to take the achievement in populated TV might be observable to the players, however not to other on-screen contributors or viewers.

Though not limited, these points of consideration have directed to discrete stresses in the design of online public environments; space directing to controllable CVRE with symbols, and position principal to more comprehensive concepts.

2.6. Innovative Kinds of Human Issues

Analysing how user findings may notify expansion of CVRE, it has developed pure new approaches may be essential to individuals naturally manipulated in assessing user's virtual reality systems. Studies of solitary user virtual reality have inclined to attraction upon distinct perceptual mindset for their direction in discovering problems s involvement, usability, and gesture sickness.

The usage of CVRE to provision collaborative struggle and societal communication offerings novel challenges for individual features: how can we recognize the landscape of societal interface inside a CVRE? Current studies have curved to a wider variety of community systematic procedures and to update CVRE plan adoptions. Revisions of initial prosecutions with the MASSIVE organization used ethnographic procedures to illustrate how familiar instruments were broken or revised in collective simulated worlds.

This effort subsidized to symbolic structure by viewing that explicitly simple symbols could well characterize members on sometimes, whereas on others faith in avatars would breakdown when originate to be vacant, for example when their holders were left appearing to events indoors their native surroundings. Further revisions highpoint problems with the usage of humanoid-elegance avatars. Applicants would consider others could perceive substances in the simulated creation usually observable in the margin of human image when in fact their pitch of opinion was strictly limited by the CVE knowledge. Possibly avatars should more exactly send their perceptual abilities in the simulated domain.

2.7. Hardware for Computer Graphics

The graphics ubiquitous computing workplaces capable of simultaneous, 3-dimensional show at high rates is possibly the key expansion behind the existing push for VEs today [5]. We have had aeronautical simulants with substantial graphics competencies for years, but all are very expensive and not easily available everywhere. It's strange that they have not been readily programmable. Aeronautical simulators are usually created with a definite purpose in observance, such as providing exercise for a military jet. Such simulators are microcomputer coded and automated in assembly language to decrease the total amount of graphics and essential processing element series required. Systems automated in this way are hard to change and sustain. Hardware advancements for such systems are frequently major activities with a small customer base. An even big problem is that the software and hardware established for such organizations are usually trademarked, thus restrictive the accessibility of the technology.

2.8. Collaboration in a 3-Dimenssional Platform

The important challenges are related with collaboration in a 3-dimensional Platform are the line of vision and distance from which acting [5]. About line of vision, virtual environment applications must resist with the fact that some valuable data might be hidden or destroy due to an unlucky choice of user point of view or entity placement. In few cases,

the consequence can lead to misrepresentation, misperception, and misunderstanding. Frequently occur drawbacks contain obscuration and unfortunate chances.

Table 1. CVRE Challenges

Challenges	***Proposed Solutions for challenges***	
	Problems	***Proposed Solutions***
C1. The dispersed Intelligible city	Circulation of model and management.	Manage the system properly.
C2. A complicated real-world application	Installation and fixing problem is difficult.	Training required from the experts.
C3. Scalability and interest managing	Graphic and interactive. Complications of virtual world. Diversity of system blockages.	To overcome the scalability challenge reduces the complications in graphics interaction.
C4. Distributed Architecture	Excessive bandwidth required. Extra load on server due to lower system interuptions. Difficult to maintain the huge network.	Build network in organized way to handle the distributed architectures.
C5. Merging lesson from 2D interfaces to CSCW	Expensive tools required for merging to CSCW.	Try to update the existing tools.
C6. Innovative kind of human issues	Difficult to recognize the societal interface inside CVE.	Try to make the devices closer to human perceptions.
C7. Hardware for computer graphics	Hardware are expensive not easily available.	Provide devices available for people at low rates.
C8. Interaction in a 3-dimenssional environment	Line of sight and distance for action not clear.	Properly guide the users. And make the devices more flexible.

3. CONCLUSION AND FUTURE DIRECTIONS

The need of CVRE is increasing with the development in the technology. CVRE is used in many fields. We are presented the problems which are unsolved and need attention. We discussed about the complex structures of the cities, the real world complicated environment, scalability and the management of the systems, distributed architectures, client server, peer to peer unicast, peer to peer multicast, migration from 2 dimensional to computer supported cooperative work, new kinds of human factors, hardware for computer graphics and the interaction in the 3-dimensional environment. CVRE needs many improvements in all these areas. Collaborative VR devices are expensive this is the big issue in the utilization.

Although, practice makes a man perfect. Similarly, ideas are generated from the practice and bring the innovation. In the field of CVRE many things are remaining to done.

4. ACKNOWLEDGEMENT

This research work was supported and conducted with the help of Department of Information Technology Government College University Faisalabad.

REFERENCES

[1] Sutherland, I.E. The ultimate display. In *Information Processing of the IFIP Congress*, Macmillan and Co., London, UK, 1965; pp. 506–508.

[2] Diego Vergara, Manuel Pablo Rubio, and Miguel Lorenzo. On the Design of Virtual Reality Learning Environments in Engineering. *Multimodal technologies and interaction*, Spain, June 2017.

[3] Benford S, Greenhalgh C, Snowdon D, Bullock A. Staging a Public Poetry Performance in a Collaborative Virtual Environment. In *Proceedings of the 5th European Conference on Computer Supported Cooperative Work* (ECSCW'97), Lancaster, UK, Kluwer Academic Publishers. September, 1997.

[4] Sandeep and Zyda's. *Networked Virtual Environments—Design and Implementation*, ACM Press, July 1999.

[5] Nathaniel I. Durlach and Anne S. Mavor, *Virtual reality scientific and technological challenges*. National academy press, Washington D.C., 1995.

[6] Elizabeth F. Churchill, David N. Snowdon and Alan J. Munro (Eds), C*ollaborative virtual environment, digital places and spaces for interaction.*

[7] Steve Benford, Chris Greenhalgh, Tom Rodden, and James Pycock. To what extent is cyberspace really a space, collaborative virtual environments, *Communication of the ACM*, **7** (vol. 44), July 2001.

[8] *Virtual reality or what is virtual reality?*,
Available: http://www.realitytechnologies.com/virtual-reality

[9] *Virtual Collaboration*
Available: https://en.wikipedia.org/wiki/Virtual_collaboration

[10] *Virtual Collaboration, Tools for creating and developing effective virtual teams*.
Available: https://www.slideshare.net/lupro/presentation-virtual-collaboration-final

[11] Adrian West and Roger Hubbold, *System Challenges for Collaborative Virtual Environments*, October 2, 2000.

[12] H. Y. Kan et al. An internet collaborative virtual reality collaborative environment for effective product design, *Computers in industry* 45, 2001, pp. 197-213.

[13] Z. Pan et al. Virtual reality and mixed reality for virtual learning environments, *Computers & Graphics*, 30, 2006, pp. 20–28.

[14] *Virtual reality or virtual realities (VR)*, Available: https://en.wikipedia.org/wiki/Virtual_reality.

[15] E. Lancheres. *Virtual Reality Is Coming and It Will Change The World In 2016*, November 2015, Available: http://www.engadget.com/2015/11/15/virtual-reality-is-comingand- it-will-change-the-world-in-2016/.

[16] GDC, *GDC State of the Industry: Most developers now confident about the future of VR*, Available: http://www.gdconf.com/news/gdc_state_of_the_industry_most.html

[17] StudyLink, *Study Virtual Reality for an Exciting Future*, 2015, Available: http://studylink.com/blog/studyvirtual- reality-for-an-exciting-future/

[18] Dimiter Velev and Plamena Zlateva. Virtual Reality Challenges in Education and Training. *International Journal of Learning and Teaching*, 1 (vol. 3), March 2017.

[19] Nigel Newbutt, Connie Sung, Hung Jen Kuo, Michael J. Leahy, *The Acceptance, Challenges, and Future Applications of Wearable Technology and Virtual Reality to Support People with Autism Spectrum Disorders*, 19 February 2017

[20] Xueni Pan1 and Antonia F. de C. Hamilton. Why and how to use virtual reality to study human social interaction: The challenges of exploring a new research landscape. *British Journal of Psychology*, 2018.

[21] Dale, R., & Fusaroli, R. The self-organization of human interaction. *Psychology of Learning*, 59, 2014, pp. 43–96.
Retrieved from https://pure.au.dk/portal/files/53762658/2014_plm_the_self_ organization_of_human_interaction.pdf.

[22] de la Rosa, S., Lubkull, M., Stephan, S., Saulton, A., Meilinger, T., Bulthoff, H., & Canal-Bruland, R. Motor planning and control: Humans interact faster with a human than a robot avatar. *Journal of Vision*, 12 (vol. 15), 2015, pp. 52. https://doi.org/10.1167/15.12.52

[23] Jack, R. E., & Schyns, P. G. The human face as a dynamic tool for social communication. *Current Biology*, 25, 2015, R621–R634.
https://doi.org/10.1016/j.cub.2015.05.052

[24] Kopp, S., & Bergmann, K. (2017). Using cognitive models to understand multimodal processes: The case for speech and gesture production. In S. Oviatt, B. Schuller & P. Cohen (Eds.), *The handbook of multimodal-multisensor interfaces: Foundations, user modeling, and common modality combinations*. New York, ACM (vol. 1), pp. 239–276 https://doi.org/10.1145/ 3015783.3015791

[25] Raija Hämäläinen, Minna LanzKari T. Koskinen. Collaborative Systems and Environments for Future Working Life: Towards the Integration of Workers, Systems and Manufacturing Environments. *Part of the Professional and Practice-based Learning book series* (PPBL, volume 21).

[26] XiaoLi, WenYi, Hung-LinChi, XiangyuWang, Albert P.C.Chan. A Critical Review of Virtual and Augumented Reality (VR/AR) Applications in Construction Safety.

Information about the authors:

Muhammad Sheraz Arshad Malik – Affiliated with Department of information technology at Government College University, Faisalabad, Pakistan. Head of Department. Email: sheraz_awan@gcuf.edu.pk

Qoseen Zahra – Affiliated with Department of information technology at Government College University, Faisalabad, Pakistan. Student of MS Information Technology. Email: qoseenzahra@gmail.com

Naila Batool – Affiliated with Department of information technology at Government College University, Faisalabad, Pakistan. Student of MS Information Technology. Email: nailabatool93@gmail.com

Manuscript received on 24 May 2018