DESIDOC Journal of Library and Information Technology, Vol. 28, No. 4, July 2008, pp. 55-62

Presence-Centered Assessment of Virtual Museums' Technologies

Styliani Sylaiou, Athanasis Karoulis[1], Yiannis Stavropoulos[2] and Petros Patias[3]

Interdepartmental Postgraduate Program in
Protection, Conservation and Restoration of Cultural Monuments
Aristotle University of Thessaloniki, University Box 473, GR-54124 Thessaloniki, Greece
E-mail:ssylaiou@topo.auth.gr

[1]*Department of Informatics, Aristotle University of Thessaloniki, Greece*

[2]*Aerosol and Particle Technology Laboratory of Centre for Research and Technology Hellas/Chemical Process Engineering Research Institute, Thessaloniki, Greece*

[3]*Faculty of Rural & Surveying Engineering, Aristotle University of Thessaloniki, Greece*

ABSTRACT

The sense of Presence is a crucial issue in virtual environments and can provide effectiveness and user engagement. A research undertaken in virtual museum websites investigated the level of Presence, the sense of being in the virtual environment and their interconnections with the various technologies they use for presenting their cultural exhibits. The main aim of the study was to explore the differences in Presence experience according to the IT tools they use.

Keywords: Virtual reality, virtual museums, virtual environments, virtual exhibitions, augmented reality.

1. INTRODUCTION

Virtual environments (VE) are applied in many scientific areas such as medicine, entertainment, transport, culture, etc. More and more are being adopted by cultural institutions such as museums to help them meet their scopes. Virtual exhibitions allow museums to easily exhibit vast collections of objects and overcome limitations of objects' fragility, exhibition space and cost. A research[1,2] and an extensive survey of the European museum sector[3] have shown that technologies such as the World Wide Web (www) enhanced by 3-D visualisation tools, virtual reality (VR), augmented reality (AR), and Web3D systems in conjunction with database technology may facilitate the preservation, dissemination and presentation of cultural artifacts in museums' collections. Such technologies could also educate the wide public in an innovative and interactive manner. The virtual museums provide opportunity to people that live far away from the "brick and mortar" museums and do not have the possibility to travel and to people with disabilities to visit their exhibitions and have an interactive, engaging, educative and at the same time a fun and satisfying museum experience.

While immersed in virtual environment (VE) simulations, users can receive a number of distinct multi-sensory stimuli (i.e. visual, auditory, haptic) which are intended to provide a sensation of 'natural' interaction with the virtual world and, consequently, an illusion of being 'present' in a VE[4]. VE that engender a high degree of presence are thought to be more enjoyable and effective for training[5]. In a virtual museum environment, the cultural content should be engaging and legible so as to be correctly interpreted and to stimulate thought, trigger enjoyment, inspiration and creativity, and reflect human curiosity

and emotions. The study presented in this article explored users' level of *'presence'* or *'sense of being there*', in the virtual museum environment according to the technologies used by virtual museum websites.

2. THEORETICAL BACKGROUND AND PROBLEM STATEMENT

2.1 Presence in Virtual Environments

The goal of a VE is the ability to mislead one's senses so well that the illusion of being somewhere other than one's physical location is created. The sense of presence is the design aim of a VE. A VE such as a virtual museum is an artificial world, created by computers, which can give the observer a sense of 'being there' (presence), in virtual environment. 'Presence' generally, refers to the subjective perception of being immersed and present in time or space in a particular location[6], the sense of "being there" in a mediated environment[7], the 'perceptual illusion of non-mediation'[8], "the observer's subjective sensation of 'being there' in a remote environment"[9]. Presence is "the extent to which the VE becomes the dominant one, i.e. that participants will tend to respond to events in the VE rather than in the real world, the extent to which participants, after the VE experience, remember it as having visited a place rather than just having seen images generated by a computer…they had an experience of being in a place, just like any other place they had been earlier in the day[10]." Presence has been identified as the subjective perception of being immersed in and surrounded by a virtual world rather than the physical world one is currently situated in[7]. This impression can be created via a host of technologies starting from traditional desktop PCs and ending to a more sophisticated and more immersive displays such as CAVE[11].

Assessment of presence has primarily focused on measuring the effects of VE technologies on a person's sense of presence[12] via questionnaires[10,13]. This study examined if the users' level of '*presence'* or '*sense of being there*' in virtual museum web pages is affected by the various technologies used.

2.2 Categories of Virtual Museums used for the Study

2.2.1 Webpage with Panoramic Images

Panoramic images based on the QuickTime VR (QTVR) technology, allow users to get the feeling of a real museum visitor in a 3-D space. The most popular museums on the www offer a Quicktime-based navigation[14]. In this case, the visitor from a certain virtual point can rotate and pan, as well as zoom in/out the panorama.

2.2.2 Webpage with Scalable Images

A simple webpage can use image formats that permit scalability and provide to the user the opportunity to examine the museum artifacts in detail. Photographs can be organised in a sequence reminding of a *virtual tour* through the museum.

2.2.3 Webpage with a Searchable Database

This is the case of a 2-D presentation of image collection with a small preview with a hyperlink to a higher resolution image. It is typically represented by web collections of 2-D exhibits like paintings or a set of photographs of 3-D objects. Such collections are often called *virtual galleries*. This does not correspond to the term *virtual reality*, but highlights the difference between real and digital world. Virtual galleries made from images are the most frequently used technique for the museum presentations on the www.

2.2.4 Webpage with Web3D Environment

This kind of webpage permits free and interactive real-time navigation in 3-D space. It permits the exploration of virtual rooms/galleries and of museum artifacts can also be presented in 3-D with layers of information by the users that can freely walk or fly through the space.

2.2.5 Webpage with Flash Technologies and Videos

There are virtual museum web pages that are created completely or partially by Macromedia Flash and may create and deliver dynamic and interactive web content with embedded sound and video.

3. MATERIALS AND METHODS

3.1 Apparatus and Visual Content

The experiments took place in an HP workstation with two 2.4 GHz Xeon processors and 2048 MB of memory. Standard display technology, such as PC 19' monitor has been used.

3.2 Participants

A total of 46 volunteers (males and females with ages from 19-37) mainly undergraduate and postgraduate students from the Aristotle University

of Thessaloniki, Greece, participated in the experiment. Participants in all conditions were naive as to the purpose of the experiment. After they navigated the virtual museums environments and performed the assigned tasks, were subsequently asked to fill in perceived presence questionnaire. All the participants reported to have at least a basic knowledge of computers.

3.3 Experimental Procedure

Emphasis was placed in using experimental settings which were as realistic as possible with respect to those in practice. Four steps were undertaken including: *goal setting* (users start with a plan of the tasks to be accomplished), *exploration* (users explore the interface and discover useful actions), *selection* (users select the most appropriate actions for accomplishing their task) and *assessment* (users interpret the system's responses and assess its progression). The participants had been informed about the scope of the study and were interviewed in private. The evaluation and the interviews took place in the laboratory of Photogrammetry and Remote Sensing at the Aristotle University of Thessaloniki, Greece, with no visitors allowed during the study so that the users could concentrate on the completion of the questionnaire administered.

The evaluation involved only one participant at a time and assistants instructed the end-users if they needed help. The evaluation used cued testing, which involves explaining to the users what the program is about and asking them to perform specific tasks or to answer questions. The users were provided with written instructions concerning sets of pre-determined tasks which guided them to navigate in the virtual museum exhibitions described bellow. This stage was concerned with the user's ability to move through the contents of an interactive program in an intentional manner.

The virtual museums that correspond to the categories defined in Section 2.2 and were used for the study are:

(i) National Gallery of Art, USA (http://www.nga.gov/): The tasks that the virtual visitors have to perform were to freely navigate and search for the presentation of the painter Van Gogh and extract information about his work with the help of zoomable images, sounds and Quicktime VR files.

(ii) Metropolitan Museum of New York (http://www.metmuseum.org/): In this virtual museum that is an online catalogue of the real museum, the virtual visitors should navigate the museum collections, to locate exhibits of their interest and take as much information as possible via zoomable images and detailed textual exhibit information. Furthermore, they could pick and choose exhibits they like and create a personal virtual museum gallery.

(iii) The Museum of Modern Art (http://www.moma.org/): In this case the participants could also have a free navigation to the various thematical areas of the museum and search by period, artist, or by title museum exhibits.

(iv) Van Ghogh Virtual Museum (http://www.vangoghmuseum.nl/): The 3-D environment of the museum permits 3-D navigation to a standalone application with keyboard arrows. The users could explore the virtual museum using the various possibilities provided (zoom image, taking info from hot points, "making photos" of the virtual space and exhibits and send them by e-mail). Also, a 2-D tourist map was provided to facilitate the navigation in the 3-D environment, allowing a transition to a virtual museum room or to a specific exhibit.

(v) Virtual Silver Screen, Cinema Virtual Museum (http://www.collectionscanada.ca/silver screen/): The participants have to explore the virtual museum that uses Flash technologies and consists of Canadian films of the early 20th century. Additionally, they have to chose and watch a black and white movie and extract information about it by sounds and texts.

4. INSTRUMENTATION

'Many interactive systems have a good *look* but a poor *feel*'[15]. In order to measure the *feel of presence* of ARCO system, a Virtual Reality Presence Questionnaire[16] was used. It provided users participating in the evaluation a series of questions that provided opportunity to decide from a range of answers on a numeric Likert scale from one to seven. The questionnaire needed five to ten minutes to be completed.

The VR Presence questionnaire was modified since it was originally constructed to assess presence in immersive environments. Its first two questions concerned the extend to which the participants used computers in their daily activities and the extent they were familiar with VR, AR and computer games, respectively. The next eight questions assessed the *sense of being there* and more specifically the

degree to which individuals experience presence while interacting with a virtual museum exhibition. The virtual visitors were asked to describe their experience in virtual museums as compared with their experience in traditional museums. Firstly, their sense of *being there* has been rated on a scale from 1 to 7, where 7 represented the normal experience of being in a physical museum environment. In addition to this, the participants were asked to assess the degree of the virtual museum environment consistency with the real world; whether the virtual museum that they visited seemed as a group of images that they have seen, or more as a gallery that they have visited. After their navigation to the virtual museum website they were asked to evaluate the intuitiveness of the system and the naturalness of control and interaction and the degree to which they felt present in the virtual museum galleries. Finally, the interviewers assessed the degree of their involvement in the virtual museum experimental task to the extent that they lost the track of time. How well they achieved the virtual museum experimental task was also assessed. The last question was asked to assess how well they achieved the experimental task.

4.1 Data

The data was summarised by calculating the average of each group of questions per questionnaire and museum. In this respect, a "virtual presence" index (denoted PM) was calculated by averaging the results of the respective questions per questionnaire and museum. The resulting PM data are then plotted in the form of a histogram for visual inspection of differences in the data distribution for the five museums. The resulting frequency histograms of the PM index for the five museums are shown in Figs 1-5.

In these graphs, the rating scale is divided into 6 bins of size 1. The total counts in each bin (i.e. the total number of PM indices that lie in each bin range) are then divided by the total number of counts (i.e. the total number of questionnaires) and multiplied by 100 to produce the per cent frequency of counts per bin. These graphs provide a picture of the distribution of the ratings among the participants. Furthermore, by adding the frequencies of each subsequent bin a "cumulative frequency histogram" is produced (Fig. 6).

The error bars shown in the Fig. 7 correspond to the standard deviation of each distribution. The elaboration methodology adheres to following four steps:

(i) It is assumed that the average of the ratings in the eight questions gives a measure of "virtual presence" (PM index) for the five museums.

(ii) It is assumed that this is directly related to the method used by each museum to enhance the virtual tour (i.e. "causation" is assumed).

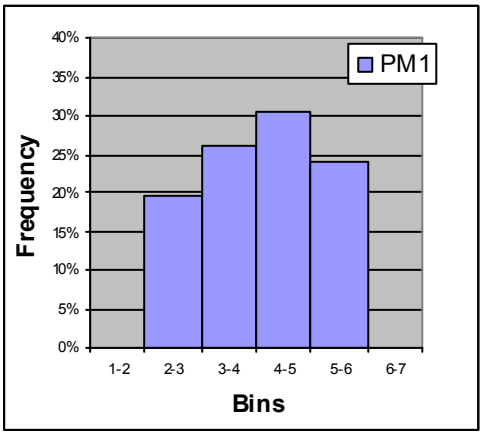
(iii) The PM results for the five museums are compared by direct visual inspection of the respective histograms.

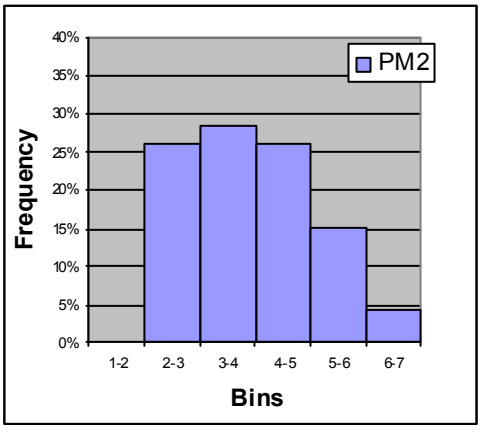
(iv) Conclusions are drawn based on the frequency of bad scores (< 3) and high scores (> 5).

5. RESULTS

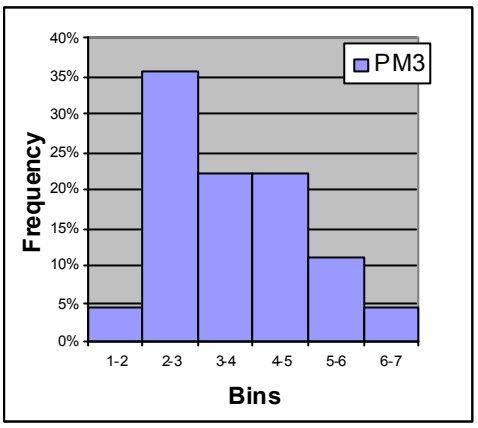
The above presented histograms revealed the following:

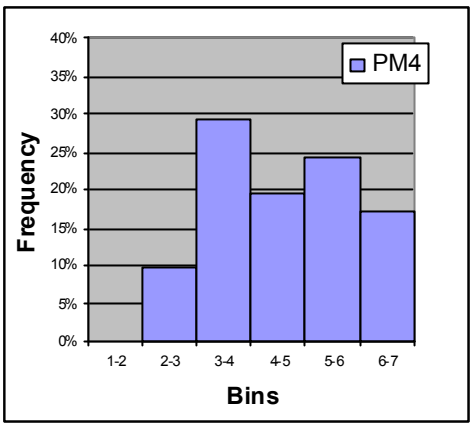
- The frequency histogram of the third museum showed that it had the worse score in the rank 2-3 (35 per cent).
- The frequency histograms of the fourth and the fifth museum showed the highest scores in the range 5-7 (41 per cent and 36 per cent, respectively).





Figures 1 and 2. Presence index of the 1st and the 2nd virtual museums.





Figures 3 and 4. Presence index of the 3rd and the 4th virtual museums.

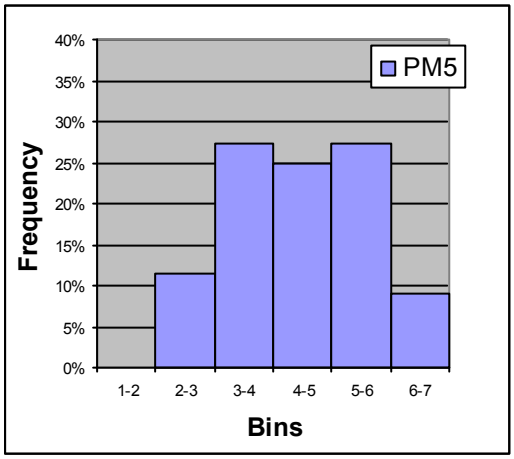


Figure 5. Presence index of the 5th virtual museum.

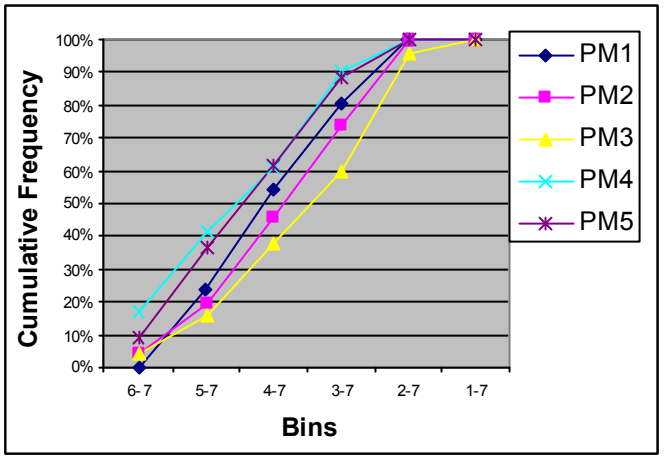


Figure 6. Cumulative frequency histogram.

- The cumulative histograms of all five museums revealed that the scores above average (3) were 90 per cent for fourth and fifth museum, 80 per cent for first museum, 74 per cent for the second museum and 60 per cent for the third museum.

Based on these findings (particularly the high scores of fourth and the fifth museum and the low score of the third museum) it may be argued that the methods employed to enhance the virtual presence in museums four and five are better than those used in museums one to three.

6. CONCLUSION

Based on the aforementioned statistical results, it can be concluded that 3-D spaces and real time navigation results in the greater feeling of presence in a virtual interface. In addition to this, some recent web technologies to enhance interaction, such as Macromedia Flash, in combination with embedded sound and/or video add to this feeling of presence significantly. In contrary, the up to now employed approach by means of a "thumbnail gallery leads to high resolution image" is no more adequate, as regards feeling present in a virtual museum environment. Even if photographs of the presented artifacts are used, the feeling is the same: a web-based "virtual gallery" in a "normal" web-based presentation style. However, in utilizing broadly accepted technologies, such as Macromedia Flash, implemented directly in the visitor's browser, enhancing thus the user-environment interaction, enriched also with sound and/or video, provides a low cost solution with good acceptance with regards to presence in a virtual environment, as the statistics of this study unveiled.

This result has its own value *per se*, as most of the contemporary collections of cultural heritage objects are presented by means of "virtual galleries". In contrast, there is concern whether employing technologies such as VR or AR approaches could severely impact usability and hinder virtual visitors in completing efficiently tasks in the interface[17]. This study does not raise such an issue; however

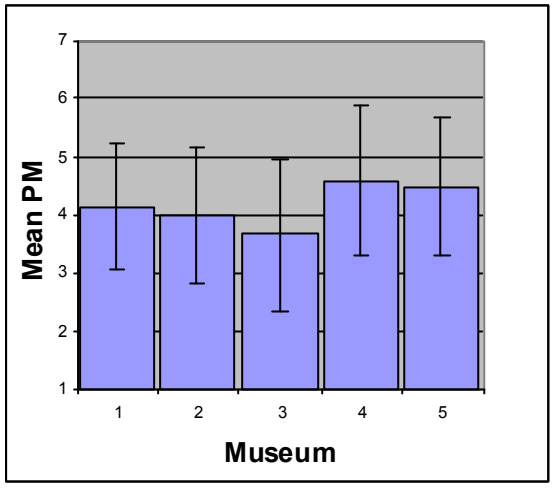


Figure 7. Summary statistics (mean and standard deviation) for the five histograms.

it was not designed to assess usability issues. So, this question, namely if high-end technologies, such as AR/VR technologies impact usability, remains open and is proposed for further research. As a closing remark, a broader look at the results of this study shows that virtual visitors feel present in a virtual environment if they can *dynamically interact* with the environment, which implies natural multimodal (tactile, visual and aural) interaction and *exploratively navigate* through it, feeling thus as being there, as far as it can be possible in a technology facilitated environment, such as a virtual museum interface.

REFERENCES

1. Jones, J. & Christal, M. The future of virtual museums: Online, immersive, 3-D environments. Created Realities Group, 2002.

2. Scali, G.; Segbert, M. & Morganti, B. Multimedia applications for innovation in cultural heritage: 25 European trial projects and their accompanying measure TRIS. *In* 68th IFLA Council and General Conference, 18-24 August 2002.

3. Tsapatori, M. ORION research roadmap, evaluation and assessment. Object Rich Information Network (ORION), 2003. Deliverable 8.

4. Mania, K. & Robinson, A. An experimental exploration of the relationship between subjective impressions of illumination and physical fidelity. *Computers and Graphics*, 2005, **29**, 49-56.

5. Sadowski, W. & Stanley, K. Presence in virtual environments edited by K.M. Stanney. *In* Handbook of virtual environments: Design, implementation and applications. Lawrence Erlbaum Associates Inc., Mahwah, NJ, 2002, pp.791-806.

6. Webster's II: New Riverside University Dictionary. Boston: Houghton Mifflin, 1984.

7. Stanney, K.M.; Salvendy, G.; Deisigner, J.; DiZio, P.; Ellis, S.; Ellison, E.; Fogleman, G.; Gallimore, J.; Hettinger, L.; Kennedy, R.; Lackner, J.; Lawson, B.; Maida, J.; Mead, A.; Mon-Williams, M.; Newman, D.; Piantanida, T.; Reeves, L.; Riedel, O.; Singer, M.; Stoffregen, T.; Wann, J.; Welch, R.; Wilson, J. & Witmer, B. After effects and sense of presence in virtual environments: Formulation of a research and development agenda. Report sponsored by the Life Sciences Division at NASA Headquarters. *International Journal of Human-Computer Interaction*, 1998, **10**(2), 135-87.

8. Lombard, M. & Ditton, T. At the heart of it all: The concept of presence. *Journal of Computer Mediated Communication,* 1997, **3**(2), 1-45. http://www.ascusc.org/jcmc/vol3/issue2/lombard.html

9. Freeman, J.; Avons, S. E.; Pearson, D. E. & Ijsselsteijn, W. A. Effects of sensory information and prior experience on direct subjective ratings of presence. *Presence: Teleoperators and Virtual Environments*, 1999, **8**, 1-13.

10. Slater, M. Measuring presence: A response to the Witmer and Singer Presence Questionnaire. *Presence*, 1999, **8**(5), 560-565.

11. Mania, K. & Chalmers, A. The effects of levels of immersion on memory and presence in virtual environments: A reality centered approach. *CyberPsychology & Behavior,* 2001, **4**, 247-264.

12. Barfield, W.; Zeltzer, D.; Sheridan, T. & Slater, M. Presence and performance within virtual environments. *In* Virtual Environments and advanced interface design edited by W. Barfield and T.A. Furness. Oxford University Press, New York, 1995, 473-513.

13. Witmer, B.G. & Singer, M.J. Measuring presence in virtual environments: A presence questionnaire. *Presence*, 1998, **7**, 225-240.

14. Chen, S. E. Quicktime VR: An image-based approach to virtual environment navigation. *In* Proceedings of the 22nd annual ACM conference on Computer graphics, 1995, 29-38.

15. Beaudouin-Lafon, M. & Mackay, W. Prototyping development and tools, edited by J.A. Jacko and A. Sears. *In* Human Computer Interaction Handbook. Lawrence Erlbaum Associates Inc., Mahwah, NJ, 2002, pp. 1006-1031.

16. Slater, M.; Steed, A.; McCarthy, J. & Maringelli, F. The influence of body movement on subjective presence in virtual environments. *Human Factors,* 1998, **40**(3), 469-477.

17. Karoulis, A.; Sylaiou, S. & White, M. Usability evaluation of a virtual museum interface. *Informatica,* 2006, **17**(3), 363-380.

About the Authors

Stella Sylaiou is pursuing PhD at the Aristotle University of Thessaloniki, Greece. She holds a BA degree in Archaeology and a MSc in Archaeological Computing, specialising in Virtual Reality in Archaeology. Her areas of interest include Cultural Informatics, Human-Computer Interaction, etc.

Dr Ioannis Stavropoulos is a Chemical Engineer from Aristotle University of Thessaloniki, Greece. His main interests are multivariate statistical process control and computer modeling of physicochemical processes. He is currently an affiliated researcher at the Aerosol and Particle Technology Laboratory of CERTH/CPERI, Greece.

Dr Athanasis Karoulis has a BSc in Mathematics, an MSc in Information Systems, an MSc in Education, and a PhD in Informatics. He is currently active as an instructor in educational technologies for secondary education, as a multimedia and web project manager, and as a researcher in the domains of HCI and of Distance Learning, regarding the application of new technologies at the Department of Informatics at Aristotle University. His scientific interests include Human-Computer Interaction, Multimedia and Web design, Educational Technologies and Distance Learning.

Prof. Petros Patias is a Professor at the Department of Rural and Surveying Engineering, Aristotle University of Thessaloniki, Greece. His main interests are Photogrammetry and Remote Sensing, Visualisation, and Cultural Informatics.

Invitation to Authors

If you are a library professional/information manager/information scientist/information specialist/computer professional or a research scholar with a vision for developments in Information Technology, including software, processors, storage media, and devices having an impact on library and information systems and services, we invite you to submit a paper for *DESIDOC Journal of Library and Information Technology (DJLIT)* and enjoy the following benefits:

- Expert editorial support: All papers are wetted by the eminent members of the Editorial Board of *DJLIT*
- Critical review: All papers are peer-reviewed by the experts in Library and Information Science
- Extensive abstracting and indexing for greater visibility: *DJLIT* is covered in major indexing and abstracting services like *LISA, The Informed Librarian, INSPEC database and Wilson database*
- Open Journal System
- Complimentary copies to the contributors

Please send your paper/queries to:

The Editor(s)
DESIDOC Journal of Library & Information Technology
House Bulletin Group
Defence Scientific Information & Documentation Centre
Metcalfe House, Delhi-110 054
e-mail:dbit@desidoc.drdo.in