List of articles proposed for study and citation analysis 2022.02.17

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1. Achibet et al, Proc of IEEE VR 2015
2. Allison et al., Proc. of IEEE VR 2001
3. Argelaguet et al, Proc. of IEEE VR 2016
4. Aristidou et al, Graphical Models, 2011
5. Bowman et al., CACM 2012
6. Brown et al, The Visual Computer, 2004
7. Burns et al, Presence 2006
8. Chaminade et al, Soc Cogn Affect Neurosci. 2007
9. Cruz-Neira et al, Communications of the ACM, 1992
10. Fox et al, Media Psychology, 2009
11. Glaeser et al, The Visual Computer, 1999
12. Ho, Basdogan et al, Presence 1999
13. Hodgins J. et al, ACM TAP 2010
14. Hoffman et al, Pain 2004
15. Interrante et al. IEEE 3DUI 2007
16. Iwata Hiroo, IEEE Virtual Reality 1999
17. Johansson, Perception and Psychophysics 1973
18. Kilteni et al, IEEE TVCG 2013
19. Krueger et al, SIGCHI 1985
20. Lecuyer, Coquillart et al, IEEE VR Conf 2000
21. Meehan et al, SIGGRAPH 2002
22. Mohler et al, Presence 2012
23. Nowack et al, Presence 2003
24. Ortiz-Catalan et al, The Lancet 2016
25. Pertaub et al, Presence 2002
26. Poupyrev et al., ACM VRST 1997
27. Ragan et al, Virtual Reality (2012)
28. Raij et al, IEEE TVCG 2007
29. Renard et al, Presence : Teleoperators and Virtual Environments, 2010
30. Rizzo et al, Medecine meets VR, 2009
31. Sanchez-Vives & Slater, Nature reviews Neuroscience 2005
32. Scharples et al, Displays 2008
33. Schultheis et al., Presence 2001
34. Stoakley et al., CHI 1995
35. Tarr and Warren, Nature Neuroscience 2002
36. Thomson et al., Presence 2004
37. Tolani et al, Graphical Models, 2000
38. Usoh et al, SIGGRAPH 1999
39. Ustinova et al., Journal of Neuroengineering and rehabilitation 2011
40. Yee et al, Communication Research 2009
41. Zell et al, Transaction on Graphics 2015

Merwan Achibet ,Adrien Girard ,Anthony Talvas ,Maud Marchal , Anatole L´ecuyer, Elastic-Arm: Human-Scale Passive Haptic Feedbackfor Augmenting Interaction and Perception in Virtual Environments, proc of IEEE VR 2015, 23-27 March 2015, Arles, France, DOI: 10.1109/VR.2015.7223325

- Haptic feedback is known to improve 3D interaction in virtual environments but current haptic interfaces remain complex and tailored to desktop interaction. In this paper, we introduce the "Elastic-Arm", a novel approach for incorporating haptic feedback in immersive virtual environments in a simple and cost-effective way. The Elastic-Arm is based on a body-mounted elastic armature that links the user's hand to her shoulder. As a result, a progressive resistance force is perceived when extending the arm. This haptic feedback can be incorporated with various 3D interaction techniques and we illustrate the possibilities offered by our system through several use cases based on well-known examples such as the *Bubble* technique, *Redirected Touching* and *pseudo-haptics*…

- R. S. Allison, L. R. Harris, M. Jenkin, U. Jasiobedzka, and J. E. Zacher. Tolerance of temporal delay in virtual environments. In *Proceedings of the Virtual Reality 2001 Conference (VR'01)*, VR '01, pp. 247–. IEEE Computer Society, Washington, DC, USA, 2001.

  - To enhance presence, facilitate sensory motor performance, and avoid disorientation or nausea, virtual-reality applications require the percept of a stable environment. End-end tracking latency (display lag) degrades this illusion of stability and has been identified as a major fault of existing virtual-environment systems. Oscillopsia refers to the perception that the visual world appears to swim about or oscillate in space and is a manifestation of this loss of perceptual stability of the environment. In this paper, the effects of end-end latency and head velocity on perceptual stability in a virtual environment were investigated psychophysically. Subjects became significantly more likely to report oscillopsia during head movements when end-end latency or head velocity were increased. It is concluded that perceptual instability of the world arises with increased head motion and increased display lag. Oscillopsia is expected to be more apparent in tasks requiring real locomotion or rapid head movement.

- Ferran Argelaguet, Ludovic Hoyet, Michaël Trico, Anatole Lécuyer, The role of interaction in virtual embodiment: Effects of the virtual hand representation, IEEE Virtual Reality conference (VR), 3-10, 2016

  - How do people appropriate their virtual hand representation when interacting in virtual environments? In order to answer this question, we conducted an experiment studying the sense of embodiment when interacting with three different virtual hand representations, each one providing a different degree of visual realism but keeping the same control mechanism. The main experimental task was a Pick-and-Place task in which participants had to grasp a virtual cube and place it to an indicated position while avoiding an obstacle (brick, barbed wire or fire). An additional task was considered in which participants had to perform a potentially dangerous operation towards their virtual hand: place their virtual hand close to a virtual spinning saw. Both qualitative measures and questionnaire data were gathered in order to assess the sense of agency and ownership towards each virtual hand. Results show that the sense of […]

- A. Aristidou, Joan Lasenby, FABRIK: a fast, iterative solver for the inverse kinematics problem, Graphical Models, 73(5): 243-260, 2011.
  - Inverse Kinematics is defined as the problem of determining a set of appropriate joint configurations for which the end effectors move to desired positions as smoothly, rapidly, and as accurately as possible. However, many of the currently available methods suffer from high computational cost and production of unrealistic poses. In this paper, a novel heuristic method, called Forward And Backward Reaching Inverse Kinematics (FABRIK), is described and compared with some of the most popular existing methods regarding reliability, computational cost and conversion criteria. FABRIK avoids the use of rotational angles or matrices, and instead finds each joint position via locating a point on a line. Thus, it converges in few iterations, has low computational cost and produces visually realistic poses. Constraints can easily be incorporated within FABRIK and multiple chains with multiple end effectors are also supported.

- Doug A. Bowman, Ryan P. McMahan, and Eric D. Ragan. 2012. Questioning naturalism in 3D user interfaces. *Commun. ACM* 55, 9 (September 2012), 78-88. DOI=10.1145/2330667.2330687 http://doi.acm.org/10.1145/2330667.2330687
  - 3D UIs are uniquely able to achieve superior interaction fidelity, and this naturalism can be a huge advantage.

- Joel Brown, Jean-Claude Latombe, and Kevin Montgomery. 2004. Real-time knot-tying simulation. Vis. Comput. 20, 2 (May 2004), 165-179
  - The real-time simulation of rope, and knot tying in particular, raises difficult issues in contact detection and management. Some practical knots can only be achieved by complicated crossings of the rope, yielding multiple simultaneous contacts, especially when the rope is pulled tight. This paper describes a graphical simulator that allows a user to grasp and smoothly manipulate a virtual rope and to tie arbitrary knots, including knots around other objects, in real time. A first component of the simulator computes the global configuration of the rope based on user interactions. Another component of the simulator precisely detects self-collisions in the rope as well as collisions with other objects. Finally, a third component manages collisions to prevent penetration, while making the rope slide with some friction along itself and other objects, so that knots can be pulled tight in a realistic manner. An additional module uses recent results from knot theory to identify, also in real time, which topological knots have been tied. This work was motivated by surgical suturing, but simulation in other domains, such as sailing and rock climbing, could also benefit from it.

- Eric Burns, Sharif Razzaque, Abigail T. Panter, Mary C. Whitton, Matthew R. McCallus, and Frederick P. Brooks, Jr.. 2006. The hand is more easily fooled than the eye: users are more sensitive to visual interpenetration than to visual-proprioceptive discrepancy. Presence: Teleoper. Virtual Environ. 15, 1 (February 2006), 1-15.
  - A virtual environment (VE) user's avatar may penetrate virtual objects. Some VE designers prevent visual interpenetration, assuming that prevention improves user experience. However, preventing visual avatar interpenetration causes a discrepancy

between visual and proprioceptive cues. We investigated users' detection thresholds for visual interpenetration and visual-proprioceptive discrepancy and found that users are much less sensitive to visual-proprioceptive discrepancy than to visual interpenetration. We propose using this result to better deal with user penetration of virtual objects.

- o Thierry Chaminade, Jessica Hodgins and Mitsuo Kawato, Anthropomorphism influences perception of computer-animated characters' actions, Soc Cogn Affect Neurosci. 2007 September; 2(3): 206–216. Prepublished online 2007 May 21. doi: 10.1093/scan/nsm017.
  - o Computer-animated characters are common in popular culture and have begun to be used as experimental tools in social cognitive neurosciences. Here we investigated how appearance of these characters' influences perception of their actions. Subjects were presented with different characters animated either with motion data captured from human actors or by interpolating between poses (keyframes) designed by an animator, and were asked to categorize the motion as biological or artificial. The response bias towards 'biological', derived from the Signal Detection Theory, decreases with characters' anthropomorphism, while sensitivity is only affected by the simplest rendering style, point-light displays. fMRI showed that the response bias correlates positively with activity in the mentalizing network including left temporoparietal junction and anterior cingulate cortex, and negatively with regions sustaining motor resonance. The absence of significant effect of the characters on the brain activity suggests individual differences in the neural responses to unfamiliar artificial agents. While computer-animated characters are invaluable tools to investigate the neural bases of social cognition, further research is required to better understand how factors such as anthropomorphism affect their perception, in order to optimize their appearance for entertainment, research or therapeutic purpose.

- o Jesse Fox, Jeremy N Bailenson, Virtual self-modeling: The effects of vicarious reinforcement and identification on exercise behaviors, Media Psychology, 12(1), 1-25, 2009/2/26, Taylor & Francis Group
  - o Social cognitive theory is often implemented when researchers develop treatments and campaigns for health behavior change. Immersive virtual environment technology (IVET) enables novel explorations of health behavior modeling. In Study 1, participants were randomly assigned to one of three treatments: vicarious reinforcement, in which a virtual representation of the physical self (VRS) gained or lost weight in accordance with participants' physical exercise; an unchanging VRS; or no virtual representation. The reinforcement group performed significantly more exercise in a voluntary phase than those in other conditions. Study 2 separated reward (weight loss) from punishment (weight gain) and also explored model identification by contrasting the effects of a VRS with a VRO (virtual representation of an other); participants exercised significantly more when they viewed the VRS, regardless of whether reward or […]

- o GLAESER, G., AND GRöLLER, E. 1999. Fast generation of curved perspectives for ultra-wide-angle lenses in vr applications. The Visual Computer 15, 7-8, 365–376
  - o Classic ultra-wide-angle perspectives are not realistic and often misleading, nevertheless, they have to be used in many applications where the viewer needs a

survey of the scene. Current hardware, however, only supports classic perspectives. We present a fast polygon-oriented algorithm that allows the use of curved perspectives in order to overcome several drawbacks, but at the cost of non-linearity. Space is projected onto a sphere rather than onto an image plane. The spherical coordinates are then interpreted two-dimensionally. We discuss the advantages and drawbacks of several approaches to curved perspectives.

- C. Ho, Cagatay Basdogan and Mandayam A. Srinivasan, Efficient Point-Based Rendering Techniques for Haptic Display of Virtual Objects, Presence: Teleoperators and Virtual Environments 1999 8:5, 477-491
    - Computer haptics, an emerging field of research that is analogous to computer graphics, is concerned with the generation and rendering of haptic virtual objects. In this paper, we propose an efficient haptic rendering method for displaying the feel of 3-D polyhedral objects in virtual environments (VEs). Using this method and a haptic interface device, the users can manually explore and feel the shape and surface details of virtual objects. The main component of our rendering method is the "neighborhood watch" algorithm that takes advantage of precomputed connectivity information for detecting collisions between the end effector of a force-reflecting robot and polyhedral objects in VEs. We use a hierarchical database, multithreading techniques, and efficient search procedures to reduce the computational time such that the haptic servo rate after the first contact is essentially independent of the number of polygons that represent the object. We also propose efficient methods for displaying surface properties of objects such as haptic texture and friction. Our haptic-texturing techniques and friction model can add surface details onto convex or concave 3-D polygonal surfaces. These haptic-rendering techniques can be extended to display dynamics of rigid and deformable objects.

- Jessica Hodgins, Sophie Jörg, Carol O'Sullivan, Sang Il Park, and Moshe Mahler. 2010. The saliency of anomalies in animated human characters. ACM Trans. Appl. Percept. 7, 4, Article 22 (July 2010),
    - Virtual characters are much in demand for animated movies, games, and other applications. Rapid advances in performance capture and advanced rendering techniques have allowed the movie industry in particular to create characters that appear very human-like. However, with these new capabilities has come the realization that such characters are yet not quite "right."

- H. G. Hoffman, Sam R. Sharard, Barbara Codad, John J. Everetta,b,Marcia Ciolb, Todd Richardsc, David R. Patterson, Manipulating presence influences the magnitude of virtual reality analgesia, Pain 111 (2004) 162–168.
    - Excessive pain during medical procedures performed in unanesthetized patients is frequently reported, but can be reduced with virtual reality (VR) distraction. Increasing the person's illusion of going into the virtual world may increase how effectively VR distracts pain. Healthy volunteers aged 18–20 years participated in a double-blind between-groups design. Each subject received a brief baseline thermal pain stimulus, and the same stimulus again minutes later with either a Low Tech or a High Tech VR distraction. Each subject provided subjective 0–10 ratings of cognitive, sensory and affective components of pain, and rated their illusion of going inside the virtual world. Subjects in the High Tech VR group reported a stronger illusion of going

into the virtual world (VR presence) than subjects in the Low Tech VR group, (4.2 vs. 2.5, respectively, P ¼ 0:009) and more pain reduction (reduction of worst pain is 3.1 for High Tech VR vs. 0.7 for Low Tech VR, P , 0:001). Across groups, the amount of pain reduction was positively and significantly correlated with VR presence levels reported by subjects (r ¼ 0:48 for 'worst pain', P , 0:005).

- Interrante, V.; Ries, B.; Anderson, L., "Seven League Boots: A New Metaphor for Augmented Locomotion through Moderately Large Scale Immersive Virtual Environments," *3D User Interfaces, 2007. 3DUI '07. IEEE Symposium on* , vol., no., pp.,, 10-11 March 2007 doi: 10.1109/3DUI.2007.340791
  - When an immersive virtual environment represents a space that is larger than the available space within which a user can travel by directly walking, it becomes necessary to consider alternative methods for traveling through that space. The traditional solution is to require the user to travel 'indirectly', using a device that changes his viewpoint in the environment without actually requiring him to move - for example, a joystick. However, other solutions involving variations on direct walking are also possible. In this paper, we present a new metaphor for natural, augmented direct locomotion through moderately large-scale immersive virtual environments (IVEs) presented via head mounted display systems, which we call seven league boots.

- IWATA, Hiroo. Walking about virtual environments on an infinite floor. In: Proceedings IEEE Virtual Reality (Cat. No. 99CB36316). IEEE, 1999. S. 286-293.
  - This paper presents a new configuration of locomotion interface for walking about virtual space. Traveling on foot is the most intuitive way for locomotion. Infinite surface driven by actuators is an ideal device for creation of sense of walking. We selected a torus-shaped surface to realize the locomotion interface. The locomotion interface employs twelve sets of treadmills. These treadmills are connected side by side and driven to perpendicular direction. Infinite surface is generated by the motion of the treadmills. The walker can go to any direction while his/her position is fixed in the real world. Effectiveness of the device is tested by motion analysis and study on sense of distance.

- Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. Perception And Psychophysics, 14(2), 201-211.
  - This paper reports the first phase of a research program on visual perception of motion patterns characteristic of living organisms in locomotion. Such motion patterns in animals and men are termed as biological motion. They are characterized by a far higher degree of complexity than the patterns of simple mechanical motions usually studied in laboratories. In everyday perceptions, the visual information from biological motion and from the corresponding figurative contour patterns (the shape of the body) are intermingled. A method for studying information from the motion pattern per se without interference with the form aspect was devised. In short, the motion of the living body was represented by a few bright spots describing the motions of the main joints. It is found that 10-12 such elements in adequate motion

combinations in proximal stimulus evoke a compelling impression of human walking, running, dancing, etc. The kinetic geometric model for visual vector analysis originally developed in the study of perception of motion combinations of the mechanical type was applied to these biological motion patterns. The validity of this model in the present context was experimentally tested and the results turned out to be highly positive.

- K. Kilteni, I. Bergstrom and M. Slater, "Drumming in Immersive Virtual Reality: The Body Shapes the Way We Play," in IEEE Transactions on Visualization and Computer Graphics, vol. 19, no. 4, pp. 597-605, April 2013. doi: 10.1109/TVCG.2013.29
    - It has been shown that it is possible to generate perceptual illusions of ownership in immersive virtual reality (IVR) over a virtual body seen from first person perspective, in other words over a body that visually substitutes the person's real body. This can occur even when the virtual body is quite different in appearance from the person's real body. However, investigation of the psychological, behavioral and attitudinal consequences of such body transformations remains an interesting problem with much to be discovered. Thirty six Caucasian people participated in a between-groups experiment where they played a West-African Djembe hand drum while immersed in IVR and with a virtual body that substituted their own. The virtual hand drum was registered with a physical drum. They were alongside a virtual character that played a drum in a supporting, accompanying role. [...] These results demonstrate that full body ownership illusions can lead to substantial behavioral and possibly cognitive changes depending on the appearance of the virtual body. This could be important for many applications such as learning, education, training, psychotherapy and rehabilitation using IVR.

- Myron W. Krueger, Thomas Gionfriddo, and Katrin Hinrichsen. 1985. VIDEOPLACE\—an artificial reality. In Proceedings of the SIGCHI conference on Human factors in computing systems (CHI '85). ACM, New York, NY, USA, 35-40. DOI=10.1145/317456.317463 http://doi.acm.org/10.1145/317456.317463
    - The human-machine interface is generalized beyond traditional control devices to permit physical participation with graphic images. The VIDEOPLACE System combines a participant's live video image with a computer graphic world. It also coordinates the behavior of graphic objects and creatures so that they appear to react to the movements of the participant's image in real-time. A prototype system has been implemented and a number of experiments with aesthetic and practical implications have been conducted.

- Lecuyer, Anatole, Coquillart, Sabine, Kheddar, Abderrahmane, Richard, Paul, and Coiffet, Philippe: Pseudo-Haptic Feedback: Can Isometric Input Devices Simulate Force Feedback?, Proceedings of the IEEE Virtual Reality 2000 Conference, IEEE Computer Society, 83–, 2000.
    - This paper considers whether a passive isometric input device, such as a Spaceball, used together with visual feedback, could provide the operator with a pseudo-haptic feedback.For this aim, two psychophysical experiments have been conducted. The first experiment consisted of compliance discrimination, between two virtual springs hand-operated by means of the Spaceball. In this experiment, the stiffness (or compliance) JND turned out to be 6%. The second experiment assessed stiffness discrimination between a virtual spring and the equivalent spring in reality. In this case, the stiffness (or compliance) JND was found to be 13.4%.These results are consistent with previous outcomes on manual discrimination of compliance. Consequently, this consistency reveals that the passive apparatus that was used can, to some extent, simulate haptic information.In addition, a final test indicated that the proprioceptive sense of the subjects was blurred by visual feedback. This gave them the illusion of using a non-isometric device.

- Michael Meehan, Brent Insko, Mary Whitton, and Frederick P. Brooks, Jr.. 2002. Physiological measures of presence in stressful virtual environments. In Proceedings of the 29th annual conference on Computer graphics and interactive techniques (SIGGRAPH '02). ACM, New York, NY, USA, 645-652. DOI=10.1145/566570.566630 http://doi.acm.org/10.1145/566570.566630
    - A common measure of the quality or effectiveness of a virtual environment (VE) is the amount of presence it evokes in users. Presence is often defined as the sense of being there in a VE. There has been much debate about the best way to measure presence, and presence researchers need, and have sought, a measure that is reliable, valid, sensitive, and objective. We hypothesized that to the degree that a VE seems real, it would evoke physiological responses similar to those evoked by the corresponding real environment, and that greater presence would evoke a greater response. To examine this [,...]

- B. J Mohler, Sarah H Creem-Regehr, William B Thompson, Heinrich H Bülthoff, The effect of viewing a self-avatar on distance judgments in an HMD-based virtual environment, Presence: Teleoperators and Virtual Environments 19(3), 230-242, The MIT-Press, 2010/6/1
    - Few HMD-based virtual environment systems display a rendering of the user's own body. Subjectively, this often leads to a sense of disembodiment in the virtual world. We explore the effect of being able to see one's own body in such systems on an objective measure of the accuracy of one form of space perception. Using an action-based response measure, we found that participants who explored near space while seeing a fully-articulated and tracked visual representation of themselves subsequently made more accurate judgments of absolute egocentric distance to locations ranging from 4 m to 6 m away from where they were standing than did participants who saw no avatar. A non-animated avatar also improved distance judgments, but by a lesser amount. Participants who viewed either animated or static avatars positioned 3 m in front of their own position made subsequent distance judgments with similar [...]

- Kristine L Nowak, Frank Biocca, The effect of the agency and anthropomorphism on users' sense of telepresence, copresence, and social presence in virtual environments, Presence: Teleoperators & Virtual Environments, 12(5), 481-494, MIT-Press, 2003/10
    - We report on an experiment that examined the influence of anthropomorphism and perceived agency on presence, copresence, and social presence in a virtual environment. The experiment varied the level of anthropomorphism of the image of interactants: high anthropomorphism, low anthropomorphism, or no image. Perceived agency was manipulated by telling the participants that the image was either an avatar controlled by a human, or an agent controlled by a computer. The results support the prediction that people respond socially to both human and computer-controlled entities, and that the existence of a virtual image increases tele-presence. Participants interacting with the less-anthropomorphic image reported more copresence and social presence than those interacting with partners represented by either no image at all or by a highly anthropomorphic image of the other, indicating that the more [...]

- Max Ortiz-Catalan, Rannveig A Guðmundsdóttir, Morten B Kristoffersen, Alejandra Zepeda-Echavarria, Kerstin Caine-Winterberger, Katarzyna Kulbacka-Ortiz, Cathrine Widehammar, Karin Eriksson, Anita Stockselius, Christina Ragnö, Zdenka Pihlar, Helena Burger, Liselotte Hermansson, Phantom motor execution facilitated by machine learning and augmented reality as treatment for phantom limb pain: a single group, clinical trial in patients with chronic intractable phantom limb pain, The Lancet, Volume 388, Issue 10062, 2016, Pages 2885-2894, ISSN 0140-6736, https://doi.org/10.1016/S0140-6736(16)31598-7.
  - Background: Phantom limb pain is a debilitating condition for which no effective treatment has been found. We hypothesised that re-engagement of central and peripheral circuitry involved in motor execution could reduce phantom limb pain via competitive plasticity and reversal of cortical reorganisation.

- Pertaub, D.P., Slater, M., and Barker, C.: An experiment on public speaking anxiety in response to three different types of virtual audience, Presence, Teleoperators and Virtual Environments 11(1), volume 11, 68–78, 2002.
  - This paper describes an experiment to assess the anxiety responses of people giving 5 min. presentations to virtual audiences consisting of eight male avatars. There were three different types of audience behavior: an emotionally neutral audience that remained static throughout the talk, a positive audience that exhibited friendly and appreciative behavior towards the speaker, and a negative audience that exhibited hostile and bored expressions throughout the talk A second factor was immersion: half of the forty subjects experienced the virtual seminar room through a head-tracked, head-mounted display and the remainder on a desktop system. [...] The negative audience clearly provoked an anxiety response irrespective of the normal level of public speaking confidence of the subject. The somatic response also showed a higher level of anxiety for the negative audience than for the other two, but self-rating was generally higher only for the static audience, each of these results taking into account prior PRCS.

- Ivan Poupyrev, Suzanne Weghorst, Mark Billinghurst, and Tadao Ichikawa. 1997. A framework and testbed for studying manipulation techniques for immersive VR. In *Proceedings of the ACM symposium on Virtual reality software and technology* (VRST '97). ACM, New York, NY, USA, 21-28. DOI=10.1145/261135.261141 http://doi.acm.org/10.1145/261135.261141
  - Developing virtual reality (VR) applications which enable actual work over a period of time requires optimization of the most basic interactions, such as object manipulation, so that the immersed participant can concentrate on higher-level tasks rather than on low-level motor activities.

- Eric D. Ragan, Doug A. Bowman, Karl J. Huber, Supporting cognitive processing with spatial information presentations in virtual environments. Virtual Reality (2012) 16: 301. https://doi.org/10.1007/s10055-012-0211-8.
  - While it has been suggested that immersive virtual environments could provide benefits for educational applications, few studies have formally evaluated how the enhanced perceptual displays of such systems might improve learning. Using simplified memorization and problem-solving tasks as representative approximations of more advanced types of learning, we are investigating the effects of providing supplemental spatial information on the performance of learning-based activities within virtual environments. We performed two experiments to investigate whether users can take advantage of a spatial information presentation to improve performance on cognitive processing activities…

- Andrew B. Raij, Kyle Johnsen, Robert F. Dickerson, Benjamin C. Lok, Marc S. Cohen, Margaret Duerson, Rebecca Rainer Pauly, Amy O. Stevens, Peggy Wagner, and D. Scott Lind. 2007. Comparing Interpersonal Interactions with a Virtual Human to Those with a Real Human. IEEE Transactions on Visualization and Computer Graphics 13, 3 (May 2007), 443-457.

- - This paper provides key insights into the construction and evaluation of interpersonal simulators—systems that enable interpersonal interaction with virtual humans. Using an interpersonal simulator, two studies were conducted that compare interactions with a virtual human to interactions with a similar real human. The specific interpersonal scenario employed was that of a medical interview.

- Yann Renard, Fabien Lotte, Guillaume Gibert, Marco Congedo, Emmanuel Maby, et al.. OpenViBE:An Open-Source Software Platform to Design, Test and Use Brain-Computer Interfaces in Real andVirtual Environments. Presence: Teleoperators and Virtual Environments, Massachusetts Institute ofTechnology Press (MIT Press), 2010, 19 (1), pp.35-53. hal-00477153
  - This paper describes the OpenViBE software platform which enables todesign, test and use Brain-Computer Interfaces. Brain-Computer Interfaces(BCI) are communication systems that enable users to send commands tocomputers only by means of brain activity. BCI are gaining interest amongthe Virtual Reality (VR) community since they have appeared as promis-ing interaction devices for Virtual Environments (VE). The key features ofthe platform are 1) a high modularity, 2) embedded tools for visualizationand feedback based on VR and 3D displays, 3) BCI design made availableto non-programmers thanks to visual programming and 4) various tools of-fered to the different types of users. The platform features are illustrated inthis paper with two entertaining VR applications based on a BCI…

- Rizzo A., Difede J., Rothbaum B., Johnston S., McLay R., Reger G., Gahm G., Parsons T., Graap K., Pair J. VR PTSD Exposure Therapy Results with Active Duty OIF/OEF Combatants, *Medicine Meets Virtual Reality 17* (January 2009)
  - Post Traumatic Stress Disorder (PTSD) is reported to be caused by traumatic events that are outside the range of usual human experience including military combat, violent personal assault, being kidnapped or taken hostage and terrorist attacks. Reports indicate that at least 1 out of 6 Iraq War veterans are exhibiting symptoms of depression, anxiety and PTSD. Virtual Reality exposure therapy has been previously used for PTSD with reports of positive outcomes. This paper will present a brief description of the USC/ICT Virtual Iraq/Afghanistan PTSD therapy application and present clinical outcome data from active duty patients treated at the Naval Medical Center-San Diego (NMCSD) as of October 2009. Initial outcomes from the first twenty patients to complete treatment indicate that 16 no longer meet diagnostic criteria for PTSD at post treatment. Research and clinical tests using the Virtual Iraq/Afghanistan software are also currently underway at Weill Cornell Medical College, Emory University, Fort Lewis and WRAMC along with 20 other test sites.
  - **VR PTSD Exposure Therapy Results with Active Duty OIF/OEF Combatants**
  - http://ict.usc.edu/publications/vr_ptsd_exposure_therapy_results_with_active_duty_oif_oef_combatants/

- M. V. Sanchez-Vives1 & Mel Slater, From presence to consciousness through virtual reality, Nature Reviews Neuroscience 6, 332-339 (April 2005) | doi:10.1038/nrn1651
  - Immersive virtual environments can break the deep, everyday connection between where our senses tell us we are and where we are actually located and whom we are with. The concept of 'presence' refers to the phenomenon of behaving and feeling as if we are in the virtual world created by computer displays. In this article, we argue that presence is worthy of study by neuroscientists, and that it might aid the study of perception and consciousness.

- Sarah Sharples, Sue Cobb,Amanda Moody, John R.Wilson, Virtual reality induced symptoms and effects (VRISE): Comparison of head mounted display (HMD), desktop and projection display

systems, Elsevier, Displays, Volume 29, Issue 2, March 2008, Pages 58-69, https://doi.org/10.1016/j.displa.2007.09.005

- Virtual reality (VR) systems are used in a variety of applications within industry, education, public and domestic settings. Research assessing reported symptoms and side effects of using VR systems indicates that these factors combine to influence user experiences of virtual reality induced symptoms and effects (VRISE). Three experiments were conducted to assess prevalence and severity of sickness symptoms experienced in each of four VR display conditions; head mounted display (HMD), desktop, projection screen and reality theatre, with controlled examination of two additional aspects of viewing (active vs. passive viewing and light vs. dark conditions). Results indicate 60–70% participants experience an increase in symptoms pre–post exposure for HMD, projection screen and reality theatre viewing and found higher reported symptoms in HMD compared with desktop viewing (nausea symptoms) and in HMD compared with reality theatre viewing (nausea, oculomotor and disorientation symptoms). No effect of lighting condition was found. Higher levels of symptoms were reported in passive viewing compared to active control over movement in the VE. However, the most notable finding was that of high inter- and intra-participant variability. As this supports other findings of individual susceptibility to VRISE, recommendations are offered concerning design and use of VR systems in order to minimise VRISE.

- M. T. Schultheis, Ronald R. Mourant, Virtual Reality and Driving: The Road to Better Assessment for Cognitively Impaired Populations, Presence, August 2001, Vol. 10, No. 4, Pages 431-439, doi:10.1162/1054746011470271, MIT Press

  - Individuals with cognitive impairments can be faced with difficulties that may challenge their ability to drive an automobile, and this impairment is often very disruptive to vocational, social, and domestic activities. Rehabilitation specialists are often given the task of determining capacity to drive. However, traditional assessment methods are fraught with various limitations, including dependence on subjective interpretation of behaviors, non standardized procedures, and few ecologically valid measures. A virtual reality-based driving-assessment system (VR-DAS) offers the opportunity to overcome many of the limitations of current methodologies.

- Richard Stoakley, Matthew J. Conway, and Randy Pausch. 1995. Virtual reality on a WIM: interactive worlds in miniature. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '95), Irvin R. Katz, Robert Mack, Linn Marks, Mary Beth Rosson, and Jakob Nielsen (Eds.). ACM Press/Addison-Wesley Publishing Co., New York, NY, USA, 265-272. DOI=10.1145/223904.223938 http://dx.doi.org/10.1145/223904.223938

  - This paper explores a user interface technique which augments an immersive head tracked display with a hand-held miniature copy of the virtual environment.

- Michael J. Tarr & William H. Warren, Virtual reality in behavioral neuroscience and beyond, Nature Neuroscience 5, 1089–1092 (2002), https://www.nature.com/articles/nn948

  - Virtual reality (VR) has finally come of age for serious applications in the behavioral neurosciences. After capturing the public imagination a decade ago, enthusiasm for VR flagged due to hardware limitations, an absent commercial market and manufacturers who dropped the mass-market products that normally drive

technological development. Recently, however, improvements in computer speed, quality of head-mounted displays and wide-area tracking systems have made VR attractive for both research and real-world applications in neuroscience, cognitive science and psychology. New and exciting applications for VR have emerged in research, training, rehabilitation, teleoperation, virtual archeology and tele-immersion.

- W. B. Thompson, Peter Willemsen, Amy A. Gooch, Sarah H. Creem-Regehr, Jack M. Loomis, Andrew C. Beall, Does the Quality of the Computer Graphics Matter when Judging Distances in Visually Immersive Environments? Presence, October 2004, Vol. 13, No. 5, Pages 560-571, MIT Press
  - In the real world, people are quite accurate in judging distances to locations in the environment, at least for targets resting on the ground plane and distances out to about 20 m. Distance judgments in visually immersive environments are much less accurate. Several studies have now shown that in visually immersive environments, the world appears significantly smaller than intended. This study investigates whether or not the compression in apparent distances is the result of the low-quality computer graphics utilized in previous investigations. Visually directed triangulated walking was used to assess distance judgments in the real world and in three virtual environments with graphical renderings of varying quality.

- Deepak Tolani, Ambarish Goswami, Norman I. Badler, Real-Time Inverse Kinematics Techniques for Anthropomorphic Limbs, Graphical Models, Volume 62, Issue 5, September 2000, Pages 353-388, ISSN 1524-0703
  - In this paper we develop a set of inverse kinematics algorithms suitable for an anthropomorphic arm or leg. We use a combination of analytical and numerical methods to solve generalized inverse kinematics problems including position, orientation, and aiming constraints. Our combination of analytical and numerical methods results in faster and more reliable algorithms than conventional inverse Jacobian and optimization-based techniques. Additionally, unlike conventional numerical algorithms, our methods allow the user to interactively explore all possible solutions using an intuitive set of parameters that define the redundancy of the system.

- Martin Usoh, Kevin Arthur, Mary C Whitton, Rui Bastos, Anthony Steed, Mel Slater, Frederick P Brooks Jr, Walking> walking-in-place> flying, in virtual environments, Proceedings of the 26th annual conference on Computer graphics and interactive techniques, 359-364, 1999/7/1
  - A study by Slater, et al.,[1995] indicated that naive subjects in an immersive virtual environment experience a higher subjective sense of presence when they locomote by walking-in-place (virtual walking) than when they push-button-fly (along the floor plane). We replicated their study, adding real walking as a third condition. Our study confirmed their findings. We also found that real walking is significantly better than both virtual walking and flying in ease (simplicity, straightforwardness, naturalness) as a mode of locomotion. The greatest difference in subjective presence was between flyers and both kinds of walkers. In addition, subjective presence was higher for real walkers than virtual walkers, but the difference was statistically significant only in some models. Follow-on studies show virtual walking can be substantially improved by detecting footfalls with a head accelerometer.

- o Ksenia I Ustinova, Wesley A Leonard, Nicholas D Cassavaugh and Christopher D Ingersoll, Development of a 3D immersive videogame to improve arm-postural coordination in patients with TBI, Journal of NeuroEngineering and Rehabilitation 2011,8:61.
    - o http://www.biomedcentral.com/content/pdf/1743-0003-8-61.pdf
    - o Traumatic brain injury (TBI) disrupts the central and executive mechanisms of arm(s) and postural (trunk and legs) coordination. To address these issues, we developed a 3D immersive videogame Octopus. The game was developed using the basic principles of videogame design and previous experience of using videogames for rehabilitation of patients with acquired brain injuries. Unlike many other custom-designed virtual environments, Octopus included an actual gaming component with a system of multiple rewards, making the game challenging, competitive, motivating and fun. Effect of a short-term practice with the Octopus game on arm-postural coordination in patients with TBI was tested...

- o Nick Yee,Jeremy N. Bailenson, The Proteus Effect: Implications of Transformed Digital Self-Representation on Online and Offline Behavior, Communication Research, Volume 36 Number 2 April 2009 285-312
    - o Virtual environments allow individuals to dramatically alter their self-representation. More important, studies have shown that people infer their expected behaviors and attitudes from observing their avatar's appearance, a phenomenon known as the Proteus effect. For example, users given taller avatars negotiated more aggressively than users given shorter avatars. Two studies are reported here that extend our understanding of this effect.

- o Zell, Eduard; Aliaga, Carlos; Jarabo, Adrian; Zibrek, Katja; Gutierrez, Diego; McDonnell, Rachel; Botsch, Mario, To stylize or not to stylize?ISSN: 0730-0301 , 1557-7368; DOI: 10.1145/2816795.2818126, ACM transactions on graphics , 2015, Vol.34(6), p.1-12

    - o Virtual characters contribute strongly to the entire visuals of 3D animated films. However, designing believable characters remains a challenging task. Artists rely on stylization to increase appeal or expressivity, exaggerating or softening specific features. In this paper we analyze two of the most influential factors that define how a character looks: shape and material. With the help of artists, we design a set of carefully crafted stimuli consisting of different stylization levels for both parameters, and analyze how different combinations affect the perceived realism, appeal, eeriness, and familiarity of the characters. Moreover, we additionally investigate how this affects the perceived intensity of different facial expressions (sadness, anger, happiness, and surprise). Our experiments reveal that shape is the dominant factor when rating realism and expression intensity, while material is the key component for appeal. Furthermore our results show that realism alone is a bad predictor for appeal, eeriness, or attractiveness.