Mixed Reality in Information and Communications Technology Committee

Mixed reality could alter our very notions of identity and reality over the next generation, as these technologies infiltrate more and more aspects of our lives, from work to education, from socializing to commerce. An autonomous and intelligent systems (A/IS) backbone that would enable real-time personalization of this illusory world raises a host of ethical and philosophical questions, especially as the technology moves from headsets to much more subtle and integrated sensory enhancements. This committee has been working to discover the methodologies that could provide this future with an ethical skeleton and the assurance that the rights of the individual, including control over one's increasingly multifaceted identity, will be reflected in the encoding of this evolving environment. While augmented, virtual, and mixed reality deal primarily with technological environments, A/IS technologies utilizing and influencing user data in these environments present unique ethical challenges society must face today to avoid negative unintended consequences that could harm innovation and greatly decrease human well-being tomorrow.

Our Committee has created the following sections within mixed reality to help address these ethical challenges:

1. Social Interactions
2. Mental Health
3. Education and Training
4. The Arts
5. Privacy Access and Control

It is our hope that by addressing these challenges today, we can create a more positive, ethical, and intentional reality, whatever the environment.

Disclaimer: *While we have provided recommendations in this document, it should be understood these do not represent a position or the views of IEEE but the informed opinions of Committee members providing insights designed to provide expert directional guidance regarding A/IS. In no event shall IEEE or IEEE-SA Industry Connections Activity Members be liable for any errors or omissions, direct or otherwise, however caused, arising in any way out of the use of this work, regardless of whether such damage was foreseeable.*

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Section 1 — Social Interactions

The nature of mediated reality and the ability for individuals to alter their identity (or for their identity to be altered by other actors) means that social interactions will definitely be affected by the widespread adoption of mixed reality.

Issue:

Within the realm of A/IS-enhanced mixed reality, how can we evolve, harness, and not eradicate the positive effects of serendipity?

Background

In the real world, bumping into a stranger when your GPS breaks means you may meet your life partner. However, in the digital and virtual spheres, algorithms that have been programmed by design may eliminate genuine randomness from our human experience. What do we stand to lose when we code "frictions" or randomness out of our lives that may cause discomfort, but can also bring joy and growth?

For several years now, we have witnessed how online systems automatically sculpt the reality we encounter. Two major forces have come together: the commercial imperative to give customers what they want, and the desire of customers to use technology to make their lives easier, more comfortable, more controllable, safer, and less disruptive. These tendencies have always existed, but out of the last decade of digital media has emerged a rudimentary version of what the coming intelligent mixed-reality world will probably look like, in terms of the use of personal data and A/IS to create an environment in which the user has actually become the product.

Eli Pariser's "filter bubble" is the inevitable result of consumers' desire to get what they want enabled by an industry that naturally wants to create products that will sell. This effect, however, will become qualitatively different and much more profound when the curated content goes from a window on a laptop to becoming a full-time part of the physical world.

Is an augmented or virtual world an improvement over the physical world when it can be controlled in ways possible only in an illusion? Or does it become a denatured place, a software concoction more inclined toward order and predictability than freedom and invention? What would widespread use of such technology have on individuals, society, and politics over the long term?

In a physical city, a great deal of life, good and bad, is open to randomness, chance, risk, and the constant threat of encountering behavior one would rather not encounter. At the same time, there are unpredictable and often inspirational

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experiences that could not happen elsewhere, and over time can broaden one's embrace of human diversity along all axes. In a gated suburb, by contrast, these qualities are markedly reduced. We trade inspiration for control. Qualities are traded off for other qualities.

Creating the digital version of the gated community will happen naturally — they are both designed systems. But how can developers create MR/A/IS experiences that allow users what might be called the city option — the ability to live in, for example, a virtual world that somehow mimics the truly unpredictable aspects many people love about cities? Can such a simulation have the same effect as the "real thing" if there's no actual risk of serious unpleasantness? Could the degree of "serendipity" be dialed in by the user?

Candidate Recommendation

1. Upon entering any virtual realm, individuals should be provided information about the nature of algorithmic tracking and mediation within any environment. This will allow not only for consent regarding the use of their personal data, but for improved trust between individuals and creators of these environments regarding user experience. This could also include a "serendipity on or off" button allowing a user to express their desire for randomness as well.

2. Work with the MR/A/IS development community to address this challenge and try to make it a standard part of the conversation from the very beginning of MR/A/IS-related project development.

Further Resources

- Kefalidou, G., and S. Sharples. "Encouraging Serendipity in Research: Designing Technologies to Support Connection-Making," *International Journal of Human-Computer Studies* 89 (2016): 1–23.

- Harford, T. *Messy: The Power of Disorder to Transform Our Lives,* New York: Riverhead Books, 2016.

- Pariser, E. The Filter Bubble: How the New Personalized Web Is Changing What We Read and How We Think. New York: Penguin Books, 2011.

- Rabin, S., J. Goldblatt, and F. Silva. "Advanced Randomness Techniques for Game AI: Gaussian Randomness, Filtered Randomness, and Perlin Noise" in *Game AI Pro: Collected Wisdom of Game AI Professionals,* edited by S. Rabin, 29–43. Natick, MA: Taylor & Francis, 2013.

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Issue:

What happens to cultural institutions in a mixed reality, AI-enabled world of illusion, where geography is largely eliminated, tribe-like entities and identities could spring up spontaneously, and the notion of identity morphs from physical certainty to virtuality?

Background

When an increasing amount of our lives is spent in a photorealistic and responsive world of software, what will happen to actual human contact, which might always remain undigitizable in meaningful ways? When an illusory world is vastly more pleasant and fulfilling than the physical alternative, will there be a significant population who choose to live exclusively, or who spend at least a majority of their time, in a synthetic world of their own making? Opting in and out will be central to the coming digital experiences; but what happens with the opposite — when people choose to opt-out of the "real" world in favor of illusion?

MR/A/IS technology could be especially meaningful in allowing people to create a physical appearance that more closely reflects who they are. For example, it could help transgender persons reconcile their physical appearance with their identity. Is the optimal digital representation of a person the externally observable physical facade, or an illusion better aligned to the individual's self-image and identity?

While the benefits of spending time in alternate realities could include increasing empathy toward others or discovering aspects of your individuality that could positively affect your identity (in either real or virtual reality), there are multiple benefits of human interaction, both physical and emotional, that could be affected adversely if too much time is spent within realities of one's own creation.

Candidate Recommendation

Provide widespread educational classes on the benefit of positive human connection/touch. This could involve fields including emotional intelligence or positive psychology.

Further Resources

- Fredrickson, B. L. "Your Phone Versus Your Heart" (Sunday Review). *New York Times,* March 23, 2013.

- McGonigal, J., and J. Whelan. Reality Is Broken: Why Games Make Us Better and How They Can Change the World. New York: Penguin Books, 2011.

- Turkle, S. Alone Together: Why We Expect More from Technology and Less from Each Other. New York: Basic Books, 2011.

- Pasqualini, I., J. Llobera, and O. Blanke. "'Seeing' and 'Feeling' Architecture: How

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Bodily Self-Consciousness Alters Architectonic Experience and Affects the Perception of Interiors." *Frontiers in Psychology 4*, (2013): 354.

- Hershfield, H., D. W. Goldstein, W. Sharpe, J. Fox, L. Yeykelis, L. Carstensen et al. "Increasing Saving Behavior Through Age-Progressed Renderings of the Future Self." *Journal of Marketing Research* 48, no. SPL, (2011): S23–S37.

Issue:

With alternative realities at reach, we will have alternative ways of behaving individually and collectively, and perceiving ourselves and the world around us. These new orientations regarding reality could enhance an already observed tendency toward social reclusiveness that detaches many from our common reality. Could such a situation lead to an individual opting out of "societal engagements?"

Background

The availability of VR and AR could lead to permanent disengagement from society that can have far-reaching implications on fertility rates, the economy, and alter existing social fabrics. People may choose to disengage.

With mixed reality, our notions of time will be multi-modal and as such will have a societal impact in terms of culture, relationships, and perception of the self. We might be able to manipulate our perceptions of time and space so as to experience, or re-experience, interactions that would otherwise be impossible. With alternative realities in reach, people may inhabit them to avoid facing problems they encounter in real life.

Candidate Recommendation

Research and potentially consider the reconstruction of our social contract as alternative mixed societies, including the concept of present virtual and physical beings that will potentially emerge from alternative realities.

Further Resources

- Petkova, V., and Ehrsson, H. (2008). "If I Were You: Perceptual Illusion of Body Swapping." *PLoS ONE* 3, no. 12 (2008): 1–9.

- Rainie, L., and J. Anderson. "The Evolution of Augmented Reality and Virtual Reality." December 14, 2008.

- Peck, T., S. Seinfeld, S. Aglioti, and M. Slater. "Putting Yourself in the Skin of a Black Avatar Reduces Implicit Racial Bias." *Consciousness and Cognition* 22, no. 3 (2013): 779–787.

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Issue:

The way we experience (and define) physical reality on a daily basis will soon change.

Background

VR and AR technologies are very popular in China, for example, where dedicated experimental zones are gaining significant traction. VR cafes are changing the way we interact with people around us and offer experiences that rival movie theaters, theme parks, and travel. For example, VR applications have been introduced to attractions' sites and are used to provide an interactive experience for tourists who can better acquaint themselves with new environments and attractions. This also changes the way we experience our physical reality on a daily basis. In addition, augmented-reality enhancement over the next generation will become ubiquitous in the physical environment, from our homes to city streets, and will inevitably alter our view of what constitutes reality or physical certainty.

Candidate Recommendation

Create widespread education about how the nature of mixed reality will affect our social interactions to avoid widespread negative societal consequences.

Further Resources

- Madary, M., and T. K. Metzinger. "Real Virtuality: A Code of Ethical Conduct. Recommendations for Good Scientific Practice and the Consumers of VR-Technology." *Frontiers in Robotics and AI* 3 (February 19, 2016).

Issue:

We may never have to say goodbye to those who have graduated to a newer dimension (i.e., death).

Background

Whether we will have the ability to keep our consciousness alive via software or create an avatar copy of ourselves or loved ones, there is the very real possibility we will see a person's representation after death as we know it. While the decision to upload one's consciousness or represent oneself as an avatar after death is a deeply personal one, there are multiple legal, societal, and cultural issues to deal with (e.g., identity, next of kin) to avoid confusion or potential manipulation of "living" family members and friends. In the future, if one's consciousness is still "alive" in some sense and able to engage in human activities, is that person still legally alive?

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Candidate Recommendation

New forms of societal norms around traditional death will need to be created for governments (updating forms of identity such as passports, etc.) along with cultural mores (sending family and friends cards letting them know a certain person's consciousness has transferred from carbon-based to silicon).

Further Resource

- Rothblatt, M. Virtually Human: The Promise—and the Peril—of Digital Immortality. New York: St, Martin's Press, 2014.

Issue:

Mixed reality changes the way we interact with society and can also lead to complete disengagement.

Background

The increasing popularity of VR and AR dedicated zones and their use in public sites in China, for example, is changing the way individuals interact with each other. Where friends and colleagues would previously emphasize eye contact and physical proximity as a way of establishing trust and a sense of cohesion, MR will change the way we perceive the people we interact with. They may be judged based on their avatars, their ability to navigate this new reality, and their willingness to interact via MR. The inability or choice whether to use MR might exclude an individual from a working environment or from a new connected socializing platform.

MR can also be used to disengage from one's environment. Individuals can choose to go back in time and relive happy memories recorded by MR technology (whether real or not), go on vacation to a venue miles and years away, or immerse themselves in some virtual entertainment — all without leaving their chair and without interacting with other people. This can lead to the disengagement of individuals even when in the company of others, as virtual interactions can supplement and surpass human interaction in the user experience they offer. In this way, individuals can "fulfill" their social needs without reciprocating those of others. This artificial "fulfillment" of basic social needs through fully immersive technologies might have unpredicted implications on the very fabric of society, especially by changing the way humans interact with each other.

Candidate Recommendations

MR content providers should be well aware of the ramifications of offering alternative social interactions that do not require a human counterpart, or severely limit key social cues.

Further Resource

- Kim, M. "The Good and the Bad of Escaping to Virtual Reality." The Atlantic, February 18, 2015.

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Issue:
A/IS, artificial consciousness, and augmented/mixed reality has the potential to create a parallel set of social norms.

Background

Mixed reality poses the potential to redefine and reset many human social norms. Traditionally human norms have been established by influences such as religion, politics, and economics, to name a few. The interactions between people and augmented/mixed reality could generate an entirely different set of norms created entirely by the designer of the mixed reality. There is likely to be opportunity to positively influence and enhance new norms via augmented/mixed reality if given a predictable environment to operate within and potential positive psychology impacts and overall wellness.

Recommendations

Those who create augmented/mixed reality experiences need to clearly define the purpose of the designed reality. Users who interact with this reality should specifically "opt in" to agree to their immersion in the reality. And during the delivery of the experience, the reality and reactions of those interacting need to be auditable against the initial agreed purpose.

Further Resource

- Wassom, B. *Augmented Reality Law, Privacy, and Ethics: Law, Society, and Emerging AR Technologies*. Waltham, MA: Syngress/ Elsevier, 2015.

Issue:
An MR/A/IS environment could fail to take into account the neurodiversity of the population.

Background

Different brains process information differently, and MR/A/IS design assumptions could potentially limit the value of MR/A/IS experiences for many potential users. At the same time, an MR/A/IS environment that accommodated neurodiversity could be a tool of immense potential good. Different people learn differently, and a neurodiversity-aware MR/A/IS could adapt itself for each individual's strengths and preferences. Different brains might well want to augment the world differently — for example, augmentation for emotional cueing of autistic persons. In addition, such an environment would offer the opportunity to learn from the ways that others experience the world due to different cognitive architectures.

Candidate Recommendations

Work with MR/A/IS developers to build neurodiversity sensitivity into the creation of intelligent experiences and hardware.

Further Resource

- Metzinger, T., and E. Hildt. *Cognitive Enhancement. The Oxford Handbook of Neuroethics*. Oxford, U.K.: Oxford University Press, 2011.

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Section 2 — Mental Health

While there are proven benefits for creating empathy in users or treating PTSD for soldiers while utilizing mixed, virtual, or augmented reality, there are also potential negative unintended consequences via loss of agency, consent, or confusion about one's place in one's world(s) depending on how these tools are used in regards to a person suffering from mental health issues, or for any individual unused to these environments.

Issue:

How can AI-enhanced mixed reality explore the connections between the physical and the psychological, the body and mind for therapeutic and other purposes? What are the risks for when an AI-based mixed-reality system presents stimuli that a user can interact with in an embodied, experiential activity? Can such MR experiences influence and/or control the senses or the mind in a fashion that is detrimental and enduring? What are the short- and long-term effects and implications of giving over one's senses to software? Moreover, what are the implications for the ethical development and use of MR applications designed for mental health assessment and treatment in view of the potential potency of this media format compared to traditional methodologies?

Background

AI-enhanced MR will generate a range of powerful applications in healthcare over the next generation, from improving medical and surgical outcomes, to virtual physicians, to performance visualization for athletes. Compelling ultra-high-fidelity systems could exploit the brain's neuroplasticity for a variety of beneficial (and non-beneficial) ends, including present-day treatment of PTSD and anxiety disorders using VR.

Being in a completely mediated VR environment could, for example, fool the mind into thinking and feeling as it did in an earlier stage of one's life, with measurable physiological effects. Psychological conditions often have accompanying physical ailments that diminish or disappear when the psychological condition is treated. While the positive impact of MR for changing cognition, emotions, and behavior is

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often talked about as having therapeutic value. If one accepts that premise, one has to also accept that such changes can occur that have less-desirable consequences.

The converse is true as well. Treating physical systems often improves mental states. With human augmentation, the physiological and psychological can both be automatically manipulated or adjusted based on either human- or machine-mandated and -controlled parameters. In addition to external sensory input, we need to consider internal input (implanted devices) which deliver information to senses as well as deliver medication (or nutrition) based upon monitoring emotional or physical states.

How can mixed reality (MR) be used constructively to engage the mind to such an extent that physiological mechanisms can be controllably affected, and what are the ethical implications? We don't have a complete understanding of what a human requires to be happy and healthy. Does this require interaction with the physical world? Or can generated experiences be an outlet for those that struggle in the real world? Should we always approach a user's interaction with a system to help them work on real-world problems, or is it okay to let them get lost in the generated world?

A VR system could radically affect how the mind processes and synthesizes information, and ultimately it could be a way to teach ourselves new ways to think and create content. However, the long-term effects of immersion are largely unknown at this point, and the exploitability of a person's (or a larger group's) notion of reality raises a host of ethical issues.

Creating awareness over who controls what in connected systems is critical. Even calling these new forms of fiction a series of "realities" blurs the line unnecessarily. The idea that there is anything human-authored that is "non-fiction" is something that needs to be explored on a cultural level, or in these ultra-high-fidelity systems "truth" will be dictated by an increasingly homogeneous and concentrated few. Even if these systems are personalized at scale by A/IS, fundamental awareness and control need to be vested with an individual.

Questions still need to be answered regarding the use of MR as a tool for mental health diagnosis and treatment. Thus far, significant literature has emerged indicating positive impact on mental health and physical functioning using theoretically-informed MR applications with well-designed content delivered within the more controlled (and safe) context of the therapy setting, administered and supervised by a well-trained clinician. However, what happens if these types of VR experiences become commodity products that are readily accessible to anyone, who might self-diagnose their clinical condition and use MR treatment content as "self-help" therapy? While some might say this is not much different from purchasing a self-help book and following the instructions and recommendations therein, MR experiences may have a deeper impact on a user than reading a book. Similar to most areas of mental health care, there is a risk that this form of self-diagnosis and treatment is based on inaccurate or counterproductive information. Another kind of problem may emerge if a clinician decides that MR would be great for generating a buzz for their practice and

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result in more business, but hasn't had training in its use and safe application. Thus, there are issues of concern here from both the patient and provider side of the equation. Consequently, we need ethical guidelines for the safe and informed use of clinical MR applications, much like the way that pharmaceutical treatments are managed by a well-trained and qualified physician.

Candidate Recommendation

Research conducted by qualified mental health experts is required in this area to determine how people can best approach immersion in new realities in ways they can control or mediate should potential negative or triggering situations take place.

In the area of clinical practice the American Psychological Association's ethical code provides a clear and well-endorsed set of guidelines that can serve as good starting point for understanding and proactively addressing some of the issues for the creation and use of MR applications (see: www.apa.org/ethics/code/#201e). Three core areas of concerns and recommendations can be derived from these guidelines (two from the APA code and one regarding patient self-help decision-making):

1. *"2.04 Bases for Scientific and Professional Judgments*
   Psychologists' work is based upon established scientific and professional knowledge of the discipline."
   MR applications that are developed for clinical assessment and treatment must be based on some theoretical framework and

documented with some level of research before they can be endorsed as evidence-based and promoted to a patient in that fashion. In an emerging area like MR, where unique and specific guidelines have yet to be established, the practitioner must be fully transparent about the evidence base for the approach and take precautions to preserve the safety and integrity of the patient.

2. *"2.01 Boundaries of Competence*
   (a) Psychologists provide services, teach and conduct research with populations and in areas only within the boundaries of their competence, based on their education, training, supervised experience, consultation, study or professional experience."
   This one is obvious. MR-delivered mental health assessment and treatment may require fundamentally different skill sets than what is needed for traditional "talk therapy" approaches. Clinicians need to have specialized training, and possibly in the future, some level of certification in the safe and ethical use of MR for therapy.

3. While not cited as an APA standard, the issues regarding patient self-diagnosis and self-treatment deserves further mention. Mental health conditions can be extremely complex and in some instances the self-awareness of the patient may be compromised. This can oftentimes lead to a faulty self-diagnosis as well as the problems that arise when the patient searches for information via the Internet, where reliable and valid content can be questionable. The same issues come into play with self-

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treatment. The problems that can ensue are two-fold.

- The patient makes errors in either or both areas and achieves no clinical benefit, or worse, aggravates the existing condition with an ineffective or inappropriate MR approach that actually does more harm than good.

- By pursuing a "seductive" MR self-help approach that is misaligned with their actual needs or has no evidence for its efficacy, the patient could miss the opportunity to actually receive quality evidence-based care that is designed and delivered based on the informed judgment of a trained expert diagnostician or clinical care provider.

These two negative impacts could occur if a company produces an MR approach without sufficient validation and over-promotes or markets it to the public as a test or a cure. This has been seen over the years with many forms of pseudo medicine, and there needs to be some principle about the promotion of a MR application that has the consumers' protection in mind. This issue is particularly important at the current time, in view of all the public exposure, hype, and genuine excitement surrounding AR/VR/MR. One can observe new companies emerging in the healthcare space without any credible expert clinical and/or research guidance. Such companies could not only do harm to users, but the uninformed development and over-hype of the benefits to be derived from a MR clinical application leading to negative effects could

serve to create the general impression that MR is a "snake oil" approach and lead to people *not* seeking (or benefiting from) an otherwise well-validated MR approach.

An example of a "grey area" in this domain concerns one of the most common fears that people report — public speaking. Technically, in an extreme form where it significantly impairs social and occupational functioning, public speaking anxiety would qualify as a phobia and be diagnosed as an anxiety disorder. However, since people have some level of sub-clinical fear of public speaking that they eventually get over with practice, this has been one of the first areas where widespread consumer access to public speaking VR exposure therapy software has occurred . Users can practice their presentation "skills" on a low-cost mobile phone driven VR HMD (cardboard, Gear VR, Daydream, etc.) in front of various types of audiences and settings. In this case, most clinicians would not show much concern for this type of self-help approach, and the potential for damaging effects to a user appears to be fairly minimal. But, from this example, can we now expect that applications will be made readily available for other and perhaps more complex anxiety-disorder-based phobias (fear of flying, social phobia, driving, spiders, intimacy, etc.), or even for PTSD treatment?

From this, general guidelines for the creation, distribution, practice methods, and training requirements should be established for the clinical application of MR for persons with mental health conditions.

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Further Resources

- Rizzo, A., M. Schultheis, and B. Rothbaum. "Ethical Issues for the Use of Virtual Reality in the Psychological Sciences" in *Ethical Issues in Clinical Neuropsychology,* edited by S. S. Bush, and M. L. Drexler. Lisse, NL: Swets & Zeitlinger Publishers, 2002.

- Wiederhold, B. K., and M. D. Wiederhold. Virtual Reality Therapy for Anxiety Disorders: Advances in Evaluation and Treatment. Washington, DC: American Psychological Association, 2005.

- Botella, C., B. Serrano, R. Baños, and A. Garcia-Palacios. "Virtual Reality Exposure-Based Therapy for the Treatment of Post-Traumatic Stress Disorder: A Review of Its Efficacy, the Adequacy of the Treatment Protocol, and Its Acceptability." *Neuropsychiatric Disease and Treatment* 11, (2015): 2533–2545.

Issue:

Mixed reality creates opportunities for generated experiences and high levels of user control that may lead certain individuals to choose virtual life over the physical world. What are the clinical implications?

Background

We do not have a complete understanding of what a human requires to be happy and healthy. Do we require interaction with the physical world? Or can generated experiences be an outlet for those who struggle in the real world? Should we always approach a user's interaction with a system to help them work on real-world problems, or is it okay to let them get lost in the generated world? Some negative examples to consider along these lines:

1. Immersion and escapism could become a problem for people who tend to withdraw into themselves, become antisocial, and want to avoid the real world. This might have to be dealt with differently depending on what the withdrawal is based on — anxiety, abuse, depression, etc.

2. There will more than likely be issues similar to the kind of video-game addictions we see now.

Some positive examples to consider along these lines:

1. AR/VR environments could be used as outlets for people who may damage themselves, others, or objects in the physical world.

2. AR/VR environments could offer a soothing atmosphere for disabled children and adults. For example, they could offer experiences similar to "stimming" and have relaxing music, noises, etc.

3. There could be an increase of AR/VR

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therapists and counselors. AR/VR-based meditations and mindfulness may also begin to proliferate. This could take the form of projecting therapists and patients who are far apart into the same VR space, projecting multiple people into the same VR space for meetings, such as Alcoholics Anonymous, etc. These methods could be used to help people who may not be able to leave the home. (For example, therapists have held autism group-counseling sessions inside of Second Life, reporting that group members did better expressing themselves when they had an avatar with which to participate.)

Candidate Recommendation

While being conscious to help people avoid withdrawal from society where the lack of human interaction could increase negative mental health, it is important for widespread testing of these systems to let these new realities (MR/AR/VR) be a tool for exploring interactions to increase positive mental health and well-being.

Further Resource

- O'Brolcháin, F., T. Jacquemard, D. Monaghan, N. O'Connor, P. Novitzky, and B. Gordijn. "The Convergence of Virtual Reality and Social Networks: Threats to Privacy and Autonomy." *Science Engineering Ethics* 22, no. 1 (2016): 1–29.

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Section 3 — Education and Training

There is value in using immersive technologies in education and training. That which is experiential can provide sustainable training in the long-term. Will all senses be stimulated within an immersive learning environment? AR/VR could be valuable in K-12 classrooms for immersion and interactivity with subject material at all different age levels. In addition, mixed reality could be one key element to lifelong learning and the ability to adapt to changing job markets.

Issue:

How can we protect worker rights and mental well-being with the onset of automation-oriented, immersive systems?

Background

In many workplace environments, humans are sharing spaces and tasks with automated systems (e.g., robots and/or A/IS algorithms). As these relationships increase, there will be increased pressure on humans to effectively "team" with these systems. There are myriad issues entangled in human-machine teaming including A/IS design (how do you enable trust?), human-system interface (command and control), and enabling better situational awareness (sensing and understanding).

AR/VR/MR will play a large part in these solutions, but the art of good immersive interfaces and experiences remains largely elusive. We currently are in a state where adding more data and more sensors is often seen as the solution, and yet this does not address the core issues of how to increase human performance given these information increases.

Candidate Recommendation

Two areas need to be considered. First is development of the technological capabilities. Human factors need to be front-and-center throughout the design and testing process, particularly with regard not only to efficacy of the task execution, but also possible deleterious effects on the human, both physical and psychological. The second area is implementation and deep consideration of the user base. Age, psychological state, and other demographic data should be considered for use cases, backed by research rather than ad hoc determinations.

Further Resource

- Madary, M., and T. K. Metzinger. "Real Virtuality: A Code of Ethical Conduct. Recommendations for Good Scientific Practice and the Consumers of VR-Technology." *Frontiers in Robotics and AI* 3 (February 19, 2016).

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Issue:

AR/VR/MR in training/operations can be an effective learning tool, but will alter workplace relationships and the nature of work in general.

Background

AR/VR/MR is already having an impact in training, operations, and production. The capabilities of just-in-time knowledge, coaching, and monitoring suggests the promise of increased safety and productivity. But how will these technologies change the workplace, alter career trajectories, and impact and influence what, how, and why we educate people?

In addition, the definition of "workplace" will radically change. Remote operation and increased telepresence capabilities, combined with interactive A/IS enabling "always available" expertise, make the likelihood high of collaborative workspaces that are entirely virtual and not necessarily synchronous. While there are potential advantages (decreased traffic and energy consumption), there will no doubt be second- and third-order effects that lead to negative outcomes.

Candidate Recommendation

Create a task force and living laboratory that focuses on the "workplace of the future." This lab will track emerging technology implementations around telepresence and remote collaboration, and create test-bed integrations of emerging tech, prototyping the "art of the possible," and enabling user studies such that a technologist can evaluate, assess, and provide insight into promise and pitfalls over the near horizon.

Further Resource

- Pellerin, C. "Work: Human-Machine Teaming Represents Defense Technology Future." *DoD News, Defense Media Activity,* Washington, DC: Department of Defense, 2015.

Issue:

How can we keep the safety and development of children and minors in mind?

Background

AR/VR may be valuable in K-12 classrooms for immersion and interactivity with subject material at all different age levels. AR can be used to interact with shapes, objects, artifacts, models of molecules, etc. in a space, while VR can be used to explore historical environments, role-play in a story or time period, or create a virtual whiteboard space for students to collaborate and interact in. How can being immersed in a different reality interfere with development and perception of reality by younger students who may not be able to completely differentiate

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between reality and virtual reality? Would escapism and immersion be a problem, for example, in mentally ill or unstable teenagers who want an escape? How can we protect the identity and information of minors, especially if virtual experiences might be connected to the Internet?

Candidate Recommendation

Augment the Consumer Products Safety Commission (or equivalent) to include policy/governance over mixed reality products. Determine appropriate age restrictions and guidelines based on proper research protocols and results.

Further Resource

- Steinicke, F., and G. Bruder. "A Self-Experimentation Report About Long-Term Use of Fully-Immersive Technology," *Proceedings of the 2nd ACM Symposium on Spatial User Interaction*, (2014): 66–69.

Issue:
Mixed reality will usher in a new phase of specialized job automation.

Background

VR and AR also give rise to a new level of automation, where specialized content and services, like piano lessons, personalized assistance and support, or even tourism guidance could be consumed at any given time and place. This will bring better customized services into our lives at a lower cost and higher availability. It is also, however, likely to negatively impact a broad class of jobs.

Candidate Recommendation

Governments are advised to keep close watch over the automation of personalized services through mixed-reality technology and offer alternative education and training to professionals in fields that are expected to be affected.

Further Resource

- Stanford University. "Artificial Intelligence and Life in 2030: One Hundred Year Study on Artificial Intelligence." Stanford, CA: Stanford University, 2016.

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Issue:

A combination of mixed reality and A/IS will inevitably replace many current jobs. How will governments adapt policy, and how will society change both expectations and the nature of education and training?

Background

It is clear that many current tasks in society will move from human-actuated to being accomplished by machine and/or algorithm. The Industrial Revolution gives an historical taste of this type of change, but given the depth and breadth of digital penetration into human life, it will be an even more profound sea change. There are two main areas of immediate concern. First is for the population — essentially, "what will I do for a living?" Educational and training missions will need rethinking, and infrastructure will need to be created or leveraged to enable rapid career changes and skill acquisition.

Second, government will need to consider the societal ramifications of automation replacing human labor, and no doubt policy will need to be crafted to enable agility in the workforce along with models for how humans work and thrive in increasingly virtual environments populated by artificial agents.

Candidate Recommendation

Create a working group to look at industries and job areas most likely to be replaced or heavily augmented by a combination of mixed reality and AI/IoT. Similarly, the group would work to predict near-term and longer-term job needs and growth areas. Look to leverage the existing community college system as a platform for "21st century trades," enabling rapid acquisition of necessary skills along with ongoing training.

Further Resources

- Nutting, R. "No, 'Truck Driver' Isn't the Most Common Job in Your State." *MarketWatch,* February 12, 2015.

- Stanford University. "Artificial Intelligence and Life in 2030: One Hundred Year Study on Artificial Intelligence." Stanford, CA: Stanford University, 2016.

- Stern, A. Raising the Floor: How a Universal Basic Income Can Renew Our Economy and Rebuild the American Dream. New York: PublicAffairs 2016.

Section 4 — The Arts

Throughout history, the arts have been a means for human expression and often healthy escapism, as well as for social and political commentary. The imminent arrival of culturally pervasive mixed-reality technologies has the potential to dramatically impact and permanently alter the methods and tools by which artists earn their living. With this in mind, how can humanity best approach the interdisciplinary and cross-cultural impacts that the new AR/VR artistic paradigms will offer?

Issue:

There is the possibility of commercial actors to create pervasive AR/VR environments that will be prioritized in user's eyes/vision/experience.

Background

In the near future, users will filter their digital landscapes by opting in or opting out of mixed-reality information-delivery mechanisms driven by A/IS frameworks that will both structure and, in many cases, alter or curate the data for private, opaque ends.

With specific regard to AR, how will the digital public landscape not simply be absorbed by private commercial interests, but allow virtual space for citizens and artists to freely participate? Will artistic content be algorithmically subordinated to commercial content?

Candidate Recommendation

Provide users/citizens the option to always "opt out" of any immersive environment to which they may be exposed and provide transparency and consent options to make this possible. This transparency could include not only the constituent algorithms, but also information about the identity of private actors behind the data.

Issue:

There is the possibility that AR/VR realities could copy/emulate/hijack creative authorship and intellectual and creative property with regard to both human and/or AI-created works.

Background

There exists the possibility for certain types of art forms or certain creative ideas when expressed in this new modality to be algorithmically suppressed. How can we make sure there is even distribution and access to ideas?

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Mixed reality presents unique opportunities for developers, artists, and story-tellers to both build upon and challenge existing modes of content creation, while helping to forge original tools and methodologies in the realization of new artistic media. Virtual reality (VR) and 360 video borrow narrative and artistic techniques from their gaming, theater, cinema and architecture antecedents; however, these media also present new occasions for developers to fashion novel modes of editing, point of view (POV), and sound (for example).

Using many of the same creative tools, AR provides a way to use public spaces as a canvas for meaningful cultural exchange and, in doing so, affords the user a fresh way of seeing such spaces as a more open and democratic media environment. The creative community writ large can leverage AR as an instrument of new media content creation, public media production, and artistic expression, which could result in a freer, more effective use of public space, as well as a more imaginative exchange of ideas between citizens. Finally, A/IS frameworks used to generate artworks are becoming more accessible, which raises questions of the role of the human artist and ethical issues of authorship and creative rights. The philosophical debate around the concepts "author" and "artist" with regard to created works is not a new one in the humanities or the legal world. However, these concepts take on entirely new dimensions when infusing the discussion with the role of a non-human actor in the creative process.

Candidate Recommendation

Research methods to allow new forms of creative copyright to be embedded within physical and virtual environments that reflect original rights or ownership to validate, recognize, and remunerate artists for original work. In addition to research, new forms of copyright will surely need to be conceived and codified that are more appropriate for the highly collaborative, inter-media, and virtual environments within which many of these mixed reality works will be created.

Further Resources

- Cartiere C., and M. Zebracki, eds., *The Everyday Practice of Public Art: Art, Space, and Social Inclusion.* New York: Routledge, 2016.

- Geroimenko, V. *Augmented Reality Art: From an Emerging Technology to a Novel Creative Medium.* Cham, Switzerland: Springer, 2014.

- Foucault, M. "Space, Knowledge and Power," in *The Foucault Reader* edited by P. Rabinow. Harmondsworth, U.K.: Penguin, 1984.

- Baudrillard, J. *Simulacra et Simulation.* Translated by P. Foss, P. Patton, and P. Beitchman. New York: Semiotext(e), 1983.

- Morey, S., and J. Tinnell, eds. *Augmented Reality: Innovative Perspectives across Art, Industry, and Academia.* Anderson, SC: Parlor Press, 2016.

- Lanier, J. Dawn of the New Everything: Encounters with Reality and Virtual Reality, New York: Henry Holt, and Co., 2017.

- Grau, O. *Virtual Art: From Illusion to Immersion*, Cambridge, MA: The MIT Press, 2003.

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Section 5 — Privacy Access and Control

While concerns over personal data access abound within existing Internet or IoT environments, the nature of the imminent pervasive and immersive landscapes of mixed reality provides unique new challenges regarding the nature of user identity and control.

Issue:

Data collection and control issues within mixed realities combined with A/IS present multiple ethical and legal challenges that ought to be addressed before these realities pervade society.

Background

AR's and VR's potential for persistent, ubiquitous recording could undermine the reasonable expectation of privacy that undergirds privacy-law doctrine as expressed in constitutional law, tort, and statute (Roesner et al., 2014). Like other emerging technologies, it may force society to rethink notions of privacy in public. Furthermore, the mobility of AR devices in particular exacerbates challenges to privacy in private spaces, such as the home, that have traditionally been subject to the strongest privacy protections.

Ubiquitous recording will challenge expectations of privacy both in public and private spaces. Excessive storage and data logging will inevitably create a target for law enforcement (think the Alexa case). The personalized consumption of controversial immersive content could pose challenges for effective public oversight and erode the distinction between what is real and what is permissible. The ability of A/IS paired with AR to match disparate data sets will challenge a bystander's ability to control her/his public image.

This also prompts the question of data ownership, access, and control in VR and AR. If users divulge personal or identifying data, we should have clear assurances that their virtual and physical identities can and will be protected within such virtual worlds. This also applies to accidental collection of data by VR systems to better customize the technology. It is important to question the level of control we have over our data and privacy when integrating these pervasive technologies into our lives.

Further, mixed-reality applications must be secured against tampering. As technology mediates the way users view their surroundings, cybersecurity is vital to ensure that only they can see the information on their displays. Unsecured applications not only leave data vulnerable, but create the possibility of digital assault or *false light*.

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Also, as AR platforms become the gateway to certain pieces of information, developers should consider the discriminatory effects of placing information behind that gateway — especially since the display of incomplete information is a form of misuse that can lead to discrimination. If some vital piece of information is only available via AR, or only available to a particular AR sandbox, some people will inevitably be locked out of that information (of course, this criticism could apply to any communications technology, so the solution may be opportunities for public access [e.g., libraries] rather than design).

Consider a mixed-reality scenario in which a user "sees" a photorealistic avatar commit a crime (a real crime, whether in simulation or not) but the avatar depicts (is cloaked) as an altogether different person (or persons) than the person who is "seen" by third-party witnesses. In that case, only an identity-management system will know who the true perpetrator was. What will happen under such circumstances to the 1) perpetrators of the crime (what constitutes probable cause and reasonable search?) and 2) what happens to the person whose identity was "falsely used" within mixed reality? What if a person is falsely accused because immersed witnesses have "seen" them commit a crime? What access to identity-management software does each of these constituencies have?

Candidate Recommendation

Further research is required in assessing the implications of data collection, A/IS, and mixed reality to include benefits and definition of boundaries.

Further Resource

- Stanford University. "Artificial Intelligence and Life in 2030: One Hundred Year Study on Artificial Intelligence." Stanford, CA: Stanford University, 2016.

Issue:

Like other emerging technologies, AR/VR will force society to rethink notions of privacy in public and may require new laws or regulations regarding data ownership in these environments.

Background

If a user has a specific interaction with mixed-reality avatars, can and should this particular storyline development become proprietary? If users divulge personal or identifying data, we should have clear assurances that their virtual and physical identities can and will be protected within such virtual worlds. This also applies to accidental collection of data by VR systems to better customize the technology. It is important to question the level of control we have over our data and privacy when integrating these pervasive technologies into our lives.

Facial recognition and other machine learning applications that can match disparate data sets will hamper people's ability to control their own image. For example, an AR application that

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matches publicly available information with facial recognition will strip bystanders of anonymity without their consent (Denning, Dehlawi, and Kohno 2014).

The development of specialized content for VR — e.g., violent shooting games, highly sexualized or illicit content — limits public oversight of controversial content consumption. Considering AR provides a high level of immersion, mixed reality will challenge established policy and social norms around privacy and data control.

Candidate Recommendation

Further research is needed on data-control issues and an A/IS or mixed-reality "guardian" or "agent" will be required to identify any potentially negative environments or issues within those environments based on an individual's preset requirements regarding data and identity issues. Including the potential role of blockchain may be part of this study. Further, it is incumbent upon technologists to educate the public on the benefits and potential for abuse of A/IS and mixed reality.

Further Resources

- IEEE P7006™, Standard for Personal Data Artificial Intelligence (AI) Agent.

- Stanford University. "Artificial Intelligence and Life in 2030: One Hundred Year Study on Artificial Intelligence." Stanford, CA: Stanford University, 2016.

Issue:

Users of AI-informed mixed-reality systems need to understand the known effects and consequences of using those systems in order to trust them.

Background

Trust will be essential to the widespread adoption of A/IS that pervades our lives and helps make increasingly crucial decisions. With black boxes playing influential roles, trust will be difficult to earn. Openness and transparency could be ideal principles to guide the development of intelligent mixed reality in a way that would alleviate much understandable wariness. Trust is a factor in not only the corporate use of personal data, but also in A/IS algorithms and the increasingly compelling mixed-reality illusions superimposed on the physical world. In a world where one's very perception has been delegated to software, unprecedented levels of trust in systems and data — and openness and transparency — will be needed to ensure the technology's responsible progress.

Candidate Recommendations

Establish a new kind of user guide for MR/A/IS focused on transparency and end-user understanding of the constituent components. Users should be able to understand the systems and their logic if they are going to opt-in in an informed manner. Perhaps there is a place for a neutral, trusted, and independent third party to evaluate MR/A/IS products and experiences along these lines.