

Transhumanism as a Philosophical and Cultural Framework for Extended Reality Applied to Human Augmentation

Bogdan Popoveniuc
Ștefan cel Mare University of Suceava
Suceava, Romania
bpopoveniuc@usm.ro

Radu-Daniel Vatavu
MintViz Lab, Ștefan cel Mare University of Suceava
Suceava, Romania
radu.vatavu@usm.ro

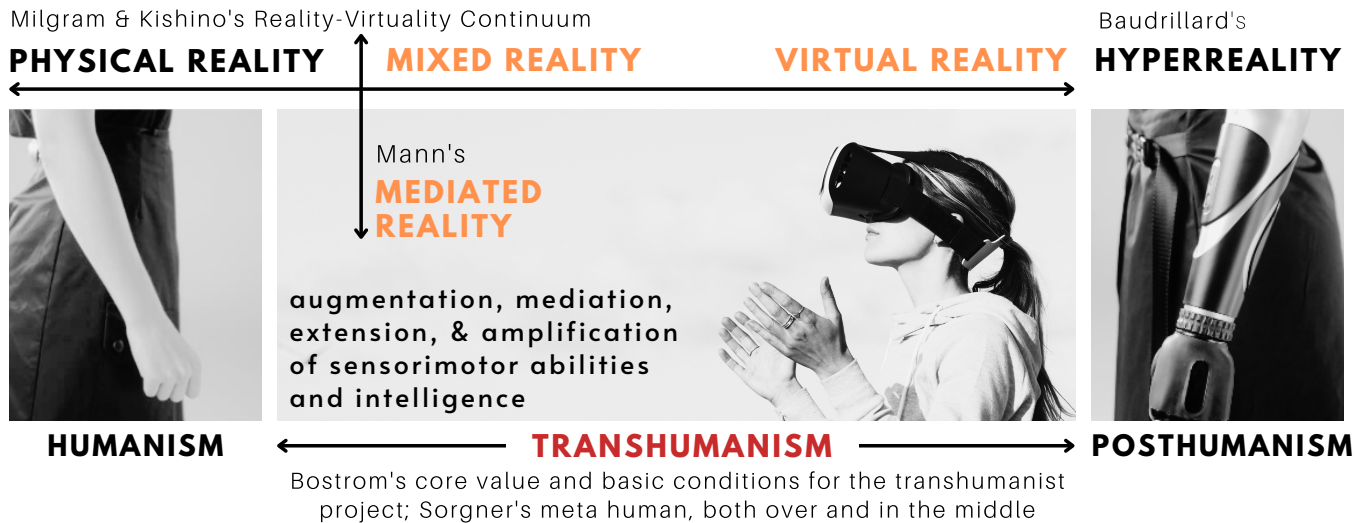


Figure 1: By its virtue of being both “over” and “in the middle,” between the potentiality of human enhancement advocated by humanism and the visions of possible posthuman futures, the transhumanist project provides a convenient philosophical, cultural, and ethical framework to address human augmentation enabled by the technology of Extended Reality in its many, diversified forms. Connections among Milgram and Kishino’s [35] Reality-Virtuality continuum, Mann’s [31] reality mediators, Baudrillard’s [6] concept of a “hyperreal,” and Sorgner’s [49] version of Bostrom’s [7] transhumanist philosophy are illustrated in this figure and examined in this paper.

ABSTRACT

We propose transhumanism as a philosophical and cultural framework for contextualizing, characterizing, and examining physical-digital environments designed to amplify, augment, mediate, and extend human sensorimotor abilities and intelligence. To this end, we connect transhumanism with Milgram’s Reality-Virtuality continuum, Mann’s reality mediators, and Baudrillard’s concept of the hyperreal to discuss innovations in human augmentation with the technology of Extended Reality (XR). We discuss three prototypes for human augmentation implemented with XR technology designed to be worn or integrated in the environment, for which we present implications in relation to the three core conditions for

transhumanism (global security, technological progress, and wide access) and four levels at which XR determines human augmentation (instrumentation, integration, control, and sensation). In the context where transhumanism can characterize the bridging state between being human and posthuman in a world that becomes into being, we conclude with the need for an XR ethics specifically addressing human augmentation.

CCS CONCEPTS

• **Human-centered computing** → **Mixed / augmented reality**;

KEYWORDS

Transhumanism, extended reality, mediated reality, hyperreality, human augmentation, augmented reality, mixed reality, smart environments, cultural framework

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1 INTRODUCTION

Computer-generated, augmented, and mediated environments, such as Augmented Reality (AR) [4], Mixed Reality (MR) [35], Mediated Reality (XYR) [31] and Multimediased Reality (ZR) [32], have the ultimate goal of enhancing human abilities to make users more effective in hybrid physical-virtual worlds. For instance, AR has been described as a form of intelligence amplification [4] and an interface and gateway to a 1:1 correspondence between the digital and the real [5], MR as an alignment of environments and synchronization between physical and virtual worlds [50] and as the presentation of real world and virtual world objects and stimuli together within a single percept [47], and XYR as an implementer of humanistic intelligence [31]. Such descriptions contour the vision of hybrid worlds in which technological augmentation of the human body and/or the physical environment supports new perceptual and cognitive abilities, such as improved vision [27], specialized hearing [61], expanded tactile perception [55], increased motor skills [46], and augmented intelligence [12].

However, advances in Extended Reality—XR, an acronym commonly used to refer to AR, MR, and VR, which we employ to denote other forms of computer-mediated realities as well, such as XYR and ZR [31,32]—bring up specific ethical concerns. While the ethics of human enhancement enabled by technology [11,33] and applications of XR [19,30,43,48,51] have been largely debated, the ethics of using XR for human augmentation has been examined to a lesser extent. Besides typical concerns [43] for XR environments, such as privacy [30,51], superrealism [48], effects of long-term immersion [30], risky content [30], and code of conducts for ethical experimentation [30], new concerns arise when XR technology is employed for the purpose of human augmentation. For example, Findlater *et al.* [15] have outlined fairness issues regarding the inaccessibility of the data and models employed by AI-enabled assistive technologies, such as systems designed for vision assistance, but also regarding the decision-making process in AI-based sensing, e.g., the type of information to be conveyed to the user, and aspects of privacy triggered by the use of such systems in public places. In this context, we believe that the application of XR technology to human augmentation needs an appropriate philosophical and cultural framework to support and drive ethical innovation.

A few works have considered transhumanism to describe technological advances in AR [42,44] and XR [45], respectively, but touched the topic only briefly. For example, Sarraco [44] noted: “Once Augmented Reality will become seamless it will change forever our perception of the world and it might be one of the first turning point in the path towards transhumanism,” and Semwal *et al.* [45] looked at applications of XR in learning, e.g., “Learning by experimenting and using perception enhancing through XR (AR, VR, MR, Ambience/Tangible interfaces, and drones) would provide new possibilities on multiple scales,” which they discussed in the context of transhumanism. *In this work, we adopt a principled approach to appropriating the core values of the transhumanist project to innovations in XR applied to human augmentation.* To this end, we present the Augmented Human community with an in-depth overview of the transhumanism philosophy [7,8] in its most recent interpretation of Sorgner [49], which we place in a theoretical framework with correspondences to Milgram and

Kishino’s [35] Reality-Virtuality continuum, Mann’s [31] mediators of reality, and Baudrillard’s [6] concept of the hyperreal; see Figure 1 for an overview. We make two contributions in this paper:

- (1) We propose transhumanism as the philosophical and cultural framework for supporting and driving innovations in XR technology employed specifically for human augmentation, a perspective that complements existing approaches to ethical design of XR worlds for other applications [30,43,51].
- (2) We exemplify our approach by discussing three prototypes of human augmentation with XR technology in relation to Bostrom’s [7] three core conditions for the transhumanist project (global security, technological progress, wide access) and four levels at which XR determines human augmentation (instrumentation, integration, control, and sensation).

1.1 XR for Human Augmentation

Before proceeding further, we provide our operational definition of XR employed for the purpose of human augmentation:

Definition: XR for human augmentation is the application of augmented, virtual, mixed, mediated, and/or multimediased reality technology for the purpose of enhancing the individual’s sensory, motor, and/or cognitive abilities towards more effective functioning in and interaction with the physical world.

According to this perspective, the primary substratum for technological augmentation is represented by (i) the physical world and (ii) the individual’s existing abilities, which are enhanced with XR technology via a process of integration, either on or with the human body or the physical environment. New sensory abilities may emerge from such integration, such as better vision [27], extended vision [14], different kinds of vision [2], and remote controlled vision [39]. For example, Pampărau and Vatavu [39] introduced FlexiSee, a HoloLens system enabling flexible control of mediated vision by the wearer, but also by remote users represented by vision monitors and vision assistants, and Ishii *et al.*’s [24] ambient-ROOM employed light, sound, and air flow to deliver information at the users’ periphery of awareness. Also, new motor abilities may be delivered with on-body augmentation, such as faster reaction times [25] via proprioceptive interaction [28] or the ability to experience different ways to grasp and manipulate objects [38,60]. For example, Nishida *et al.* [38] introduced HandMorph, a glove-like device with mechanical links that approximates the experience of having a smaller grasping range, while the dynamic, adaptive, and shape changing TRANSFORM furniture of Vink *et al.* [56] assists the user in reaching for and manipulating physical objects.

Human augmentation with XR technology can thus be implemented at the level of the body, as in FlexiSee [39] and HandMorph [38] representative of wearable computing, or at the level of the physical environment, as in ambientROOM [24] and TRANSFORM [56], which employ technology representative of ambient intelligence (AmI) environments. Thus, we place the scope of our definition in the context where XR and augmented environments overlap and complement each other. For more details, we refer readers to Vatavu’s [54] three postulations regarding the similarities between the philosophy and visions of AmI and AR.

2 CONTEXT: EVOLVING HUMANS AND ENFRAMING

Any well-designed artifact, including the variety of forms that applications of XR may take, are more than mere products of human intelligence, and rather stand as endowments and improvements of the potential for human intelligence [18]. It is thus both useful and sensible to position our discussion in the context of the evolutionary process in which human sensorimotor abilities and intelligence, supported by technology, have made possible *Homo sapiens* to appear on the world's stage and sustain their evolution ever since.

Technology embodied in the form of human evolution has revealed different drives of growth compared to its biological counterpart. The core principle of technology-supported intelligence is “enframing,” which, according to Heidegger [22], represents “the gathering together which belongs to that setting-upon which challenges, which sets upon man and puts him in position to reveal the actual, in the mode of ordering, as standing-reserve. As the one who is challenged forth in this way, man stands within the essential realm of enframing” (p. 2). From this perspective, not only the nature and human are a “standing reserve” [22, p. 20], but the technological progress converges itself in an incessant recurrent dialectic where things are readily available for technical application and used as resources for further improvement of the humans as technological beings. However, according to Lourdes *et al.* [17], “science and technology do not offer criteria to guide the practical and conceptual use of their own contents simply because they do not contain the conceptual space for the ought-to-be.” At the same time, current humanist ethics is incapable to deal with the challenges of technological progress because of its basic foundation on the supremacy of the natural while, in the sight of technological progress, wise use of technology—meaning with prudence in the Aristotelian sense—is unfeasible [36].

Technology-supported evolution has therefore enhanced biology with an epiphylogenetic compound, which strives for self-fulfillment, i.e., “the pursuit of the evolution of the living by other means than life” [52]. As the pace of technological progress has surpassed that of biological evolution, e.g., XR-based extension of the human field of view [14], human vision beyond the visible range of the electromagnetic spectrum [2], or new motor abilities [25,38,60], the balance between natural and technology-supported evolution has become fragile. In this context, a proper philosophical and cultural framework is mandatory for innovations in XR technology developed for and applied to human augmentation. Our proposal of such a framework is transhumanism [7,8] and, specifically, its concrete form of metahumanism or weak transhumanism described by Sorgner [49]. Next, we discuss the need for such an approach for XR technology applied to human augmentation.

3 A TRANSHUMANISM APPROACH TO XR APPLIED TO HUMAN AUGMENTATION

Transhumanism is the cultural philosophy that seeks to legitimize the freedom to technologically enhance humans not only as a valuable enterprise, but possessing moral values as well [7]. The transhumanist creed is the constant adaptation to the up-to-date state of philosophical insights, scientific knowledge, and advances in technology towards a better driven human evolution [49]. The

programmatic aim is epicurean at its core pursuing the good life through incessant technological enhancement, and endeavors to break the limitations of all previous types of humanism—e.g., secular, naturalistic, or evolutionary—based on a technology-centered view of the world. Thus, transhumanism speaks for a materialistic, non-dualistic, relational perspective on human nature via the use of technology as a defining feature of *Homo sapiens*. Detached from its roots in humanism, which promotes education and cultural refinement, transhumanist “rhizomes” resort to overcoming biological limits with technology towards a posthuman life [7].

According to the “Transhumanism FAQ” [8], the formal definition of the transhumanist project comprises two aspects: (i) an intellectual and cultural movement affirming both the possibility and desirability of improving the human condition fundamentally and (ii) the study of the aspects involved in overcoming human limitations, such as ethical matters of the use of enabling technology. Thus, the fundamental premise in transhumanism is that humans, emerging from evolutionary processes, may run extinct if their adaptation to the ever-changing environmental conditions happens to fail [49]. Nowadays, the process of adaptation is supported by a recurrent technological loop within an environment that is gradually changing from natural to technologically modified and, ultimately, to entirely fabricated and a hybrid version of the physical and the virtual. The anticipated future technological evolution is that *adaptation to the environment will take the form of creating the environment with enabling technology*, which connects well to XR environments that present users with mediated [31,32] or augmented [4,35] views of the physical world.

3.1 XR as part of “We Aint Seen Nothin’ Yet”

Transhumanism defies humans to assume the unpredictability of possible futures of their species by active participation in an unforeseeable development brought by technological innovation and use of augmentations [49]. Although modern humans are already transhumanized in a weaker sense [40]—e.g., as quasi-cyborgs, partially prosthetic beings, techno-enhanced with wearables, medical treatments, and online lives—they do not acknowledge this image of themselves. In fact, cyborgization, i.e., augmentation of biological beings with mechanical devices and nano devices and/or capabilities, is one of the most promising technological augmentation promoted by transhumanism alongside genetic, morphological, and pharmacological enhancement [8]. In this context, XR represents one possible way to achieve human augmentation (see Figure 2) with a specific technology that offers distinct possibilities compared to others but also specific ethical dimensions that need proper consideration. Sorgner’s [49] perspective of metahumanism, in which human augmentation is already present and prevalent, can be useful to address ethical innovation in XR, which we discuss next.

3.2 The Transhumanist Framework and Values for XR Applied to Human Augmentation

XR technology does not aim for a radical transformation of the human condition, but rather to foster its potentiality through a creative virtuality. Hence, XR worlds can be seen as an affirmative aspect of enframing [22] (see Section 2), the recurrent natural self-creative and evolutionist process of the *Homo sapiens* enhancing

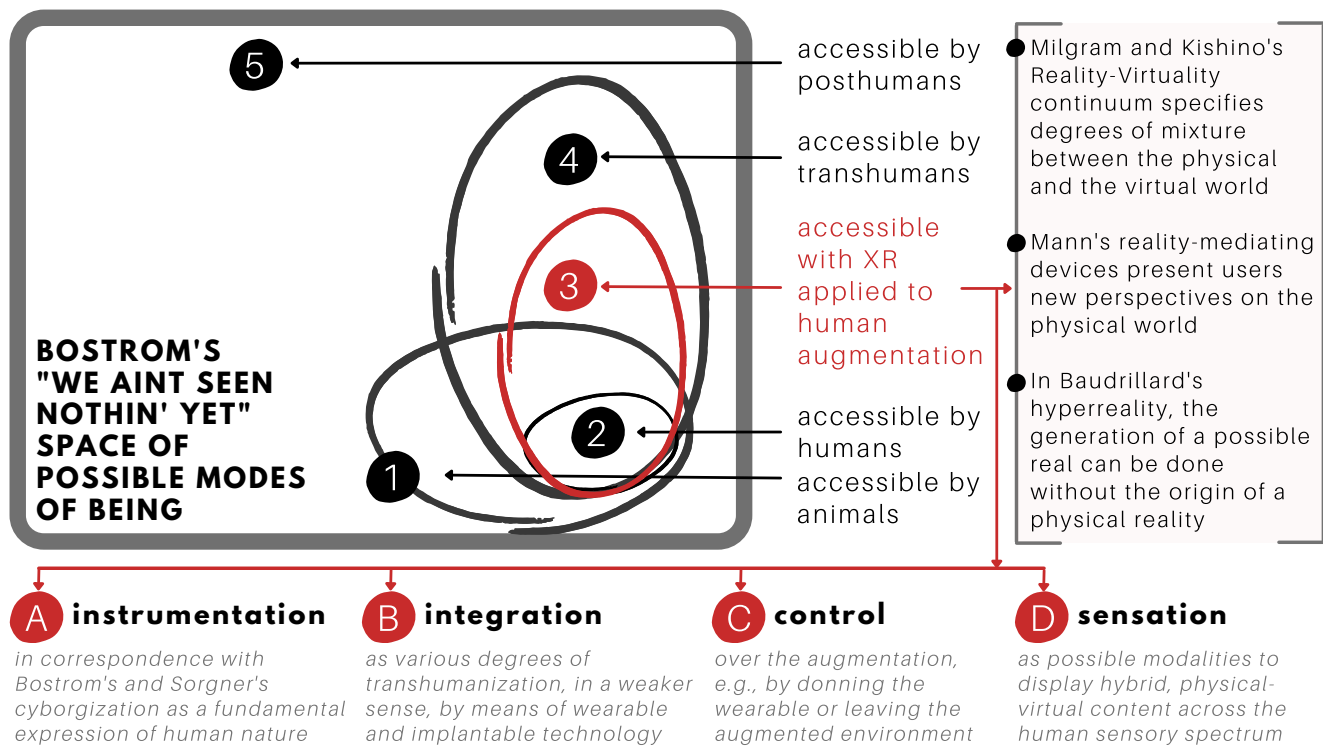


Figure 2: Adaptation of Bostrom's [7] representation of the space of possible modes of being (not drawn to scale), in which we highlight human augmentation with XR that becomes possible in the conceptual frameworks delivered by the Reality-Virtuality continuum [35], reality mediators [31], and the hyperreal [6].

themselves by the very means of their own creations. This process can be characterized in the realm located between *humanism*, as the philosophical stance that emphasizes the potential and agency of humans, and *posthumanism* that concerns the state of being beyond our current understanding of what is human; see Figure 1 for a visual illustration. In this ontological and cultural “middle,” various types of augmentations are possible with XR technology, both of the human body and the physical environment. Furthermore, this middle can be put in correspondence to Milgram and Kishino's [35] Reality-Virtuality continuum, where virtual objects are mixed and aligned with the real world in various degrees as well as with Mann's [31] mediation axis, where the physical reality is presented to users in new ways, between unmediated and fully mediated. *In this conjunction, XR develops virtual potentialities for the metahuman [49] that has left the biological path of natural evolution, but has not transformed yet into the posthuman, just like our current world is a mixture of the physical and the virtual.* Taken to the extreme, these potentialities create mixed worlds saturated with virtual content, for which the distinction between what is real and what is virtual may be difficult, if not impossible, to comprehend. Such a possibility was described by Baudrillard's [6] *hyperreality*, where the generation of a possible real can be done without the origin of a physical reality, and creatively illustrated in Keiichi Matsuda's¹ dystopia of hyper AR; see the right part of Figure 1.

The unlimited ability of the *Homo sapiens* to technologically adapt to the physical environment and of self-enhancement seems to make technoscience an ideal means for fulfilling the humanist ideal of human progress. Humans are changing in unexpected ways because, paradoxically, they still need to adapt to the new technological environment. Driven by technological progress, humans are implacably doomed to overpass their humanity, i.e., according to Hegel [21], “The very fact that something is determined as a limitation implies that the limitation is already transcended” (p. 134). This dynamics towards “we ain't seen nothing yet” turns salient the crisis of conventional ethics. The condition of modern humans is inevitable transhuman, i.e., artifactually imbued. Ethics and moral are based on an ancient view of natural as the benchmark for what is good, and yet the artificiality has been from the start the defining expression of human nature, actually making its tremendous evolution possible. Invention and creation of technological devices for human enhancement have been the melting pot of human evolution [52]. From this perspective, we have always been cyborgs [49], and technology nothing else than a fundamental expression of human nature. Based on these considerations, we resort to the basic conditions of the transhumanist project [7] as a framework for ethical innovation in XR technology applied for human augmentation; see next.

¹<http://km.cx/projects/domestic-robocop>

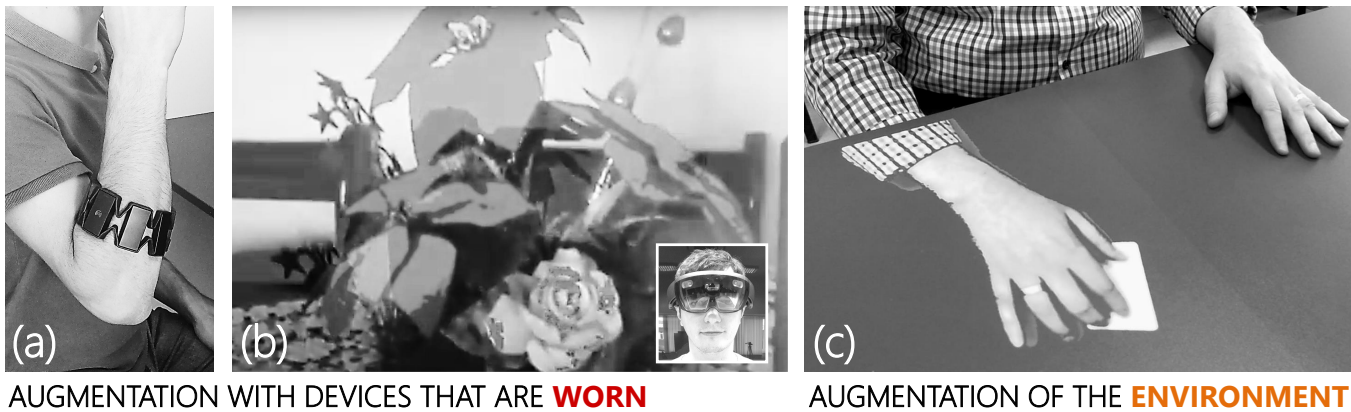


Figure 3: Examples of human augmentation using various XR technology, which we discuss in this work from the perspective of transhumanism: (a) a wearable armband provides vibrotactile cues about specific events, outside the wearer’s sensory reach; (b) the visual field of a user wearing HoloLens under the control of a remote person; and (c) a video-projected hand, aligned with the user’s physical body, that plays prerecorded movements.

3.3 Core Conditions of Transhumanism Applied to XR for Human Augmentation

We propose contextualization, characterization, and examination of ethical human augmentation enabled by XR technology in the framework set by Bostrom’s [7] three “basic conditions for realizing the transhumanist project”: *global security*, *technological progress*, and *wide access*. Technological advances endows human species with the capacity of altering its own evolution and to become co-creator of humanity. Consequently, XR technology challenges traditional ethics by its possibility to enhance all human capacities, from sensory modalities to new faculties and sensibilities as part of the emotional, intellectual, and general bodily functionality with impact on life and health span.

3.3.1 Global security. A nonnegotiable requirement for the transhumanist project, according to which the use of technology might lead to an undesirable, adverse outcome where Earth-originating intelligent life is either annihilated or its potential diminished permanently or drastically [7]. Among all of the core conditions of transhumanism, global security is by far the most difficult to predict in terms of possible implications of large-scale use of technologies that radically alter human abilities. For instance, when XR is used for human augmentation, this condition has consequences and implications with regards to (1.1) extreme dependency on artificial worlds [30] and use of wearable computing and augmented physical environments enabling access to such worlds and (1.2) living in a permanent blended reality [57] that can diminish considerably the capacity for focused attention and for discerning and appreciating the authenticity of the “here and now;” see Waterworth and Hoshi [57] for an in-depth discussion regarding the latter. Madary *et al.* [30] even argue that “It is not excluded that extended interactions with VR environments may lead to more fundamental changes, not only on a psychological, but also on a biological level” (p. 3:4). Any technological innovation, no matter how well intended or even conceived in the first place to mitigate some risks, may have potentially unwanted adverse effects, amplify other risks, or even

create new ones. In this regard, the precautionary principle [1,36] from traditional ethics is futile as long as its factual application bans any significant technological advancement [23].

3.3.2 Technological progress. Refers to all instrumentally useful artefacts created to alleviate human biological shortcomings [7]. A characteristic of technological progress is its tremendous pace and capacity to change at a deep level all of the dimensions of human life, including biology, psychology, sociality, and culture. What was a little while back considered radical or even unthinkable is already debatable or even acceptable. Concerning XR, this aspect implies the availability of XR technology in terms of devices, software, and services to render hybrid physical-virtual worlds and favor immersion and interaction in those worlds, but also technological progress that is driven by sound theoretical and scientific knowledge, legal systems, and ethical frameworks. Traditional ethics is unprepared and an ethics of XR for human augmentation does not exist yet. Nevertheless, a suitable ethics for dealing with inevitable transhuman outcomes of continuous technological human enhancement is an imperative to overcome the prohibiting passivism of traditional ethics, which cannot accommodate the rapid pace and the moral dilemmas and challenges raised by converging technologies at individual, professional, and social level [34].

3.3.3 Wide access. Represents a basic condition of the transhumanist project to reduce inequality, express solidarity and respect for fellow humans, and increase fairness for the accessibility and availability of technology [7]. For XR applied to human augmentation, this means designing interactive devices, applications, and systems that are accessible to people with various abilities, including with universal [29], inclusive [37], and ability-based design [59] approaches. Also, technological augmentation and enhancement of the human body needs a legitimizing discourse to be made acceptable at society level. The exponential progress of technology and innovation challenge the human natural fear of the unknown and lack of control, respectively. XR technology surpasses the understanding of the lay person, which sees only what the technology

can do, but does not necessarily understand how it works. The wide access to technological outcomes can also be seen as the expression of positive freedom, a condition *sine qua non* for the “desirable and affirmable achievement” of transhumanist ethics.

4 PRACTICAL EXAMPLES

To illustrate the application of the transhumanist framework of thought to human augmentation using XR technology, we present three prototypes of systems that are either worn or designed to augment the physical environment; see Figure 3. The first prototype involves a smart armband, implemented with Myo,² that delivers vibrotactile feedback in the form of short pulses on the forearm, informing the wearer about events outside their typical sensory reach, such as changes in weather conditions when the user is not outdoors, e.g., sudden rain on a sunny day; see Figure 3a. The second prototype is a HoloLens³ application enabling vision mediation in XYR [31], where what the user sees, e.g., a view of the physical world with highlighted colors, edges, or objects of interest, can be controlled by the user themselves but also by a remote person that logs in, via the Internet, to the application running on the head-mounted display; see Figure 3b. The third prototype is a spatial AR installation that complements the user’s physical body with the image of a video-projected hand, resembling an AR rubber-hand illusion [53], but extended in functionality with the capability to play prerecorded movements, independent of the user’s actions; see Figure 3c. We do not insist on the engineering details of these prototypes, less important for our discussion, and instead focus on examining their capabilities for human augmentation from the perspective of the transhumanist philosophy and its core conditions.

The three prototypes span a spectrum of a variety of possible forms of human augmentation, involving both wearable devices and augmentations of the physical environment, but also different modalities to deliver the respective augmentations across the human senses. They all adhere to the *technological progress* core condition of the transhumanist project [7] due to their goals to alleviate shortcomings in human biology, from limited sensorial cues to perceive events from other environments located at a distance from the observer (Figure 3a) to limited control over sensing, understanding, and interpreting the visual environment (Figure 3b) to biological limitations in terms of possible motor abilities caused by the hand anatomy and mechanics (Figure 3c). Moreover, such prototypes can be readily implemented with off-the-shelf technology, e.g., smart armbands, head-mounted displays, and video cameras and projectors, respectively, in accordance with the *wide access* core requirement of the transhumanist project [7]. The spectrum of systems illustrated in Figure 3 presents a progressive integration of XR in the physical reality perceived by the user, in various forms and using various technology, which can be characterized from the transhumanistic perspective at multiple levels; see next.

4.1 Instrumentation

At the *instrumentation* level, corresponding to Bostrom’s [8] and Sorgner’s [49] cyborgization as a fundamental expression of human nature, augmentation of the human body is achieved progressively,

from a simple arm band worn on the forearm (Figure 3a) to a more invasive head-mounted display (Figure 3b) to a video-projection in the surrounding environment, exterior but in relation to the body (Figure 3c) challenging the identification of one’s own body parts in the representation of the conscious self. According to Madary and Metzinger [30], “VR technology directly targets the mechanism by which human beings phenomenologically identify with the content of their self-model.” The fusion illustrated in our spectrum of prototypes renders pointless any categorical division of substance between humans and things. In this new anthropological context, the Kantian fundamental ethical principle of prohibition against instrumentation needs to be revised; see Sorgner [49] (pp. 77-81).

4.2 Integration

At the *integration* level, corresponding to various degrees of transhumanization occurring in a weaker sense by means of wearable and implantable technology [40], our first two prototypes deliver augmentations only when they are worn, while the third requires presence in a specific environment for integration between the physical body and the video-projected limb to take place. In the former case, removal of the device from the body ceases the augmentation; in the latter, leaving the physical premises is a requirement for the augmentation to stop. The type of the integration with the body and/or the environment determines when and where augmentations are possible, which can be interpreted as a strong point (i.e., technology under the control of the user), but also as a limitation (i.e., some augmentations are only possible in restricted areas). Immersion in new, hybrid realities and dependence on augmented capabilities and permanent connection to a specific environment unveil new ethical challenges for living in such environments [26,48,51]. Also, the augmented body and environment feature new abilities and skills requiring reinterpretation and reevaluation of the real world interactions and norms of conduct [9,13].

4.3 Control

Regarding the *control* possibility mentioned in the previous subsection, the three prototypes from Figure 3 offer different opportunities to control the augmentation. The arm band (Figure 3a) delivers notifications automatically, but it can be easily removed at will; the head-mounted display (Figure 3b) provides vision mediation with a mixed form of control, either by the wearer or by a remote vision assistant that can “log in” and control what the wearer of the head-mounted display is seeing; while the video projection of the artificial limb (Figure 3c) acts independently, outside the control of the user’s body to which it is aligned.

4.4 Sensation

At the *sensation* level, corresponding to various possible modalities to display hybrid physical-virtual content across the human senses [35], human augmentation is achieved by simple notifications in the form of vibrotactile patterns felt on the forearm, complex mediation of visual perception of the surrounding reality, and the proprioception contradiction created by witnessing credible movements of an artificial hand, not belonging to the user’s body, but matching the body proportions and being physically aligned with the body. Such sensations enabled by applied XR technology,

²<https://developerblog.myo.com>

³<https://www.microsoft.com/en-us/hololens>

among many other possible, reflect Bostrom's [7] emphasis on technological progress as a core condition for the instrumental alleviation of human biological shortcomings. Moreover, they enable humans to play the role of proactive explorers of new possibilities to their biology offered by their own co-creation of humanity as a process of continuous evolution of the transhuman.

5 DISCUSSION

The necessity for a new philosophical and cultural framework for XR applied to human augmentation is supported by the novelty and magnitude of the phenomena that large-scale use of XR will bring about into the human psychic, society, and culture. The effects of XR cannot be evaluated locally, individually, or for short periods of time since XR is to become a critical component of our "onlife" way of living embedded in our digital relationships. The widespread of computer-supported cooperative work [20], ambient intelligence [54], and ubiquitous computing [41] backed by XR augmentation is already forming a hyperspace or cyberspace, set to dramatically change "our self-conception (who we are); our mutual interactions (how we socialise); our conception of reality (our metaphysics); and our interactions with reality (our agency)" [16].

In this context, the scientific and cultural paradigm is not prepared to provide a beneficial and sustainable approach to the challenges that man-made realities will raise because of the lack of second-level or meta-epistemological perspectives. XR as one major element of technological progress is epistemologically and culturally supported by cognitive sciences, i.e., linguistic, analytical philosophy, cognitive psychology, neuroscience, computer science and, less influential, anthropology. The current mainstream paradigms from psychology, cognitivism, and philosophy are stuck in an "epistemological bubble" within cognitive sciences. As long as they function based on and along with computer science, they are entrapped in a knowledge loop, reinforcing the paradigm they are supposed to critically evaluate. XR environments cannot be designed uncritically and unreflexively due to the impressive influence they have on human psychology, society, and culture. Instead, "the critical property which designers are seeking, which we call appropriate behavioral framing, [...] is rooted in sets of mutually-held, and mutually available, cultural understandings about behaviour and action" [20]. Otherwise, this cultural and epistemological paradigm risks to threaten our humanness. There is not any stable or objective image, description, or depiction of what humans are given that everything, including the natural sciences, consists of discourses, which are ways of constituting knowledge. The advance and development of a transhumanist perspective are required to avoid a cultural shock where people realize they are living in a physical-virtual world for which their established norms, values, and common knowledge cannot accommodate.

XR worlds of communication and living are fully human designed. According to Wittgenstein's [58] proposition 5.6, "The limits of my language mean the limits of my world." If the language employed to specify new worlds is limited to computer programmable or translated sentences leading to quantitative and positivist depictions of reality, then the human (self-)narrative, which constructs its self-image, is in peril to be demoted to this artificial character and devoid by its higher attributes of affection, belief, spirituality,

sense of the sacred, and felt community. *In the lack of a proper philosophical and cultural framework, XR devices, systems, and worlds are bound to remain artificial and isolated from the process of enframing that allows humans to reveal reality as their standing reserve.* We believe that transhumanism, by characterizing the bridging state between being human and posthuman in a world that is becoming into being, represents a suitable perspective to support and drive innovations in XR applied to human augmentation.

6 CONCLUSION

We discussed in this paper the perspective of transhumanism for XR applied to human augmentation, which we brought to the attention of the Augmented Human scientific community to trigger further discussion. To this end, we stress the moral responsibility to anticipate the potentialities of XR applied to human augmentation, where XR researchers need to collaborate with philosophers, psychologists, and sociologists. In this context, transhuman ethics should be trans- and multi-disciplinary (involving ethicists, social scientists, scientists, and technologists), multi-leveled (disclosing, theorizing and/or developing and applying normative evaluation) [10], and able to cover the major aspects of human enhancement: Freedom and Autonomy, Fairness and Equity, Societal Disruption, Human Dignity and Good Life, Rights and Obligations, Policy and Law [3]. We are looking forward to future explorations of XR applied to human augmentation in the framework of the transhumanist project.

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