All Reality: Values, taxonomy, and continuum, for Virtual, Augmented, eXtended/MiXed (X), Mediated (X,Y), and Multimediated Reality/Intelligence

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ABSTRACT

Humans are creating a world of eXtended/Artificial Reality/Intelligence (AR, AI, XR, XI or EI), that in many ways is hypocritical, e.g. where cars and buildings are always "allowed" to "wear" cameras, but humans sometimes aren't, and where machines sense our every movement, yet we can't even understand how they work. We're constructing a system of values that gives more rights and less responsibilities to AI (Artificial Intelligence) than to HI (Humanistic Intelligence).

Whereas it is becoming common to separate the notions of IRL (In Real Life) and "Augmented" or "Virtual" Reality (AR, VR) into completely disparate realms with clearly delineated boundaries, we propose here the notion of "All Reality" to more holistically represent the links between these soon-to-be-outdated culturally accepted norms of various levels of consciousness. Inclusive in the notion of "All Reality" is also the idea of "ethically aligned reality", recognizing values-based biases, cultural norms, and applied ethics of the creators of technology.

As a new field of study, All Reality is multidisciplinary. We must consider not just the user, but also how the technology affects others, e.g. how its physical appearance affects social situations, and how sensor-based reality (e.g. wearable and implantable cameras in the smart city) affects privacy, security, and trust. All Reality includes Virtual Reality (VR), Augmented Reality (AR), X-Reality (XR), X-Y Reality (XYR), and Mixed, Mediated, etc. realities (MR). It also includes realities that come from nature itself, allowing us to directly experience real (but otherwise invisible) phenomena, such as wave propagation and wave interference patterns, so that we can see radio waves and sound waves and how they interact with objects and each other. This expands our capacity to understand our world beyond synthetic realities to include also phenomenal/phenomenological realities and blends between synthetic and phenomenal realities.

By showing the evolution and diversity of the various technologies in the Mediated Reality space, we demonstrate why "ethically aligned reality" is a critical element of All Reality, governing not just AI in its oftentimes reductionist and computationalist applications, but in the wider opportunities of its more holistic usage incorporating HI (Humanistic Intelligence) and the realities of our natural environment, i.e. phenomenal reality (Φ R).

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Note to reader: This paper includes a summary of some of the material in https://arxiv.org/pdf/1804.08386.pdf [39].

Figure 1: Realities Timeline: from VR to All R

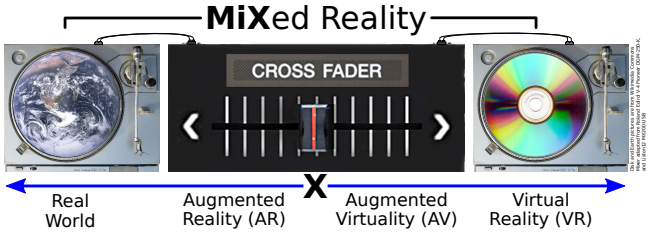

Figure 2: Disk Jockey (DJ) Mixer Metaphor of mixed reality: Imagine two record players (turntables), feeding into an audio/video mixer. Real-world and virtual world mixtures are selected by sliding a one-dimensional "fader" left or right. This allows us to choose various blends as points along an "$\mathbb{X}$" axis between the extremes of Reality, "$\mathbb{R}$", and Virtuality, "$\mathbb{V}$".

1 HISTORICAL CONTEXT

1.1 Virtual, Augmented, and MiX-Reality

VR (Virtual Reality) is a computer-generated simulation of a realistic experience that blocks out the real world ("Reality") and replaces it with a "Virtual" world. The virtual world may be generated by a computer, or by interactively playing back recorded media. An example of the latter is the Aspen Movie Map of 1978 that used computers to play back analog laser disk recordings to render an interactive virtual world as hypermedia [47], or, more recently, Google Street View with Earth VR.

AR (Augmented Reality) is a similar concept, but instead of blocking out reality, the computer-generated content is added onto, or embedded into, the real world experience, so that both can be experienced together [3]. The first augmented reality system was created by Ivan Sutherland in 1968, and although quite rudimentary, it provided the world's first overlay of computer graphics on top of the real world [54].

It has been suggested [45], that Augmented Reality exists along a continuum between the real and virtual worlds, as "mixed reality", as illustrated metaphorically in Fig. 2. In this context we can think of AR as a setting on a "mixer" or "fader" or "slider" that is somewhere between reality and virtuality.

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This "slider" is analogous to the "X-axis" of an X-Y plot or graph, treating "X" as a mathematical variable that can assume any quantity on the real number line. Thus mixed reality is sometimes referred to as "X-reality" or "XR" [5, 29, 48]. Paradisio and Landay define XR as a mixed reality environment that is "the union between ubiquitous sensor/actuator networks and shared online virtual worlds", i.e. as a specific kind of mixed reality [48]. Coleman states: "Cross-reality (also known as x-reality) is an informational or media exchange between real-and virtual-world systems." [5].

XR as extrapolation ("extended reality" or "extended response") dates back as early as 1961 when Charles Wyckoff filed a patent for his "XR" film which allowed people to see nuclear explosions and other phenomena beyond the range of normal human vision [8, 60, 61]. In 1991, Mann and Wyckoff worked together to build "XR vision" devices into wearable computers (AR/VR headsets, etc.) for human augmentation and sensory extension by way of High Dynamic Range (HDR) imaging blended with virtual/augmented reality [29], as eXtrapolation, to eXtend/augment/eXpand human sensory capabilities through wearable computing. In this sense "X" defines an axis that reaches past "reality".

The terms "XR", "X-Reality, "X-REALITY, and "XREALITY appear as trademarks registered to Sony Corporation, filed in 2010, and used extensively in the context of mobile augmented reality across Sony's "Xperia" X-Reality™ for mobile products (Fig. 3)

Figure 3: Sony's trademarked X-Reality and XR

Sony's use of XR and X-Reality is consistent with the Wyckoff-Mann conceptualization of extended human sensory perception through high dynamic range.

There is some confusion, though, since XR (X-Reality) now has at least three definitions, one in which it is a proper *superset* of mixed reality (Mann-Wyckoff eXtrapolation), another in which it *is* mixed reality (Coleman/Milgram interpolation/miXing), and another in which it is a proper *subset* of mixed reality (Paradiso-Landay's combination of wearables and smart cities).

What these three definitions of XR/X-Reality all have in common is that XR/X-Reality is based on an "X-axis" defining a number line that passes through both "reality" and "virtuality", along a one-dimensional path, i.e. as parameterized by one scalar real number, $X \in R$.

1.2 Mediated Reality (X-Y Reality)

Many technologies function as an intermediary between us and the environment around us. Technology can modify or change (mediate) our "reality", either as a result of deliberate design of the technology to mediate reality, or sometimes as an accidental or unintended side-effect. These two variants of mediated reality are further discussed below.

Examples of deliberate modification of reality include the upside-down eyeglass invented 122 years ago by George Stratton to study the effects of optically mediated vision on the brain [53]. Computer-mediated reality has also been explored [27, 30].

Mediated Reality is not just for psychology experiments, though. It has many practical everyday applications such as eyeglasses that filter out advertisements, and, more generally, helping people see better by getting rid of visual clutter. HDR (High Dynamic Range)

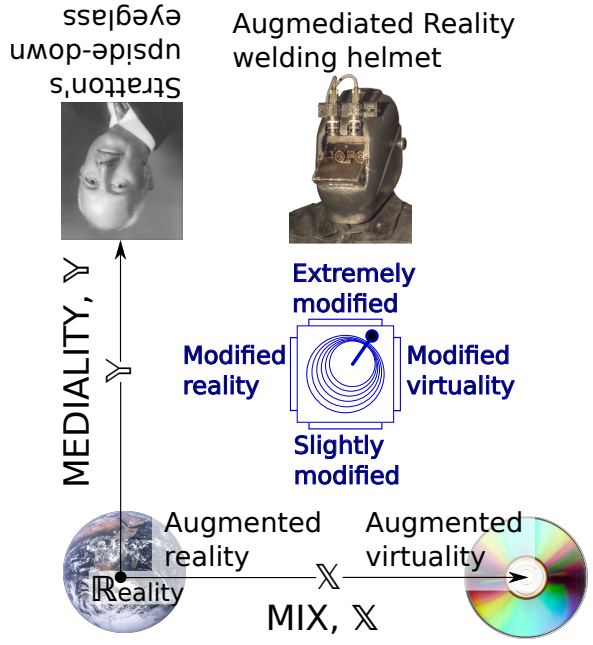

Figure 4: Mediated Reality (X,Y) Continuum: There exists a continuum in both the degree to which reality can be virtualized, as well as the degree to which it can be modified. The "MIX" axis ("𝕏" axis) runs left-to-right (reality to virtuality). The "MEDIALITY" axis ("𝕐") runs bottom to top (Slightly modified to Extremely modified). George Stratton's upside-down glass is an example of a wearable eyeglass technology that involves no virtuality but a great deal of mediality, and thus occupies an area in the upper left. The EyeTap HDR welding helmet [7] an example of extreme reality modification (mediality), that also involves a moderate amount of virtuality. The amount of virtuality it has is about the same as a typical augmented reality setup, so it exists near the top middle of the space. This top middle area of the Continuum is sometimes called "Augmediated Reality" (Augmented Mediated Reality) [20, 46].

welding helmets use computer vision to *diminish* the otherwise overwhelming brightness of an electric arc, while *augmenting* dark shadow detail. In addition to this Mediated Reality the HDR welding helmet also adds in some virtual content as well [7].

Mediated Reality has also been examined in the context of wearable computing, prosthesis, and surveillance [55].

1.3 Mediated Reality (X,Y) Continuum

The above examples as well as many more examples of "reality" technologies do not fit into the one-dimensional "mixer" of Fig. 2, and thus we need at least one additional axis when describing technology that specifically modifies reality. For this reason, Mediated Reality [13, 27, 55, 56] has been proposed. See Fig 4. In this Mediated Reality taxonomy (continuum), there are two axes: the virtuality axis ("X") exactly as present in XR/X-Reality/MiXed-reality, and a second axis, the Mediality axis ("Y"). This allows us to consider other possibilities like mediated-augmented-reality ("augmediated

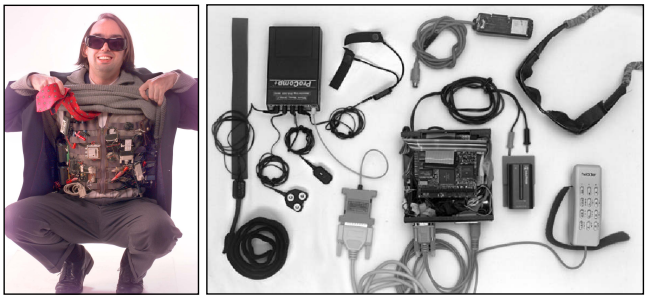

Figure 5: Example of Quantified Self (formerly Quantimetric Self-Sensing) presented to K. Kelly at WiReD in San Francisco, 1996 [21, 22, 28]. The system recorded a highly complete set of scientific measurements of the body as well as its surroundings, including: " *1) ultraminiature cameras concealed inside eyeglasses and oriented to have the same field of view as the wearer, thus providing the computer with the wearer's first-person perspective; 2) ... additional cameras ... a rear-looking camera with a view of what is directly behind the wearer; 3) sets of microphones, ... one set to capture the sounds of someone talking to the wearer ... and a second set to capture the wearer's own speech; 4) biosensors, comprising not just heart rate but full ECG waveform, as well as respiration, skin conductivity, sweat level, and other quantities, each available as a continuous (sufficiently sampled) time varying voltage; ... 5) footstep sensors typically comprising an array of transducers inside each shoe; 6) wearable radar systems in the form of antenna arrays sewn into clothing*" [28]. In the words of Kevin Kelly: "*You most definitely were doing the quantify self back then [1996].* [22]"

reality") [7] (e.g. HDR welding helmets), as well as mediated virtuality (e.g. taking an existing VR system and then flipping the image upside-down, to allow us to repeat George Stratton's 1896 upside-down eyeglass experiment but in a virtual world).

1.4 Quantimetric Reality (QR)

The multidimensional and multisensory reality of Humanistic Intelligence (HI), i.e. human-in-the-loop quantimetric self-sensing [28] formed the basis for the Quantified Self (QS) movement [21, 22], forming the basis for Quantimetric Reality or Quantified Reality (See Fig. 5). Such a reality can be richly complex, and multidimensional, and does not fit well within existing reality taxonomies and continuua.

2 ALL REALITY

There is a need for a unified framework for VR, AR, ΦR, XR, XYR, MR, QR, and numerous other realities and meta-realities having both synthetic and phenomenological components.

2.1 Technologies for sensory attenuation

The Wyckoff-Mann Continuum (XR), the Milgram Continuum (mixed reality, Fig 2) (Milgram 1994 [45]) and the Mann Continuum (X-Y reality, Fig 4) (Mann 1994 [27]) all place reality at the left or the lower left, i.e. the"origin" in Cartesian coordinates.

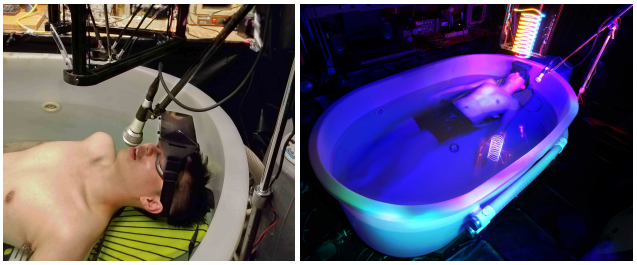

Figure 6: Mersivity™ Multi/mediated/meditated Reality in a sensory deprivation tank. Left: Initial setup before beginning operation. Right: During operation. Interactive shared meditation and throat singing competition in which participants see and hear sound waves in a shared multimediated environment while other competing senses are attenuated. While floating in complete isolation, it is much easier to suspend disbelief in the virtual environment, and immerse one's self fully, using acoustic, visual, and EEG biofeedback.

Neither Wyckoff's, Milgram's, nor Mann's Continuum directly addresses visual sensory attenuation technologies like sunglasses and sleep masks, or attenuation of other senses by such technologies as ear plugs or sensory attenuation tanks (also known as "sensory deprivation tanks" or "flotation tanks").

Sensory attenuation technologies form an underexplored yet richly interesting space for technology. Consider some of the following examples:

- Interactive sleep masks for shared lucid dreaming;
- Submersive Reality™environments like computer-mediated sensory tanks that use water for sensory attenuation (Mann 2004), and "immersive multimedia" of "Fluid User Interfaces" [33] using water in conjunction with interactive multimedia, such as the Reprivation™biofeedback tank of Fig. 6;
- Interactive darkroom experiences such as interactive lightpainting with reality-based media such as persistence-of-exposure and "Phenomenological Augmented Reality" (e.g. being able to see radio waves, sound waves, or metawaves by way of a darkroom environment with eyes adjusted to the dark).

2.2 Multimedia in Photographic Darkrooms

A light bulb or LED (Light Emitting Diode) waved around in a dark room will tend to create the visual appearance or impression of shapes, curves, patterns, etc., by way of a "persistence-of-exposure" effect in human vision as well as in photographic or videographic media. There is a long history of photographic "lightpainting" (http://lpwa.pro/event/15). There is also a well established "flow arts" community doing artistic dance in a dark environment with light sources, e.g. LED (Light Emitting Diodes), as well as "fire spinning" and juggling light-emitting objects as a medium of creative expression. Flow art is similar to lightpainting but for direct viewing rather than through photography. Some tools (specialized light sources) and devices are used for both lightpainting and flow arts.

The tradition of darkness (sensory attenuation) combined with sensory media (e.g. controlled lighting) dates back to the early days of theatre. Theatrical productions typically take place in a space in which all or most of the walls are painted black, and there is usually a black floor, and black curtains, such that lighting can be controlled carefully. In fact the world's first use of the term "Virtual Reality" came from theatre in 1938 [2].

We consider this to be the origin of the underlying concepts of virtual reality, rooted in the sensory attenuation capabilities of the theater, and thus, in some sense, the true spirit of VR.

This tradition of sensory attenuation and controlled sensory stimulus was also evident in Morton Heilig's "Sensorama" (U.S. Pat. #3050870), a multi-sensory experience which was also the world's first "3D film", in 1959.

2.3 Multimediated Reality Darkroom

In the 1970s, the idea of an interactive darkroom was taken a step further, by conducting a series of experiments to make otherwise invisible phenomena visible. These experiments involved light sources connected to the output of powerful yet very sensitve amplifiers that were driven by transducers or antennae that sensed a physical quantity or meta-quantity of interest.

In one example, a light source was used to "sweep" for video "bugs" and the light source glowed more brightly when in the field of view of a surveillance camera, than when not in the camera's field of view [39]. The simplest example of this was to use a television receiver as the light source, as shown in Fig. 7.

Alternatively a linear array of light sources is used, as shown in Fig. 8. When the light shines on a camera it causes the camera to exhibit small but measurable changes, causing video feedback. Waving the lights back and forth in front of the camera makes the "sightfield" of the camera visible. It has been suggested that this is a form of augmented reality (Mann 2014) but it is a special kind of reality in the sense that it comes directly from nature itself. Unlike many other forms of reality, it does not come from a computer simulation. Here the light bulb filament has a dual role: it is both the mechanism by which a physical quantity is sensed, and it is also the display mechanism. Therefore, due to the fundamental physics of the situation, the alignment between the "real" physical world, and the "augmented" world is exact (there is no need for any tracking mechanism since the process itself is self-tracking).

We proffer to call this Phenomenological Reality, because it makes visible true physical quantities by way of directly physical means, i.e. a direct connection between a physical quantity and the sensed quantity.

Multimedia display technologies such as video, as well as special eyeglasses, can be used to sample and hold the data captured by a moving sensor. A multimedia darkroom setup of this type is shown in Fig. 9 and Fig. 9.

3 MULTIMEDIATED REALITY IS MULTISCALE, MULTIMODAL, MULTISENSORY, MULTIVEILLANT, AND MULTIDIMENSIONAL

Multimediated reality is more than just a taxonomy of real and synthetic experience. It also considers how we interact with the

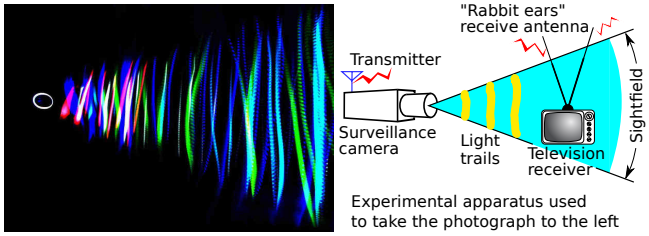

Figure 7: Phenomenal reality (ΦR). Real world phenomena and meta-phenomena can be made visible by moving light sources in a dark room. Metasensing is the sensing of sensing: sensing sensors and sensing their capacity to sense. Metavision is the visualization of vision, e.g. seeing a camera's ability to see.

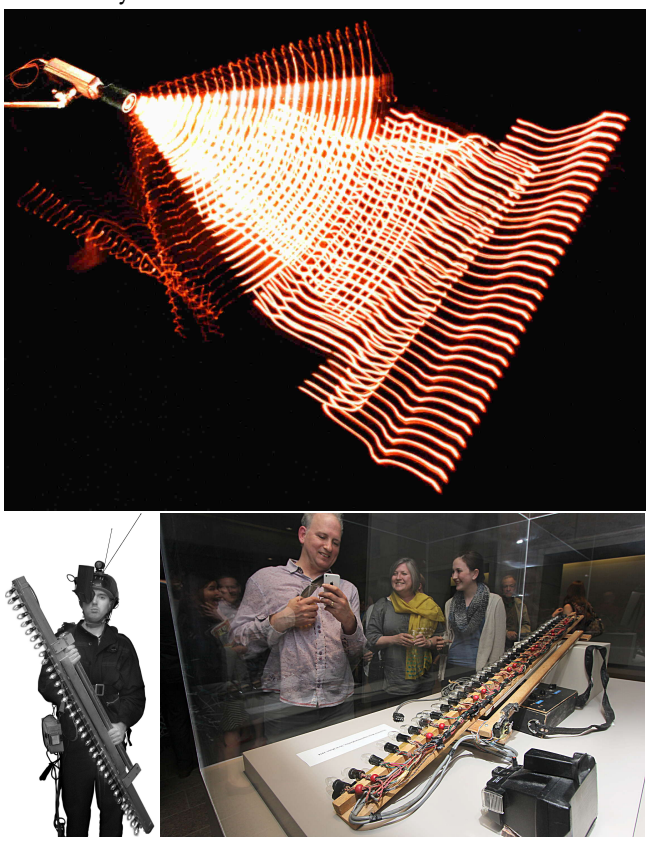

Figure 8: Sequential Wave Imprinting Machine (SWIM) consisting of a linear array of electric light bulbs connected to a wearable computer and wearable lock-in amplifier. This functioned like a giant "paintbrush" to create an augmented reality world from the physical phenomenology of metaveillance [26, 36], "painting" with the light to expose the human eye or photographic film to the camera's metaveillance field. Rightmost: World's first wearable augmented reality computer (built by S. Mann in 1974) on exhibit at National Gallery in 2015.

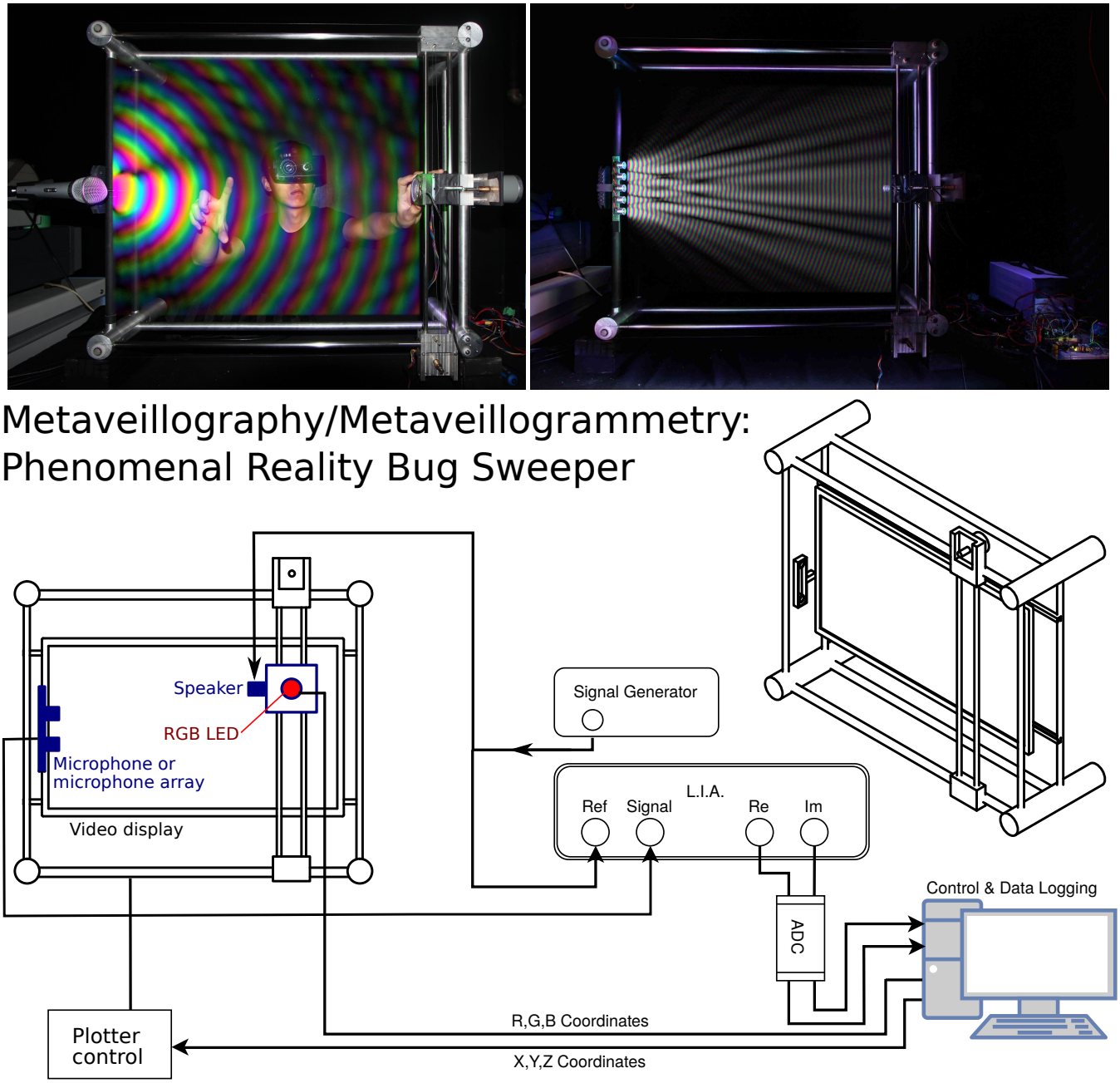

Figure 9: Multimediated Reality darkroom with 3D mechanical position control device that scans a space with transducers connected to a special lock-in amplifier. Top left: Metaveillograph (metaveillance photograph) of a microphone's capacity to hear sound. Top right: Metaveillograph of an array of five microphones. Here we can see the metaveillance wave function as a beamforming array, with a capacity to listen to weak sound signals from a long distance away. Bottom: Experimental apparatus for multimediated reality. An XY(Z) plotter carries a listening device (transducer) together with an RGB (Red Green Blue) LED (Light Emitting Diode) through all possible positions in space. At each position the sound is sensed phase-coherently by way of a L.I.A. (Lock In Amplifier), while sound is produced by a transmit array comprised of two transmitters, receiving the same signal to which the L.I.A. is referenced. The outputs Re (Real) and Im (Imaginary) of the L.I.A. are converted to RGB values for display on the LED. A picture is taken of this movement and presented to a video display, to provide a persistence-of-exposure. Alternatively the video display may be driven directly by data stored in the Control & Data Logging system. In this case, it can be animated by multiplication by a complex number of unit modulus, so that the waves on the screen slowly "crawl" at any desired speed-of-sound (e.g. the speed of sound can be set to zero or to some small value so as to be able to see it clearly).

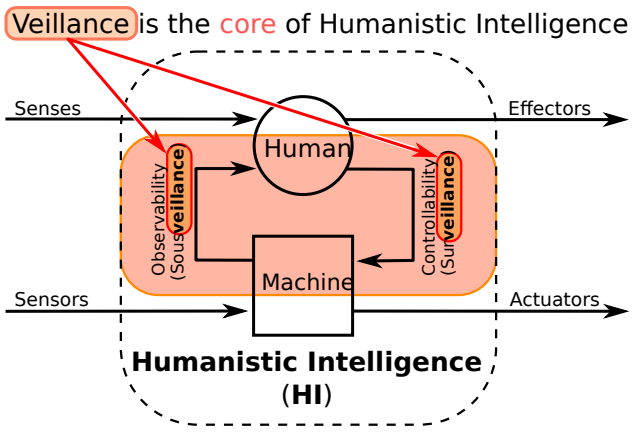

Figure 10: An important aspect of multimediated reality is HI (Humanistic Intelligence). HI addresses systems in which our human senses (sight, hearing, etc.) and effectors (e.g. hands) are augmented or mediated by machine intelligence having sensors and actuators. HI is intelligence that arises by having the human in the feedback loop of a computational process. It requires sousveillance (undersight) whenever surveillance (oversight) is present, i.e. it requires a full closed-loop such that if a machine can sense us, we must also be able to sense the machine [46]. This reciprocity is the core feature of HI that enables it to form a fundamental basis for multimediated reality. Thus multimediated reality is multiveillant (in contrast to monoveillant technologies that include only surveillance without sousveillance).

world around us and each other, through the use of technology as a true extension of our own minds and bodies. Specifically we consider the concept of AI (Artificial Intelligence) as well as human-in-the-loop-AI, also known as HI (Humanistic Intelligence) [46]. HI posits that technology should function as an intermediary between us and our environment in such a way that the intelligence it affords us arises through a computational feedback loop of which we are a part. See Fig. 10

Multimediated reality involves multiple physical scales, including both wearable technology as well as technology in the environment around us, like smart rooms (e.g. smart darkrooms). This multiscale and multiveillant nature of multimediated reality is illustrated in Fig. 11

3.1 Multisensory Synthetic Synesthesia

Synesthesia is a neurological condition in which there is crosstalk between human senses, e.g. chromesthesia which is hearing colors of light, or "The Man Who Tasted Shapes" [6].

Multimediated reality often involves a multimedia-induced (synthetic) synesthesia among and across our existing senses (e.g. seeing sound), or, extrasensory, i.e. beyond our existing senses (e.g. seeing or feeling radio waves). In this way, multimediated reality is multisensory and multimodal.

4 MULTIMEDIATED REALITY CONTINUUM

Many of the systems presented in this paper do not fit nicely into existing taxonomies of VR and AR, or any of the more general taxonomies of synthetic experience [51]. We proffer a more general "reality" continuum in which the space is multidimensional, and in which the origin is the absence of sensory stimulation, allowing us to consider technologies such as sleep masks, interactive sleep masks, sensory deprivation tanks, interactive sensory deprivation tanks [32, 40], aquatics facilities, theatres, darkrooms, therapy systems, and the like, as a basis upon which to create new multimedia realities directly connected to physical or intellectual phenomena. See Fig. 12.

Note the many dimensions and the many ways they can be combined. For example we can have a mix of Reality and Virtuality that gives AR (Augmented Reality), and then further add some phenomenality to get PAR (Phenomenological Augmented Reality [38]). We can add to AR some Fluentity to get SR (Submsersive Reality [32, 40]). And if we do PAR while swimming fully submerged in water, we're spanning the four dimensions of Reality, Virtuality, Phenomenality, and Fluidity/Fluentity.

5 ETHICALLY ALIGNED DESIGN AND INTERVENTION

All Reality has been presented as a new framework that spans physical scales from implantables and wearables, out to smart cities and smart worlds. It spans all sociopolitical scales from sousveillance to surveillance, and all informatic scales from "little data" (distributed, e.g. blockchain) to "big data" (centralized repositories).

Summarizing, we suggest two main thrusts:

- ethically aligned design [16]; and
- ethically aligned intervention.

Ethically aligned design is of fundamental importance, and we must fully understand it before we can proceed with any full understanding of the realities. Entire books touching on the underlying themes have already been written [14, 15, 17] and should be required reading for anyone doing product or system design. These serve as important guidelines of self-restraint for those who architect the future.

The second thrust is ethically aligned intervention. Whereas ethically aligned design can be thought of as designing products based on an input of ethics, ethically aligned intervention is activity taken to convey these ethics to the world, e.g. exerting some influence on others, not just one's self or own research and development team.

For example, in the cyborg age, we can no longer see invention and design as merely a response. Inventions can also become interventions.

In(ter)ventions can include such topics as re-inventing ourselves. Take, for example, individuals like Mann and Harbisson, who created for themselves new sensory capacity through self-modification. This has had an immediate effect on formalism such as the presentation of self in everyday life [11], with, for example, the passport office being one example of the infinite force of existentiality against the immovable object of burueacracy. Whereas the passport offices forbid any kind of covering, at the same time, there is an existential technology that must, ultimately, become the self. This has, by

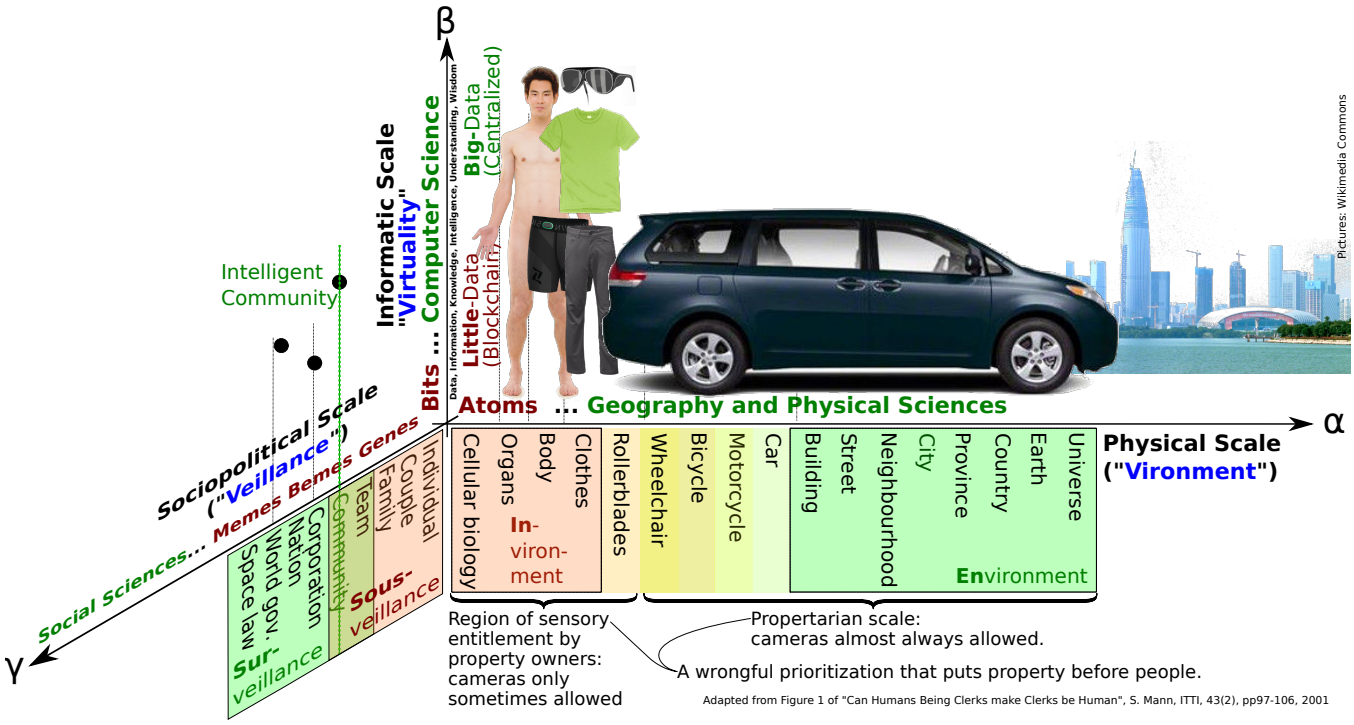

Figure 11: Multimediated reality is multiveillant (surveillance AND sousveillance) as well as multiscale (wearables AND smart environments). We can identify at least three axes: Firstly, a physical scale axis (of physical reality) defines the environment (that which surrounds us) and the invironment (us ourselves). At the border between the environment and invironment are things like clothes, and other technological prostheses. A Virtuality axis defines also a scale from "Bits" all the way out to "Big Data". A sociopolitical or "Veillance" axis defines sousveillance (individual/internal) out to surveillance (external). At the origin are "Bits", "Atoms", and "Genes". Genes, for example, are the smallest unit of "humanness" (human expression). The axes are labeled α, β, and γ. The first of the three axes (α) is denoted pictorially, at physical scales starting from naked, to underwear, to outerwear, to a vehicle (car), to the "smart city". Interestingly, at smaller physical scales (e.g. human scales), cameras are only sometimes allowed, but at larger physical scales (e.g. property scales), cameras are almost always allowed. We see this as a fundamental wrong that favours smart things over "smart peopole", i.e. that wrongly favours AI over HI.

some, been cited as evidence of being a "cyborg" or government sanctioned cyborg [58].

S. Mann was originally refused a passport because of devices attached to his eyes, but eventually, in 1995, Mann was issued a passport wearing a computer vision system. Subsequently, in 2004, Neil Harbisson was refused a passport, and also eventually got one on similar reasoning [58]. See Fig. 13.

5.1 Ethically Aligned Vision

The world of vision provides us with some interesting ethics-based examples. Vision occurs at multiple scales, from wearable camera systems (such as found in a seeing aid or computer vision eyeglass), to vision-based self-driving wheelchairs, bicycles, and automobiles, to smart buildings in which every light fixture [4], elevator, toilet [18], or handwash faucet has a camera built into it, to smart cities where every streetlight has a camera embedded in it [52].

A simple taxonomy of vision categorizes vision according to veillance, i.e. sur**veillance** (overslight) [12, 24], or sous**veillance** (undersight) [1, 9, 10, 19, 25, 31, 42, 44, 49, 50, 57, 59], or metaveillance (the sight of sight itself) [36].

While a number of precise mathematical definitions have been proposed for these veillances, the difference is fundamental and can be understood by anyone, even a child. See Fig. 14 Children have a wonderful naiveté that cuts through a lot of complicated politics and allows them to understand complex issues in simple ways. To a year-old, it is totally absurd that people could be forbidden to record (and thus recall) what they see, while cars and buildings are always allowed to see, record and recall whatever is captured by their cameras.

Yet, it is people (not cars and buildings) who are held to be responsible for what they do. It is people (not cars and buildings) that must give a truthful account of what they have witnessed, if called before a courtroom. It is people (not cars and buildings) that have a genuine need to recall the details of their lives. For example, imagine an elderly citizen (maybe a person suffering from Alzheimer's disease or dementia, or maybe just someone with a bad memory) being called before a Court of Law in order to answer questions about their past. Would it not be helpful (and reasonable)

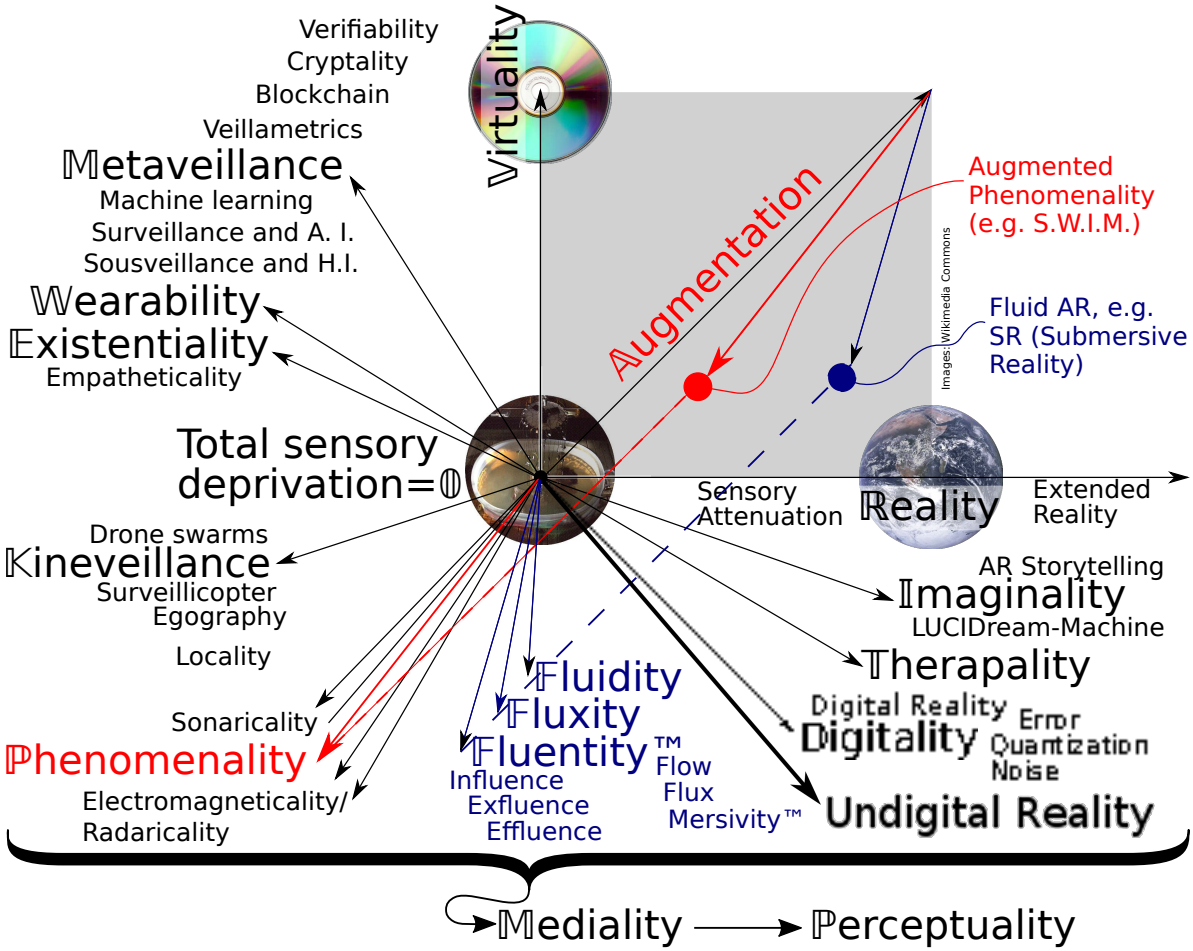

Figure 12: The Multimediated Reality Continuum. Reality is the main axis going from left-to-right, starting at "Total sensory deprivation" (the origin, indicated by a sensory deprivation tank), then to "Sensory attenuation", then Reality, and then beyond Reality to give also Extended reality. Virtuality is the secondary axis pointing upwards. Augmentation exists in the 2-dimensional space spanned by Reality and Virtuality. A third axis, phenomenality, indicates any kind of phenomenological reality, such as phase-coherent photography of radio waves or sound waves, such as by Sequential Wave Imprinting Machine (SWIM). In this sense, PAR (Phenomenological Augmented Reality) [38] is a combination of AR and P (Phenomenality). A point in this space is indicated by the red dot as "Augmented Phenomenality". As another example, consider a point (indicated in blue) that comes out from AR along the Fluentity axis. An example of this kind of reality is the Internet-based underwater virtual/augmented reality performance space [32, 40]. When we submerge ourselves in a large swimming pool, with an underwater SWIM to see sound waves (e.g. to test out an underwater sound system and see the interference patterns between two underwater speakers), we're in a reality described by adding the two vectors (red dot and blue dot) taking us into an additional higher dimension. The All Reality Continuum thus allows us to understand sensory attenuation (interpolation between sensory deprivation and reality) as well as eXtended reality (extrapolation beyond reality), in addition to the many other dimensions shown, such as Metaveillance [36] (Sur/Sous-Veillance, smart cities, smart buildings, etc.), Wearability (Mann's "Wearable Reality" of 1974 and Canadian Patent 2388766), Kineveillance (drone and swarm-based realities [41]), Imaginality (e.g. lucid dreaming in the sensory deprivation tank), and Therapality (the axis of lasting effects that persist even after shutting off and removing a technology). Not all axes are desirable, e.g. Digitality is the axis of quantization noise that embodies the undesirable artifacts of *being digital*, pixelation, etc. Ideally we wish to use computers for *being undigital* [43].

for such a person to draw on recordings of their past in order to give an accurate account of their conduct? Why then do so many people seek to restrict the use of wearable devices by which recollection can be enabled?

It is interesting to note that a wheelchair is like a car in many ways, but it is allowed, at least in principle, to enter into any space a person can legally enter. Like a car, a wheelchair with self-driving cameras, or security cameras, or similar sensory navigation or security system, would be allowed under nearly any circumstance.

Figure 13: Mann and Harbisson created for themselves new sensory capacity through self-modification. These have often been cited as the first examples of government-sanctioned "cyborgs".

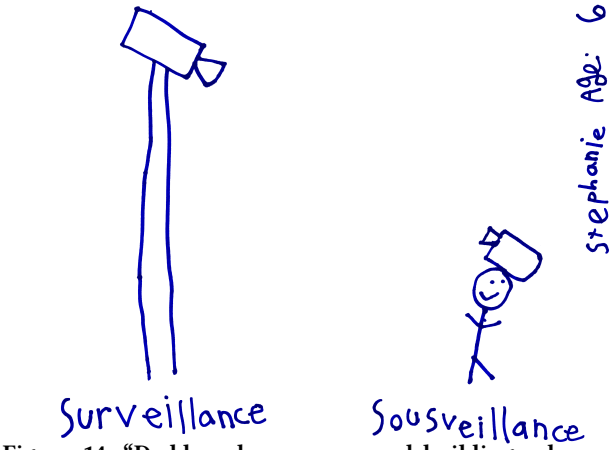

Figure 14: "Daddy, why are cars and buildings always allowed to wear cameras, but people sometimes aren't?" –Stephanie, age 6, in response to her father being physically assaulted for wearing a computerized seeing aid.

Figure 15: Surveillance is the veillance of hypocrisy – the veillance that claims sensory entitlement over other veillances [23, 35–37].

We no of no situation in which a person with a camera-based wheelchair was forbidden access, yet we know of many situations in which persons wearing vision-based seeing aids have been physically assaulted or been refused entry to establishments evoking the kind of hypocrisy evident in Fig. 15. Referring to Fig. 11, we can thus define a region from Wheelchair outwards to the edge of the universe, in which cameras are always allowed, and a region from Rollerblades, inwards, where cameras are only sometimes allowed.

But the benefits accrued to wheelchairs, cars, buildings, and cities should also be available to clothes, and people.

To address matters like these will require Ethically Aligned Intervention.

5.2 Copyright © and Subjectright Ⓢ

Other examples of ethically aligned reality include the concept of Subjectright [34], analgous to copyright, but designed to protect the subject of the data, not just the one acquired the data.

A common reason for the hypocrisy of surveillance is the fear of copyright violation. This leads, for example, to surveillance cameras in bookstores and movie theaters to help prevent people from taking their own pictures.

What is being violated, however, is also the rights of the subject (human, person) not to be photographed. In this way, surveillance tends to value the privacy of merchandise (e.g. books) over and above the privacy of people (humans).

We see this as a serious shortcoming. Accordingly, an ethically designed reality would need to address the concept of subjectright, Ⓢ.

5.3 Conclusion

We anticipate the need for "ethically aligned reality" as an important element of All Reality, governing not just AI, but also touching on aspects of HI. Whereas all-consuming ubiquitous AI is the future, HI is upon us right now, and demands immediate attention.

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