D2.1 Social Implications and Preconditions for Responsible Design

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Executive Summary

The goal of this report is to introduce the social implications and preconditions for the responsible design of holography with dense wireless networks. This is accomplished by giving a brief overview of the development of the technology in context with society, followed by analyzing how the impact of the technology and responsibility to be taken for it will depend on the stakeholders and the environments in which the technology is applied.

Following, two approaches to responsible design are introduced. The first being Guidance Ethics, which focuses on the values of the stakeholders and embedding responsible design into the product. The second approach applies established literature on Function Creep, Contextual Integrity, Ambient Intelligence, and Technological Environmentality.

Next, the features that may differentiate this technology from pre-existing technologies are presented with some analysis on their societal effect. Finally, introductory results from a Guidance Ethics workshop are shared. This workshop included researchers from HOLDEN and invited guests representing relevant stakeholders. There were three goals of the workshop: 1) discover contexts for use, 2) discern stakeholder values, and 3) take initial steps towards responsible design.

This report reveals that the features and contexts with which this technology is applied will have varying societal impacts. Therefore, the fewer roles, the lower the gravity of each role, and less data stored by HOLDEN technologies, the easier it will be to design ethical use cases. For example, if the technology has multiple roles within a home, including high responsibility tasks such as ensuring the health and safety of someone chronically ill, all while collecting data that could be repurposed, ensuring ethical use will be more difficult than a system with one use case that has an external system of checks and balances. The domains in which the data collected by this technology can be used should also be regulated to prevent both naïveté towards the system and abuse of the system.

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1. Introduction

The goal of this report is to introduce the social implications of holography with dense wireless networks as the technology pertains to the aims of the EU-funded HOLDEN project. In this report, we take both a bottom-up and top-down approach to analysing the technology. Often philosophers focus on the possible negative outcomes of new technologies and recommend taking a cautious approach toward innovation. This top-down approach has merit, recognizing in advance the potential harmful consequences of technological development. Nonetheless, repeatedly, market and other values persist that result in technological development regardless of philosophical predictions. Our challenge is to bring the philosopher into the design process, so that the technology may be developed in a way that allows meaningful progress without undermining societal ethical values. Therefore, in addition to utilizing existing ethical literature, such as Helen Nissenbaum's work on the ethics of privacy, the bottom-up Guidance Ethics Approach is employed to clarify stakeholder interests.

1.1. HOLDEN

HOLDEN is an EU-funded grant dedicated to the ethical development of technology to use RF-wave sensing to create "vision." The built environment is awash with electromagnetic waves outside of the scope of human sensing. A portion of these waves derive from wireless network sources such as WIFI routers, telecommunication towers, and cell phones. These radio frequency (RF) waves can travel through walls and reflect off surfaces. HOLDEN attempts to visualize the environment and those in it in an ethical way, by responsibly using sensor feedback from dense wireless networks.

HOLDEN accomplishes this mission using three different methods. 1) forming holography from electromagnetic scattering, 2) discrete point measurement using beamforming/steering and smart antennas, and 3) incorporating machine learning with electromagnetic waves produced from 5G and beyond to understand increasingly complex environments, movements, and behaviours. Built into the grant is the requirement that each phase of the project be ethical. This can be a challenge for socially disruptive technologies with unforeseen impacts. Therefore, this report is a first step for providing an overview of the social implications and preconditions for responsible design.

1.2. State of RF Wave Sensing Research

The first successful transatlantic morse code radio message of 'S' pulsated from an antenna, traveling from Cornwall, England to St. Johns, Newfoundland to reach a receiver in 1901 [1]. Fast forward over a century and the technology has evolved to where it is today, where RF waves are emitted carrying voice messages from cell towers to cell phones, delivering search engine results from routers to laptops, and transporting an array of sensor derived data between a plethora of "smart" devices. It is now common to access free WIFI in malls and even on buses. Demand for mobile and wireless technology has expanded research in internet communication technologies (ICT) and increased the amount of RF waves unknowingly interacted with each day.

It is natural that RF waves are now being used for vision. Afterall, the most relatable connection humans have to the electromagnetic spectrum are the colours we see from red to violet. This light covers a fraction of the electromagnetic spectrum with waves ranging from 380nm to 750nm. Even further down the spectrum, where the wavelengths are so short that they disrupt our cells, are X-rays and MRIs, which can expose the innerworkings of the body. Compared to X-ray and MRIs waves, RF waves, are relatively harmless – so low in frequency and long in wavelength that they are non-ionizing and would be quite inefficient tearing down our cells. Nonetheless, as with any technological advancement, there may be yet undiscovered effects (bodily or otherwise) inflicted by waves in the RF spectrum to humans, the environment, or animals. However, the influence of waves on our physical or mental constitution is not the subject of this project.

So far it has been discovered that RF waves are indeed an option for holography. RF waves have been used to detect gestures in the dark and through walls [2], [3], recognize emotions [4], track sleep [5], detect breath and heartrate [6], [7], track where someone is in their home and what they are doing [8], and even in studies to recognize the early signs of dementia by tracking movement and behaviour [9]. Each of these contexts have unique ethical concerns and social implications, on which we will focus.

The fidelity of the "vision" produced from the technology is dependent on the density of the waves and the receivers. The more receivers, though, the lower the quality of the waves, because they drain energy from the original signals. Meaning that implementing this technology through increasing the number of receivers could lower the quality of telecommunication signals. The variance in detail afforded by RF wave holography means that it is possible to get a sense of where people are or what they are doing without recognizing individual faces.

Yet, there are ways to recognize people beyond clothing and facial recognition. Research has shown, that with the help of machine learning, it was possible to recognize and differentiate two similarly dressed individuals from RF waves [10]. Once machine learning is introduced and more sensors and antennas are added, the more that can be seen and recognized. The impact of machine learning on the ethics of HOLDEN technologies is important and will be elaborated in Section 2.2 and further discussed in the second iteration of this report.

This technology has numerous potential application areas. Elderly care is commonly described as an immediate use case for the technology. Other possible long-term use cases include robotics, crowd monitoring, and smart home functionality. This technology, while still under development, is primed to be brought to the market while most of the population has never considered holography from "the cloud" to be a possibility. This means legally, society is ill equipped to handle this emerging technology, especially when the possible use cases are so vast.

Furthermore, RF wave vision has expanded beyond academia resulting in patents. An overview of patents is included in the internal HOLDEN Report D1.1.

1.3. Stakeholders and Responsibility

Socially disruptive technologies are defined as technologies that can "disrupt social relations, institutions, epistemic paradigms, foundational concepts, values, and even the nature of human cognition and experience" [11]. Holography with dense wireless networks has the capacity to do just that. Just as cameras redefined our notion of privacy, so too may the notion of *ubiquitous* sensing be redefined by this technology. One day, wherever the network surrounds us sufficiently, we could be "seen" with gesture and movement recordings. This could all happen "unobtrusively" without the need for gadgets and wearables. Those who wish to escape the possibility of being tracked would have to be quite literally "off the grid."

Imagine a world where network providers build hardware and software into each router that can track movement in the house. Picture privacy only being preserved for those with the autonomy to fully self-govern – people who are healthy enough to not need to be monitored for health reasons, people self-sufficient enough to not need to be monitored for their own safety, people independently wealthy enough to not be monitored by their employer to know if they are working effectively. Aspects of this imagined reality are already the case today. Babies are monitored over video, children are tracked with their watches, phones, and AirTags, the elderly and sick are monitored to lessen the caretaking load. Workers are monitored through cameras and time tracking down to the individual tasks that they are working on each hour. Many carry a smart phone that is constantly collecting data both in the physical and digital realm – apps used, websites visited, real world location, places visited. The difference will be whether a ubiquitous, wireless system is possible that can be used in combination with or replace existing systems. Unlike these “obtrusive” devices that could theoretically be discarded or burned, there will be no means of escape from RF wave vision, and there will likely be an even more limited understanding of “where” it is and what exactly it is doing.

The implications of this technology are vast. The fact that RF holography and sensing already functions at this current stage means that it could already be in use and under development by businesses and the military without most of society even knowing that such technology is even possible. Depending on how the technology is used and regulated, our definitions of public and private could fundamentally shift. If RF holography is designed to know the whereabouts and movements of an anonymous person, then a person would be more discrete doing something in public than in their own home, where it is likely that they are the one performing the action. Unlike cameras, it is also harder to know the “limits” of RF vision as it operates in the dark and through walls. “Hiding” is also an interesting conundrum since light absorbent clothes create a shadow that can also be “seen.”

Each stakeholder in society will have a different relationship with the technology for each context in which it is applied. Homeowners, visitors of homes, employees, business owners, telecommunication companies, the elderly and chronically ill, caretakers, doctors, artists, governments, dictators, prisoners, disabled people, children, scientists, the list continues. If we consider non-humans, plants, animals, and the environment, there will be new positives and negatives to consider. Do certain species of animals react differently to RF waves than humans? How energy depleting are these algorithms? Will this cause more dense wireless infrastructures to be built and will that influence the planet and its inhabitants? Might this tech have an influence on technologies that we have already developed? The answers to these questions would help ascertain the social, global, and environmental impact of the technology, but will take time and research to answer. The answers to these questions are also outside of the scope of the HOLDEN ethics group. The global market is not patient when it comes to innovation [12]. Therefore, possible fallout and redesign is bound to occur after the technology is already installed and running.

Who then is responsible for the outcomes of this technology? Until the public is made aware of the technology, how it works, when it is used, and why it is being implemented, it is impossible for society to advocate for or against its use. Fully informing the public is challenging and easily succumbs to discrimination, as it is easier to reach connected people of a higher education level who speak the same language than those generally less privileged in society. False consent due to lack of knowledge should not put the onus on the individual. Meanwhile, the government ideally protects the interests of its citizens, but needs the knowledge of the technology and its impacts (which as previously shown might not be clear until the technology is already in use) to institute laws, policies, and regulations. Scientists often work in the pursuit of discovery and not implementation. Those discoveries can then be brought to market with an urgency to optimize a single sector and generate increasing revenue, sometimes wilfully ignorant of the repercussions for second degree stakeholders. Bringing all parties together early in the development stage might help more fairly distribute responsibility and grant more agency to those often side-lined. In the next section, an example of a bottom-up approach to responsible ethical development will be discussed.

1.4. Guidance Ethics from the Bottom Up

Guidance Ethics is an approach to philosophy of technology developed by Peter-Paul Verbeek and ECP | Platform for the Information Society. Peter-Paul Verbeek is a philosopher who expanded upon Don Ihde's work to further develop mediation theory. In Verbeek's view, technology is integral to the human experience, not a separate entity impacting humanity – technology *mediates* the human experience [13]. Due to technology and humanity being intertwined, it is not useful to think of technological developments purely as moral dilemmas. Instead, with a Guidance Ethics approach, technology can be developed positively in a way that pushes forward society's needs and achieves stakeholder values.

There are three distinct characteristics of the Guidance Ethics approach. 1) It operates from the *bottom up*, meaning that instead of philosophers imposing views on the technology from pre-existing literature, the stakeholders themselves can articulate needs and values for the technology. 2) It occurs from within, which translates to the technology being developed with ethics in mind instead of facing external technology assessment after the fact. 3) It focuses on *positive ethics*, concentrating on what we want from the technology instead of worst-case –scenarios [14].

One challenge with Guidance Ethics is getting all the right stakeholders in a room and the impossibility of a single stakeholder being able to represent their whole group. Individuals most at risk or most likely to "misuse" technology are challenging to bring into a research study. For holography with dense wireless waves, it is essential to talk to the elderly, children, as well as hackers and those who might wish to use this technology to manipulate and control people. Those in low paying jobs also often cannot afford to take time off work to join research studies. Lastly, individuals struggle to follow through on their own values. People say that they value health, but the desire for peace of mind, fun and ease, leaves many making choices that undermine their own wellbeing.

As will soon be demonstrated in the following section, there are plenty of top-down concerns regarding HOLDEN. Such top-down analysis though often leaves out practical real-world instances, where such technology might have value. Furthermore, holography through dense wireless networks already exists and is a logical appropriation of the RF wave portion of the electromagnetic spectrum that is now possible due to the increased density of wireless signals, faster computational power, and machine learning. At this point, it is crucial to create practical regulations and design requirements to ensure that the technology is developed and used in ways that better all stakeholders. This might also include regulations and tools to protect individuals and society from the technology itself.

1.5. Top-Down Concerns

Some established concepts can help avoid pitfalls in the development of holography with dense wireless networks. "Function creep" occurs when technology that was created and installed for one purpose is gradually used for another often, unrelated motive. It is an easy way to build the infrastructure for a use case that would be unpopular by providing a desired service. Theoretically, bringing ultra-fast 5G connectivity into homes and cities and then using the waves emitting WIFI for ubiquitous sensing would fit this description. The dream of surveillance without "added" infrastructure piggybacks on the drive for knowledge and connectivity. This drive has led to the quick evolution through five generations (5G) of ICT. Would people be so supportive of increased ICT infrastructure if they knew what increased wireless density may bring?

Health concerns and unsubstantiated paranoia from members of the public, suggests that people do not want increased RF wave density at any cost, especially of the higher frequency radio waves introduced by

5G that allow for faster transfers of information at a closer range. Misinformation spread during the corona virus pandemic, leading people to violence, attacking cell phone towers under the belief that 5G was helping spread COVID19 [15]. While higher frequency RF waves are still non-ionizing, and, unlike lower frequency RF waves, too short to pass through skin and walls, they still heat cells (to a much lesser degree than the sun) and are less studied, causing confusion amongst lawmakers as to what level of exposure, distance, and usage is optimal [16]. This leads to circumstances such as the Apple iPhone 12 being produced, brought to market, and sold worldwide, and then banned for sale in France by Agence nationale des fréquences (ANFR) due to the specific absorption rate (SAR) exceeding the legal limit for on-body emissions [17]. Meanwhile, 5G has been labeled as a form of environmental pollution [18].

Ethics is dedicated to determining, defending, and systematizing right from wrong actions and behaviors. Values assist in reckoning between moral and immoral states. There are various ways of evaluating systems as ethical or unethical such as looking at the consequences (consequentialism) or at the actions themselves (deontology). Is happiness for all most important or is the scientific advancement of humanity? Much of traditional western philosophy upheld virtues of autonomy, freedom, and justice but excluded slaves, females, and “inferior” racial groups from their normative decision making. In this modern age it is essential for ethics to be inclusive, not only of *all* people, but also the planet and other animals.

Narrowing down to practical use cases of holography with dense wireless networks, some established schools of thought may be helpful to understand the social implications and preconditions for design. Helen Nissenbaum’s view of privacy as contextual integrity focuses on what people really care about when they speak of privacy [19]. People want their partners and close friends and family to know intimate details of their life. They want their doctor to have access to their medical history and they want their alma mater to know what courses they took and grades that they received. This does not mean that they want that information to leak into the non-relevant zones of their life. Applying this theory to HOLDEN would mean that to protect privacy we must ensure that data stays in realms relevant to the user and is not carried over to unapproved use cases. For example, it could be required that the technology can only store relevant data, keep data locally, delete data when it is not needed, and only be accessible and retrievable by relevant parties. Similarly, it could be required that the technology only record data to the resolution relevant for approved tasks.

If HOLDEN develops ubiquitous vision not only to store information, but to generate reactive or interactive environmental responses, it will be a form of Ambient Intelligence (AmI), where the environment is invisibly smart and interactive. AmI systems are formulated as increasing autonomy because they generate more ways to control or interact with the environment and may take cognitive load off the individual by the environment itself being smart. However, philosopher Philip Brey has pointed out that AmI can also lead to loss of control. Some forms of loss of control might be 1) the system misunderstanding what the user is trying to convey; 2) the system only having limited means of communication so the user has to transform their behavior to match that of the system; 3) where the interests of the system align more or equally with a 3rd party than the user itself; or 4) when the system is primarily a means of surveillance [20].

Technological Environmentality has been introduced as a term to connect smart environments to both Material Engagement Theory and Post-phenomenology. As demonstrated by Ciano Aydin, Margoth González Woge and Peter-Paul Verbeek, humans shape infrastructure and the infrastructures in turn shape humanity [21]. One can envision a school, office building, or road and how each elicit certain behaviours. Even “natural” infrastructure affects the individual – the view from the *trail* of a hike becomes the internal depiction of the natural environment, even though most would agree that the most authentic part of a forest would require bushwhacking to reach. The technological environment both mediates the world and, as it is ubiquitous and invisible, becomes the world. This makes the potential impact quite high as it is bound to reshape behaviour and experience. How the system is developed and the features it promotes will fundamentally shift the social implications of the technology. An initial feature overview is described in the following section.

2. Social Implications of Features

Given that there are already systems in place for monitoring individuals, anonymous or otherwise, this section will briefly consider what makes this technology unique. This feature list may grow or shrink over time but will continually be referred to in the pursuit of ethical design.

2.1. Ubiquitous Vision

The ability to see through barriers and in the dark makes it easier to remove blind spots. This technology may be theoretically implementable by either 1) setting up WIFI emitters with the hardware and software necessary to create holography, 2) adding in smart receivers to dense wireless zones, or 3) installing new units specifically for the purpose of holography. Option 1 would force people to become part of the system, because most people are dependent on WIFI, and, even if one is not carrying a WIFI receiving device, they would still be tracked. Option 2 would allow for some negotiation of when and where the receivers are placed. Perhaps it could be made visible when they are in use or not and only implemented for a specific purpose. Option 3 separates the WIFI for information sharing from the WIFI for holography, thereby avoiding function creep. Perhaps with Option 3 a different frequency could even be used to not disrupt the WIFI signal. If there was no longer a need for the monitoring, then the whole device could be removed. Of course, Option 3 forgoes the promise of double dipping on an already available resource, but it does allow for easier removal and is less of a Trojan Horse approach to the introduction of the technology.

2.2. AI and Gesture Recognition

Although currently it is energy and time intensive to generate pristine images from RF wave holography, with the help of machine learning, it is possible to “read” feedback from the waves to differentiate individuals, recognize individuals, and recognize gestures. A study has even combined energy usage data to ascertain what appliances people were using [22]. There is extensive literature on the social implications of AI, such as concerns for not knowing how algorithms make their decisions. This can lead to unrecognized bias. Will gesture recognition work for someone missing a limb or with Tourette’s Syndrome? Depending on how dependent and trusting society becomes of the system the social implications may be grave.

Just as facial recognition has led to the wrong people being arrested, including a heavily pregnant woman who could not have committed the crime [23], if this RF Holography is not as high fidelity as cameras and the raw data cannot be read by humans, then there should be discernment to what extent can the output of the algorithms be trusted. It might be helpful to legislate the extent to which data from the system can be used. Even without AI, mathematical approximations are *approximations*. If the technology is used for industrial robots working with humans, it is critical that workers not overly trust the robot by getting too close during potentially dangerous tasks.

2.3. Wirelessness

Wirelessness disentangles us from needing wired sensors and visible devices to measure things like sleep and location. Theoretically, with wirelessness, one could play a video game without a controller or turn lights on and off without a switch. This can be helpful where the wires or device get in the way of completing the task and/or the data is very important to collect. It is uncomfortable to sleep covered in wires and inefficient to work with a robot if you are always needing to use a joystick or press buttons to pause production. The downside is that it is plausible that one system will end up carrying the load of many tasks, and that the system will get more challenging to turn off the more duties it has to fulfil. A smart watch may be a bit clunky, but one can always remove it. A smart watch may feel obtrusive, but it is at least not all encompassing. As shared in the prior section, Ambient Intelligence has the potential to generate *and* undermine autonomy. Furthermore, if the system is reactive and ubiquitous it will reshape the way humans move in the spaces where the system is installed.

2.4. Connected IoT

Holography with dense wireless networks is a meta internet of things because it "sees" from the reflections of the cloud or information traveling via RF waves through space. Given the urge to connect more appliances to the cloud, it is curious the extent to which these increasingly dense WIFI networks will impact holographic vision. Conversely, it is also interesting the extent to which the information derived from the holographic systems too will be shared through RF waves and become itself an IoT device. The smart toilet could know that someone is likely walking to it and then start to warm up its smart seat. Determining how much is shared between devices, especially for a tool that can essentially be used for surveillance, is imperative.

2.5. Breathing and Heart Rate Monitoring

Research shows that it is possible to measure breath and heart rate using RF waves and to distinguish between various individuals' breath rates while sitting together [7]. This capability was then used for emotion recognition [4]. Theoretically, emotion recognition in combination with gesture recognition could help monitor mental and physical health, but the risks mentioned earlier in this and in previous sections, still apply. Would people trust the system more than themselves or their doctor? Who would have access to this information, and could it be used by third parties or as a mood ring gimmick in a smart home? There may be cultural biases. Furthermore, heart rate and breath rate are personal biological information that theoretically the company running the system would have access to in every instance where the technology is installed. Even if HOLDEN does not pursue development of systems to monitor breath and heart rate, the fact that it might be possible to ascertain this data using the same systems, systems which could be hacked, is essential to note. This shows the importance of cleaning and deleting data and being purposeful over what data is stored. This will not only help avoid preventable leaks but be better for the environment by not taking up extra server space.

3. Guidance Ethics Workshop

3.1. Methodology

To figure out possible use cases for holography with dense wireless networks, stakeholder values, and requirements for ethical design, the University of Twente (TWE) group of HOLDEN organized a Guidance Ethics workshop for HOLDEN members and external stakeholders. This one-day workshop was approved by the University of Twente Behavioural and Management Sciences Ethics Review Committee. The workshop consisted of an individual demographics survey, a layperson's talk, an initial response survey, a group survey on opportunities and risks, a group survey on stakeholder values, and finally a group survey on ethical design criteria. The workshop took place on 22 November 2023 and lasted from 10:00-17:00. In total, there were 18 participants, one lead researcher and three research assistants. All participants signed a consent form and were aware of the nature of the study before participating. The info sheet and consent form are included in the appendix.

Figure 1 – Guidance Ethics Approach

The workshop was designed to mirror the Guidance Ethics Approach (Figure 1). The layperson talk contextualized the technology itself. Next, groups were formed of similar stakeholders to think of use contexts for the technology in terms of opportunities and risks. Following, new groups were comprised of mixed stakeholders, where, for various use cases, groups had to consider the values of various actors and the effects those values might have in those use cases. Finally, new groups were tasked to rank contexts and design an ethical use case of the technology, keeping in mind regulations and hardware/software considerations. Each session had four groups with four to five members. At each group table a research assistant or lead researcher was available to take observational notes and clarify survey questions.

3.2. Initial Results

As this is the first of two reports on the social implications of HOLDEN, this section will serve as a quick overview of some initial findings from the first Guidance Ethics Workshop. The next report will go further in depth analysing the results.

3.2.1. Demographics

The workshop consisted of 18 participants, 14 male, 3 female, and 1 who preferred not to disclose their gender. 50% of the group was 26-35 years old, 28% 36-45 years old, 17% 46-55 years old, and 6% 18-25 years old. 12% had either a mental or physical disability. 89% of the group had a graduate or professional degree. 17% of participants were primary caregivers. The group was 61% White, 17% Asian, 6% Black, 6% Arab, with 11% preferring to not disclose racial and ethnic identity.

3.2.2. Initial Responses

After the layperson's talk, individuals had the opportunity to share their responses. Some initial feedback included that the technology could be helpful for safety, but also intrusive, as it could be used for surveillance and through walls. People pointed out that it could be used for a range of applications, some of which it might not be any more effective than pre-existing options. A couple individuals thought it was interesting that it might be possible to use the technology for more anonymous surveillance. 15 participants filled in a survey indicating the extent to which they agree to statements regarding the technology. The responses are shown in Figure 2.

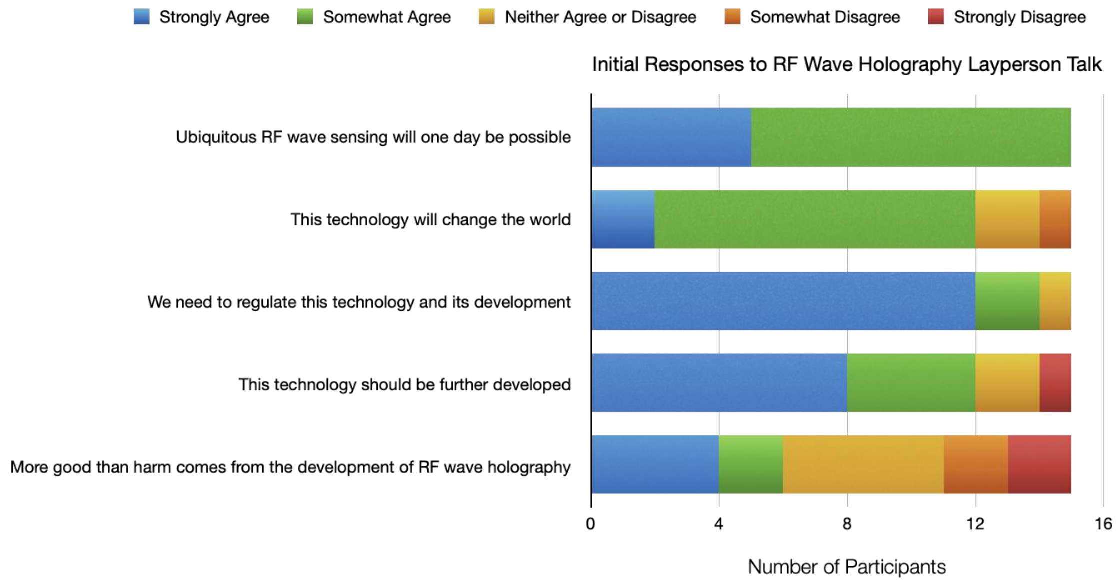

Figure 2 – Layperson Talk Initial Responses

3.2.3. Contexts

Several ideas for use were generated by working groups during the workshop. These opportunities were combined and abbreviated to allow for ranking. Each group was tasked with ranking the generated contexts. Table 1 shows these final opportunities in order by average ranking amongst groups. Groups chose their own criteria for ranking. Some reasons for ranking included "benefits for stakeholders, balance of public, science interest and business relevance," "added value of the tech, impact, potential to solve (existing or future) societal, long-term challenges like aging society," "short term feasibility, readiness, availability, who and how many people could possibly benefit, [and the] social impact of the technology acceptance rate." The final group went in a circle with everyone picking their top choices until none were left.

	Context Ranking 1-18				
Use Cases (Contexts)	**Group 1**	**Group 2**	**Group 3**	**Group 4**	**Average**
Automation (Heating Ventilation)	6	7	5	1	4,75
Built in Safety Measures for Working Environments	3	2	12	6	5,75
Ability to Live at Home Longer for those Aging or with Disabilities	1	5	11	8	6,25
Crowd Monitoring (Festivals, events)	5	8	9	4	6,5
Long-term Health Monitoring	2	4	13	9	7
Indoor Navigation	7	9	2	11	7
Behaviour Monitoring and Recognition	13	1	15	3	8
More advanced Smart Home Functionalities	9	10	8	7	8,5
Intrusion Detection	15	12	3	5	8,75
Facility Management and Monitoring	11	17	7	2	9,25
Gaming	17	6	4	12	9,75
Human Recognition for Robotics and AI	12	3	17	10	10,5
Embedded Art Systems	14	15	1	13	11
Baby Monitoring	8	16	6	15	11,25
Democratic Engagement through global gestures	4	14	10	17	11,25
Ubiquitous Surveillance for Law Enforcement	10	11	16	14	12,75
Ubiquitous Transparency (Like Body Cams for Police)	16	13	14	16	14,75

Table 1 – Opportunities for Use Ranked by Groups

3.2.4. Values

To determine what values stakeholders found important, the opportunities from stage one were grouped into similar wider contexts. Table 2 shows these findings with some rewording for clarity and simplification. Each group was given two contexts, for which they had to determine the values the context supported and undermined. Groups were able to define their own values and were not limited to a specific philosophical approach.

Context	Examples	Values Supported	Context Values Undermined
Monitoring Group (People)	Crowd Monitoring, Population Control, Surveillance for Law Enforcement, Student Counting on Campus, Behavioural Experiments	Efficiency, Control, Safety, Sustainability (resource management and energy consumption), Accessibility	Reinforce paranoia about government tracking and health impact on bodies and animals (wi-fi free communities), privacy, right of oblivion, control, undermines democracy (consent is not always asked), dehumanising and associate people to data points
Smart Environment	Indoor Navigation, Automation (Heating/Ventilation), Safety Measures for Working Environments, Home Care for Elderly and Ill, Optimising design of built	Healthcare, Personalization, Customization	Free market and access to benefits (privatization)

	environment, More advanced Smart Home Functionalities		
Entertainment	Gaming Embedded Art Systems	Enjoyment, Education, Health, Social Cohesion, Privacy, Diversity	Privacy, Democracy, sustainability (computational requirements), (social) Justice
Monitoring Non-People	Agriculture Health Building Maintenance Environment	Animal welfare (also: wildlife detection) / animal citizenship, (animal) health, safety, efficiency, sustainability, quality, transparency.	Autonomy of animals, privacy, justice
Health	Preventive Chiropractor	Self-Care, Freedom of Movement, Autonomy, Self-Sustainability	No Time to Finish
Monitoring Individual (People)	Behavioural Monitoring Intrusion Detection Military Monitoring Reveal Violence and domestic abuse Transparency (Police Body Cams) Baby Monitoring	Government: might like they get more information about the population, for example, criminal activity. Businesses: Being able to gain more data.	Privacy, Ethics, Trust, Data Validity, Autonomy, Human Dignity
Protection from the Technology	Regulate who can draw on the technology at what time (through access point) Democratic engagement in smart spaces through gestures (inclusive 'global' gestures - advantage for immigrants engaging without needing status) Gesture recognition to individually regulate the technology (and what it records)	Privacy, Fairness, Accountability, Security	Human progress (knowledge) Innovation in health care, Capitalism
Robotics/AI	Human recognition (smart cars/robots), Vehicle logistics	Reducing inequalities through job creation, Innovation for the benefit of humankind, improving quality of life, Profits, increase capabilities to meet other values.	Human interaction, Privacy, Accountability, Transparency, Fairness

Table 2 – Values of Contexts

3.2.5. Design

During the ethical design stage of the workshop, each group designed for their top ranked context. These were "Automation (Factory Automation, Industry)," "Behaviour Monitoring and Recognition," "Embedded Art Systems," and "Home Monitoring and Care for the Elderly and Chronically Ill." Top design requirements were visibility and informed consent as well as regulations to avoid function creep. At the end of this 75min session, only the groups designing for "Home Monitoring and Care for the Elderly and Chronically Ill" and Automation (Factory Automation, Industry)," thought their final designs were ethical. All groups except for the Embedded Art Systems group thought that if their regulations and design requirements were implemented their product should be brought to the real world. The Embedded Art Systems group was split 50-50 and chose to mark that their design should not be brought to market.

4. Conclusion

The University of Twente team plans to delve deeper into data analysis from the Guidance Ethics workshop in the following iteration of this report. For now, it can be shared that the initial workshop may give limited insights to the impact and interests of society *as a whole* given that most participants were highly educated white males and members of HOLDEN. Nonetheless, it presented the opportunity for internal discussion and invited external stakeholders to meet and discuss the technology and its opportunities and it is a first step in analysis.

Some themes repeatedly surfaced in this initial analysis. Holography with dense wireless networks is possible and has a wide range of use cases. Societal impacts will vary amongst stakeholders and between use cases. It is essential to have multiple stakeholders present in the design process to mitigate risk. There is a risk of this technology being applied widely for a multitude of use cases due to it relying on an already existing omnipresent infrastructure. The technology has the potential to both increase and reduce autonomy as well as alter the human condition by changing how our environment functions. Risks can be mitigated by designing for specific purposes and deleting all superfluous data. Finally, Informed consent is a baseline for ethical design.

Appendix A. Workshop Materials

A.1. Info Sheet

Information Sheet for HOLDEN Guidance Ethics Stakeholder Workshops

20/11/2023 - YOU ARE WELCOME TO KEEP THIS SHEET

Who are "We": We are members of the Philosophy of Science & Technology Section of the University of Twente. This research is conducted for HOLDEN: https://holden-project.eu/. HOLDEN is a research project funded by the European Innovation Council for the Ethical Design of Holography with Dense Wireless Networks.

Purpose of Research: The goal of this research is threefold. First, we want to determine contexts for the use of ubiquitous holography from wireless networks for a variety of stakeholders. Second, we want to understand the ethical concerns and opportunities for each use context. Finally, we want to discover technical constraints and regulations that can lead to ethical design of holography with dense wireless networks.

What We Collect: We collect general demographic data as well as observational notes of group interactions that will be anonymized. Additionally, we collect information from group forms and materials left after the workshop. Video will be recorded of the Layperson's Talk at the beginning of the workshop. Some photos will be taken to record the workshop.

What Happens to the Data: All data will initially be served in a password protected hard drive at the University of Twente. Once anonymized, the original data will be deleted, and the anonymized data will be stored on the shared EU based server of HOLDEN. Note that this anonymized data may be reused for future research purposes and thereby stored in other locations.

Benefits and Risks: Your involvement in the project can directly impact the ethical development of holography through dense wireless networks. There is a risk of your opinions being attributed back to you.

Withdrawal Procedure: If at any point you decide that you no longer want to contribute to this study, please let the lead researcher know and we will not collect or include any further data from you. However, your contributions prior to withdrawal will remain in the final dataset as it would be unfeasible to untangle them from the group responses.

Contact Information: S.I. Cammers-Goodwin, Email: s.i.cammers-goodwin@utwente.nl

Phone: [redacted]

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee of the Faculty of Behavioral, Management and Social Sciences at the University of Twente by ethicscommittee-bms@utwente.nl

A.2. Consent Form

Consent Form for HOLDEN Guidance Ethics Stakeholder Workshops

THIS IS A COPY OF THE DOCUMENT YOU SIGNED ON 22/11/23

Please tick the appropriate boxes	Yes	No
Taking part in the study		
I have read and understood the study information dated [20/11/2023], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	□	□
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason, but my responses up to the point of withdrawal <u>will</u> be included in the study.	□	□
I understand that taking part in the study involves working in different groups and recording findings in questionnaires. I am additionally aware that observational notes from the workshop will be recorded, and that demographic data will be collected.	□	□
Risks associated with participating in the study		
I understand that there is a possibility that my participation in the study may be revealed, and that people may try to associate findings with my contributions even though only anonymized data will be shared and used for research purposes.	□	□
Use of the information in the study		
I understand that information I provide will be used for reports, research papers, website, and media.	□	□
I understand that personal information collected about me that can identify me, such as [e.g., my name or where I live], will not be shared beyond the study team.	□	□
I agree that my contributions can be anonymously quoted in research outputs.	□	□
Audio/Video/Photo recording		
I agree to be audio/video/photo recorded.	□	□
Future use and reuse of the information by others		
I give permission for anonymized observational data and group forms that I contribute to be archived in an open repository so it can be used for future research and learning. This data may be used for all use cases by those who requested it.	□	□
I give the researchers permission to keep my contact information and to contact me for future research projects.	□	□

References

[1] G. A. Isted, “Guglielmo Marconi and the History of Radio - Part II,” *Gen. Electr. Co. Rev.*, vol. 7, no. 2, pp. 110–122, 1991, Accessed: Dec. 08, 2023. [Online]. Available: http://www.trevorwright.com/GEC/Journals/GEC_Review/v7n2/p110.pdf

[2] M. Zhao *et al.*, “Through-Wall Human Mesh Recovery Using Radio Signals,” in *2019 IEEE/CVF International Conference on Computer Vision (ICCV)*, Seoul, Korea (South): IEEE, Oct. 2019, pp. 10112–10121. doi: 10.1109/ICCV.2019.01021.

[3] T. Li, L. Fan, M. Zhao, Y. Liu, and D. Katabi, “Making the Invisible Visible: Action Recognition Through Walls and Occlusions,” in *2019 IEEE/CVF International Conference on Computer Vision (ICCV)*, Seoul, Korea (South): IEEE, Oct. 2019, pp. 872–881. doi: 10.1109/ICCV.2019.00096.

[4] M. Zhao, F. Adib, and D. Katabi, “Emotion recognition using wireless signals,” in *Proceedings of the 22nd Annual International Conference on Mobile Computing and Networking*, New York City New York: ACM, Oct. 2016, pp. 95–108. doi: 10.1145/2973750.2973762.

[5] S. Yue, Y. Yang, H. Wang, H. Rahul, and D. Katabi, “BodyCompass: Monitoring Sleep Posture with Wireless Signals,” *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.*, vol. 4, no. 2, pp. 1–25, Jun. 2020, doi: 10.1145/3397311.

[6] Y. Gu, X. Zhang, Z. Liu, and F. Ren, “WiFi-Based Real-Time Breathing and Heart Rate Monitoring during Sleep,” in *2019 IEEE Global Communications Conference (GLOBECOM)*, Waikoloa, HI, USA: IEEE, Dec. 2019, pp. 1–6. doi: 10.1109/GLOBECOM38437.2019.9014297.

[7] S. Yue, H. He, H. Wang, H. Rahul, and D. Katabi, “Extracting Multi-Person Respiration from Entangled RF Signals,” *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.*, vol. 2, no. 2, pp. 1–22, Jul. 2018, doi: 10.1145/3214289.

[8] L. Fan, T. Li, Y. Yuan, and D. Katabi, “In-Home Daily-Life Captioning Using Radio Signals”, [Online]. Available: http://rf-diary.csail.mit.edu/papers/rfdiary_eccv.pdf

[9] I. V. Vahia *et al.*, “Radio Signal Sensing and Signal Processing to Monitor Behavioral Symptoms in Dementia: A Case Study,” *Am. J. Geriatr. Psychiatry*, vol. 28, no. 8, pp. 820–825, Aug. 2020, doi: 10.1016/j.jagp.2020.02.012.

[10] L. Fan, T. Li, R. Fang, R. Hristov, Y. Yuan, and D. Katabi, “Learning Longterm Representations for Person Re-Identification Using Radio Signals,” in *2020 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, Seattle, WA, USA: IEEE, Jun. 2020, pp. 10696–10706. doi: 10.1109/CVPR42600.2020.01071.

[11] J. Hopster, “What are socially disruptive technologies?,” *Technol. Soc.*, vol. 67, p. 101750, Nov. 2021, doi: 10.1016/j.techsoc.2021.101750.

[12] R. Owen, D. Baxter, T. Maynard, and M. Depledge, “Beyond Regulation: Risk Pricing and Responsible Innovation,” *Environ. Sci. Technol.*, vol. 43, no. 18, pp. 6902–6906, Sep. 2009, doi: 10.1021/es803332u.

[13] P.-P. Verbeek, “Toward a Theory of Technological Mediation: A Program for Postphenomenological Research,” in *Technoscience and postphenomenology: the Manhattan papers*, J. K. B. O. Friis and R. P. Crease, Eds., in Postphenomenology and the philosophy of technology. , London: Lexington Books, 2015, pp. 189–204.

[14] P.-P. Verbeek and D. Tijink, “Guidance Ethics Approach: An Ethical Dialogue about Technology with Perspectives on Actions.” ECP Platform voor de InformatieSamenleving, 2020. Accessed: Oct. 12, 2023. [Online]. Available: https://ecp.nl/wp-content/uploads/2020/11/Guidance-ethics-approach.pdf

[15] D. Jolley and J. L. Paterson, “Pylons ablaze: Examining the role of 5G COVID-19 conspiracy beliefs and support for violence,” *Br. J. Soc. Psychol.*, vol. 59, no. 3, pp. 628–640, Jul. 2020, doi: 10.1111/bjso.12394.

[16] F. De Vocht and P. Albers, “The population health effects from 5G: Controlling the narrative,” *Front. Public Health*, vol. 10, p. 1082031, Dec. 2022, doi: 10.3389/fpubh.2022.1082031.

[17] “Apple iPhone 12: Validation of Apple’s update proposal after SAR limit was exceeded,” Agence Nationale Des Fréquences. [Online]. Available: https://www.anfr.fr/liste-actualites/actualite/apple-iphone-12-validation-of-apples-update-proposal-after-sar-limit-was-exceeded

[18] C. L. Russell, “5 G wireless telecommunications expansion: Public health and environmental implications,” *Environ. Res.*, vol. 165, pp. 484–495, Aug. 2018, doi: 10.1016/j.envres.2018.01.016.
[19] H. Nissenbaum, “Privacy as contextual integrity,” *Wash. Law Rev.*, vol. 79, pp. 119–157, Feb. 2004.
[20] P. Brey, “Freedom and Privacy in Ambient Intelligence,” *Ethics Inf. Technol.*, vol. 7, no. 3, pp. 157–166, Sep. 2005, doi: 10.1007/s10676-006-0005-3.
[21] C. Aydin, M. González Woge, and P.-P. Verbeek, “Technological Environmentality: Conceptualizing Technology as a Mediating Milieu,” *Philos. Technol.*, vol. 32, no. 2, pp. 321–338, Jun. 2019, doi: 10.1007/s13347-018-0309-3.
[22] C.-Y. Hsu, A. Zeitoun, G.-H. Lee, D. Katabi, and T. Jaakkola, “SELF-SUPERVISED LEARNING OF APPLIANCE USAGE,” 2020.
[23] H. Kashmir, “Eight Months Pregnant and Arrested After False Facial Recognition Match,” *New York Times*, Aug. 06, 2023. [Online]. Available: https://www.nytimes.com/2023/08/06/business/facial-recognition-false-arrest.html