



D3.4 Privacy and Ethical Constraints in Static Environments

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Executive Summary

In this HOLDEN (Ethical Holography of Dense Wireless Networks) report, we investigate privacy implications & societal impacts of RF sensing in static environments to develop recommendations and specifications for design, implementation and use.

We build on privacy, human-technology relations, and responsible design (WP2) and investigate physical layer design opportunities. Via mediation analysis and scenario development, we also investigate potential implications for users and society, to take these into account in design, implementation, and use.

The report begins with an overview on Innovation I – Static Holography with RF waves, including how they differ from cameras, what can be modified about the system and what application will be pursued within HOLDEN.

Next, we review and expand upon the philosophical concerns and findings so far during HOLDEN (D2.2 and D8.9) with specific regard to Static RF Holography.

Following, we introduce the role of Value Sensitive Design (VSD) within the project along with some challenges of the VSD approach.

Afterwards, we go into further detail on the features that might shift the ethical and privacy outcome of the technology.

Finally, we apply our findings to introduce preliminary design requirements for Human/Object Detection in restricted areas.

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1. Introduction

1.1. Overview

The European Union based HOLDEN (Ethical Holography of Dense Wireless Networks) Project is divided between three technical radio frequency innovations. This report details the first, static imaging using passive, ambient waves. This innovation is under development by the HOLDEN team at Technical University Munich. Passive static radio frequency (RF) sensing can be compared to black and white photography. Ambient radio frequency electromagnetic waves ranging approximately between 1-100GHz (as opposed to the visual light spectrum ranging from 400 THz to 700THz) function as the light source while receivers capture RF light. To make images it is common to employ back projection algorithms, or with enhanced performance, to do linearized inverse source solving. This function solves for equivalent sources from where the waves detected by the receivers originate. Such information combined with the strength of the light allows for differentiation in imagery. Just as one might see a paper due to the shine of a desk lamp in a dark room, receivers can detect a conductive body due to its shine from nearby routers. This technology uses algorithms to unravel the scene based on the information gathered by receivers – it does not need or use artificial intelligence to interpret the environment.

1.2. Uniqueness

If the technology is just trying to capture images like a camera, why not just use a camera?

There are several key differences between this technology and cameras. RF waves operate differently than electromagnetic waves in the visible light spectrum. They travel further and are virtually undetectable to humans, meaning that they operate the same in light, dark, and hazy environments. They also can penetrate through surfaces normally blocked by visible light, such as walls and allow for 3D imagery. Finally, they pick up on different characteristics than objects revealed by the visible light spectrum. Color, in the spectrum that humans interpret, is irrelevant in the radio frequency spectrum – the molecular composition of varying surfaces may reflect different frequencies of the RF spectrum which diverge from those in the visible light range. Conductivity is much more apparent in the RF range, meaning conductive bodies shine brighter than absorbent and dampening objects.

Currently it is impossible to generate crystal-clear high-resolution imagery comparable to cameras using static RF imaging. Furthermore, the process is time consuming, requiring additional time for increased image clarity. **Figure 1** shows an image taken by static RF sensing next to a camera image. Key details are missing. It is hard for a human to visually determine anything from such an image, but when multiple images are linked together it is possible to register a change in the scene. This image took 17.4 hours to generate. (However, it should be noted that it may be more efficient to focus the system on certain areas of interest.) Static RF holography might be more privacy preserving than cameras while working in settings unfeasible for standard cameras (in the dark and through certain obstacles). These features could also be used in combination with cameras to reduce blind spots.

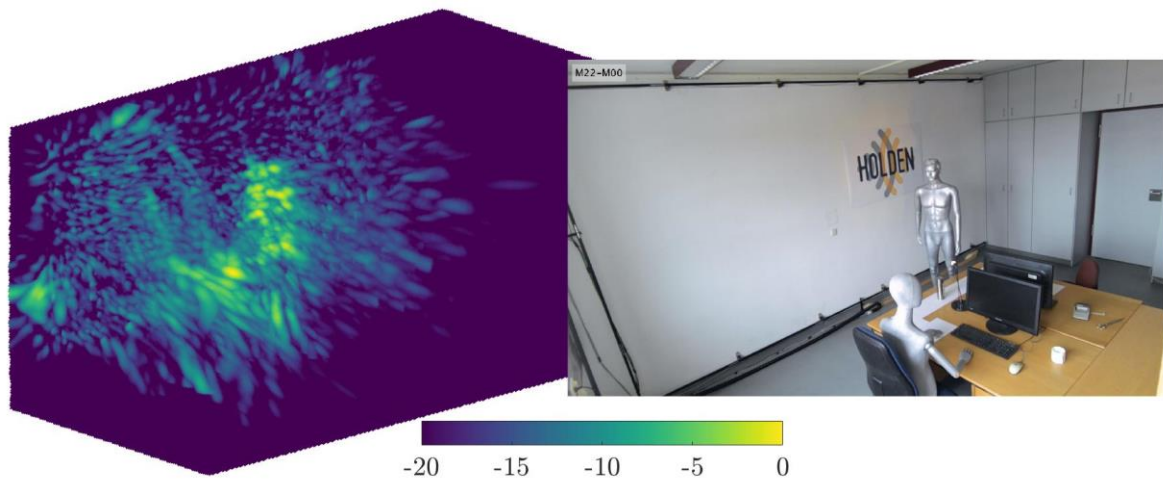


Figure 1. Office Setting Mannequins with Static RF Image and Photo

Theoretically, it could be possible to build a wallpaper of receivers combined with hardware such as the 30cm x 30cm receiver array from Starlink and take higher resolution images in real time. Thus, it is important to distinguish between the current and future capabilities of static systems. With regards to mitigation measures, we may further distinguish between opportunities for re-designing the system during the run time of the project and the further advancements of the technology after the project ends. Two scenarios are conceivable: Either static systems will become more like the other two HOLDEN innovations in terms of speed and the information that can be derived, which would imply that we can learn from the other innovations, or advanced static systems will show distinct properties, which will require special attention.

1.3. Implementation Options

There are several design considerations that should be contemplated to achieve preferable social and ethical outcomes. One consideration is that the technology could be stationary, installed in one location and optimized for that environment, or used to image in various environments that may have differing RF wave density by being portable or affixed to a drone. Additionally, the positioning of the system (ex: whether the images are generated from the side or above) could affect what can be understood even though RF imaging can be used to make more 3D type images. The system could have limits on the scope of its vision (can it see through walls), the clarity of information it captures (should it be detailed enough to distinguish identifiable features), and how it displays information (what do different colors represent and how is likely accuracy represented). It is also possible to shape the environment to enhance the usage of the technology such as adding RF-IDs to objects or users that may be helpful to track or putting special materials within walls to better perform a through wall structural analysis. Furthermore, there are regulatory considerations that could be used to restrict or enhance the scope of such technology.

1.4. Application for People/Object Detection in Restricted Areas

As part of Task 6.1, ADANT with the help of other project partners chose an application for static RF holography. Within the scope of HOLDEN, we will begin to focus on human and object detection in restricted areas. This report details a wider scope of possibilities than this specific context as it was

not clear what the final application would be when conducting research for this report. However, the recommendations section of the report focuses on the application.

The following description of the application is summarized from D6.1. A more extensive overview of the application including the functional requirements and ethical profile can be found there as well.

“People/Object Detection in Restricted Areas” could surpass CCTV because it can work through various obstructions and in the dark. It is also more sensitive than motion detectors for capturing slow moving entities and will not be prone to certain environmental false positives such as temperature fluctuations. Moreover, it can be integrated into pre-existing technologies. Possible use case environments could include restricted areas in airports and museums.

2. Ethical Considerations from HOLDEN

Technical University of Munich's work on static imagery without the use of AI is quite novel, as AI is now being pushed as the primary methodology to make sense of big data. Nonetheless, scientists have been working on radio-frequency vision with and without AI for over a decade. Where HOLDEN is entirely unique is the project's approach and dedication to ethics being at the forefront of each innovation. In D2.2, Social Implications and Preconditions of Responsible Design, HOLDEN's team at University of Twente considered possible social implications and ethical approaches for each HOLDEN innovation. Here we will briefly review the ones relevant to Innovation I – static imaging.

2.1. A Holistic Approach

Throughout the HOLDEN project, Twente has been working on a methodology to ensure ethical use across the three innovations (**Figure 2**).

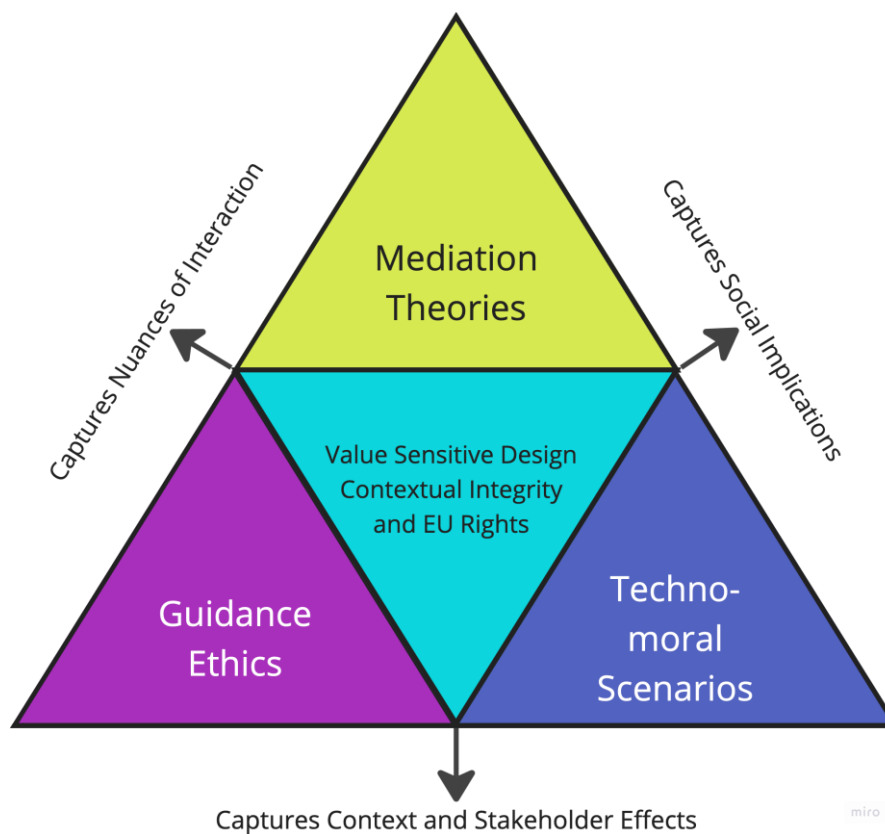


Figure 2: Current Approach to Addressing Ethical and Social Implications of RF Sensing

The development of this approach can be seen across D2.1, D2.2, D8.7, and D8.9. Our approach covers the inherent experiential influence of the technology (mediation theories), how the technology might reshape norms and values (techno-moral scenarios), how to design the technology based on stakeholder needs and interests (guidance ethics), guiding principles to follow (such as contextual integrity, EU charter of fundamental rights), and value sensitive design to translate the learnings from each domain into design requirements.

Ongoing ethical considerations for all HOLDEN innovations are captured in D8.9 (The Ethics Status Monitor).

2.2. Mediation Theories

Technical Mediation Theory [1], Technological Environmental Theory (TET) [2], and Technological Gaze Theory (TGT) [3] anticipate and enable the responsible societal integration of ethically compliant RF sensing. This technology has the potential to reshape *lived experience* in space depending on the individuals understanding (or misunderstanding) of the technology and its capabilities. Depending on what it does, it can reshape how we think of the world or even think of ourselves. For example, what a “good” building is might be reshaped to reflect a new metric only possible with through-wall vision capabilities. Furthermore, the technology sees in a way impossible through human biology. What the technology then sees becomes a new way of interpreting the world beyond what is possible in our biological scope. In Task 2.2 we will study the appropriation of the technology in further depth.

2.3. Guidance Ethics

In our Guidance Ethics [4] workshop in 2023 participants were most concerned about RF technology reducing autonomy, privacy, justice, and human dignity. People also saw opportunities for the technology to *enhance* autonomy. When well implemented the technology may expand human capability, thus allowing one to do more with less time, increasing efficiency. It may grant a sort of freedom by mechanizing a specific task. Participants also thought that the technology would enhance safety. That could only work if bad actors know the system is in place and thus refrain from malicious behavior. Perhaps if the system stored biometric identifiers, it could increase justice by helping to identify perpetrators. This level of information might require more data that would reduce the privacy preserving benefits of the technology.

2.4. Techno-moral Scenarios

Once the technology is introduced to the public it will have the potential to reshape ethical norms and values. Surveillance could become more normalized. Or, if this technology could reduce the personal data collected by traditional surveillance means while still preserving safety, then the technology could set a new norm whereby traditional cameras are seen as outdated. How the technology is designed may shift social ethical norms and expectations.

By creating scenarios and considering what supporters and dissenters may think it is possible to approximate the moral shift that may occur. This can be achieved through techno-moral scenarios (TMS) [5]. On 10 September 2024 we held a short TMS workshop at the EEFTA conference in Padua, Italy that received ethics approval from the University of Twente. In the workshop we described a fictive technology generated by Corporation LLC called PortaVision: *the “ethical” drone that sees through walls and maps out infrastructure*. This technology uses passive radio frequency vision, does not capture faces, erases data that is unlikely to be non-infrastructure, and has a semi open operating system due to the right to repair. The two scenarios below were presented.

Scenario 1: *An Authoritarian government decides to use this technology to create a digital twin of Authoritania. The drones become the new metric for infrastructural safety. Building standards change to optimize for the technology. Government drones become normalized in public space and outside of homes. If someone protests the screening, they are considered a suspect, and their homes and businesses are searched by human agents. The city adds RF waves to poor neighborhoods to*

illuminate the system without giving usable WiFi. Those suspicious of the government try to block the drone from seeing into the home by covering their walls. Given that the drones and software can be manipulated, people do not trust that the system is only monitoring infrastructure. The government double downs that the goal of the program is to keep everyone safe.

Scenario 2: *Global Good NGO wants to help uplift slum dwellers in the Global South. To achieve their mission, they decide that they first need to map the slums. This would help understand living conditions and the population size of the slums. Global Good relies on local governments to set up communication with the population living in the slums then sends drones through the communities. There is very unstable WIFI in the rural communities so Global Good outfits the drones with RF emitters, turning the drones into pseudo active systems. PortaVision was not trained on slum infrastructure, so it is harder to distinguish rooms from houses and the building materials vary greatly across various global slum dwelling communities. The data becomes the "truth" despite potentials for inaccuracy. The data is owned by Global Good NGO without any community members ever seeing it or giving explicit permission for the data to be captured. Global Good NGO and the local governments are relieved that they no longer need to send people into communities to conduct state of living censuses.*

For Scenario 1 eight out of ten people shared “I hope this never happens.” The other two were divided between being excited for the use case and feeling neutral about it. Contrarily, for Scenario 2 four out of ten people shared that “I hope this never happens,” three were excited for the technology and three were neutral. Although both systems involved a force trying to datafy private dwellings without explicit permission from the occupants under the guise of safety, people found the use case in the Global South more appealing. This demonstrates the moral norm that it is okay to break privacy standards to “do good” for an underserved population.

For Scenario 1 individuals found tension between safety and privacy – that advocates would say it benefits the safety of the commonwealth and dissenters would argue that it lowers individual (and group) privacy. For Scenario 2 individuals thought that using this technology to map the slums could directly help the poor and improve quality of life while creating less work for on the ground aid workers and volunteers. They believed that dissenters would complain about data accuracy, privacy, lack of autonomy of the community to decide for themselves if they want the technology. One participant pointed out the merely introducing technology would not improve living conditions.

While the workshop was too small to show conclusive results, it demonstrates that individuals can have vastly different opinions of the *same* technology when applied in differing contexts. In the case of object/people detection in restricted areas, there is already a norm of surveillance in restricted areas. Adding an extra sensor in already restricted locations likely will not cause much social uproar. As the technology develops, people might want to repurpose the system for other means such as surveilling non-restricted areas. The privacy preserving nature of the technology might make people feel more comfortable installing the technology instead of or in addition to cameras to tell when an individual is out of a cameras line of sight.

2.5. Additional Core Concerns

There are a few additional concerns central to the pyramid and research conducted earlier in the project as seen in D2.1, D2.2, D8.7, and D8.9.

Function creep, where a technology becomes repurposed for an entirely different function, is inherent with ambient RF imaging. RF waves in use for telecommunications such as 4G, 5G, and WIFI will be repurposed as light sources to take environmental snapshots in the dark and through walls. People might love having quick internet access but not have agreed to the infrastructure if they knew that it would eventually be used for semi ubiquitous sensing. Moreover, social and class discrepancies in RF wave density mean that some areas, likely those that are poorer, will have a less reliable infrastructure for static imagery. If the tool becomes something needed and useful then the social disparity will increase. If the tool becomes a form of surveillance, lower income communities might suddenly find increased RF waves in their neighborhoods and homes for surveillance purposes that they might not even be able to afford or use.

The next concerns address **access and ownership**: who the images are for and how are they shared. What gives someone the right to place a RF camera in a space? Do they have to own the room? Does it depend on who or what is in the space? If the devices are very expensive then only a small subset of society will be able to afford to use and install such systems. This means that organizations like the government, corporations, and wealthy individuals will be installing the technology. Is the image just shared with those who own the device, does the company making the images have access, or do those who the technology monitors get to access the readings? In the case of restricted area surveillance it seems that the right to record would be the same as the rules for video surveillance, for which there are already established EU guidelines [6].

Helen Nissenbaum's orientation of privacy through **contextual integrity** might be a useful way to determine rules of access and ownership [7]. Contextual integrity recognizes that privacy is not a one-size-fits-all approach across different domains. Instead, people wish for sensitive information to be readily accessible in the domains they see fit and unreachable in others. This is easy to recognize when one considers that they would like their doctor to have access to their medical records while not granting such information to their employers. In the context of static imaging, it will be essential to determine what the technology is for and whether those being surveilled accept that goal. If so, the imagery should only be shared to those needed to achieve the goal and not shared so wide as to undermine the integrity of the data. Data retained should be relevant to the purpose of the system to protect the autonomy of those who may work in such areas. For example, if data is collected to make sure art in a vault is not stolen, there is no need save information on janitorial staff dancing in the hallway.

There is also a concern of **accountability** that the technology is misinterpreted or overinterpreted. There is a double-edged sword to blurriness, where it may tell information without revealing details, but spotty information can be misjudged. Furthermore, even algorithms can make mistakes or leave out details of an image. In the future there is also the likelihood of continued advancement in speed and clarity. It is important to determine what different levels of resolution can and cannot be used for. Even though this technology does not use machine learning, the output could still be siphoned into AI systems. This means that the output of the imagery could be trained on camera data and then used to guess what a human legible picture of the RF snapshot looks like. Such secondary uses might be subject to the EU AI Act.

Finally, sustainability is a concern. Many technologies have a violent cycle starting from metals mined by low paid laborers, to planned obsolescence, to an end where at best they are recycled and at worst are discarded, leaching toxic chemicals into the earth. This is not including the energy consumed during the peak of their lifecycle. It is important to build in strategies to repair and upkeep technology and make sure that RF holography is not a less sustainable solution than comparable alternatives.

3. Translating Ethics to Design

Values Sensitive Design (VSD) was first introduced as a method in the field of Human-Computer Interaction and has been developed by Bataya Friedman and her colleagues since the late 1980-ties [8]. Since the early 2000s, VSD has grown into a family of related approaches, which have in common a non-instrumental understanding of technologies, which assumes that users realize (moral) values by using technologies and the design of these technologies has an influence on how and if a particular value can be realized. A prominent variation of VSD is, for example, privacy-by-design which focuses on the value of privacy and how information technologies can be designed to minimize the negative impact on privacy when using the technology [9]. In the European context the idea of “data protection by design” has been implemented in the “General Data Protection Regulation” (Regulation (EU) 2016/679) while the idea of “Ethics by Design” has been highlighted in the recent statement of the European Group on Ethics in Science and New Technologies (EGE) [10].

As demonstrated in Deliverable D2.2, we need to extend the scope of our inquiry beyond the narrow scope of privacy and, therefore, we will apply a general VSD framework, which will also allow us to address other moral and societal values. We can build on work undertaken by M. Nagenborg in the context of mm/THz-detection systems [11] and use the “Design for Values” framework as a starting point [12].

Our key question in this report is: What are the significant features of the technology developed in WP3 where we can consider morally relevant design alternatives? These are expanded on in the following section.

3.1. Critical Reflections on VSD

In preparing this report, we also addressed some of the shortcomings of VSD. We would like to highlight three challenges for applying VSD in the HOLDEN project.

1. VSD is a rather resource-intensive methodology. [13], [14]
2. VSD is easier to apply to some technologies than for others. We should recognize this bias. [15]
3. VSD takes design requirements as a starting point. Therefore, it is not meant to raise the question whether there should be a technological solution to a problem at all. It is also not a tool, which allows us to ask what is a problem. [14]

We respond to these three lines of criticisms as follows:

1. As stated in section 2.1, VSD is only one element in our holistic approach, and we primarily interested in ideas of how to translate values into design requirements. Therefore, we do not claim to apply VSD throughout the research project and for all potential cases. We rather use VSD as a theoretical lens to pay attention to the differences which could potentially benefit the ethical outcome of the technology.
2. We are aware of the potential bias caused by VSD, especially when it comes to balancing security/safety and privacy. Therefore, we avoid focusing solely on privacy and aim for a holistic approach.
3. We are aware of the limitation of VSD and will clearly state, which questions and challenges lie outside the VSD methodology.

4. Technical Considerations and Effects

To apply VSD it is necessary to identify morally relevant design alternatives.[11] At the current stage, we consider the following alternatives shared in the introduction as relevant. This section goes into more detail and connects the design alternatives to ethical considerations.

4.1. RF Wave Density and Type

Innovation I is a passive system, which means it uses the existing radio frequency waves without adding emitters. If there are no waves, there is no “light” to see objects. This means that the technology will work better in locations with more access to telecommunication technology. Areas that are more off the grid might be unable to utilize such a tool. This could exacerbate class divides beyond cost – generally, lower-income neighborhoods have less reliable access to network technology. Globally there is a division as well in terms of connectivity. On the other side, having access to information infrastructures such as WiFi networks also makes it more likely that people and objects will become visible to the passive system. In this respect, poor communities may enjoy more privacy.

Receivers also have differing electromagnetic frequency ranges within which they work. 5G offers a broader bandwidth. Perhaps focusing on higher frequency waves introduced by 5G might offer more precise images but may not work as well through walls.

Regarding the responsible design of Innovation I, we need to recognize that the functioning of passive systems largely depends on the infrastructure available in the area of operation. In addition, additional emitters could be added to the environment, which may influence the system's technical capabilities.

From the perspective of VSD, the dependency on external factors is good news in cases where we have sufficient information about and control the environment to find a fitting solution. At the same time, there is little hope that we can find a solution that fits all contexts, which becomes problematic for mobile solutions or environments that are not entirely under our control (as we have seen in the discussion of the Techno-Moral-Scenarios). The potential to repurpose existing artifacts (such as the Starlink array) already points to the challenge of ensuring that Innovation I is exclusively used for the intended purposes.

That is not to say, that there is no good use for mobile and portable solutions, since such a system can be used to compare different infrastructures for example or be rented for a specific functionality. In this respect, portable systems are more accessible, yet it remains harder to limit their technological capabilities.

4.2. Location and Positioning

In contrast to mobile solutions, stationary systems or solutions integrated into the built environment provide us with better opportunities to design context-specific solutions. For example, locating the sensors overhead on a ceiling might make it easier to do head counting without obstructions or to track non-stacked objects. In contrast, sensory walls capture information on a different plane and might reveal scenes more typical of a human. Built-in and stationary sensor systems could also be

optimized based on where the RF “light” is coming from, which also provides us with opportunities to determine the level of detail captured by the system in a specific area.

The potential of integrating passive systems into walls also raises questions about the visibility and, thus, the contestability of a particular system. For example, body scanners at the airport (and similar portal solutions) may raise privacy concerns, but at least they are clearly recognizable artifacts that the users can question. On the other hand, fully integrated and hidden systems will require a much more vigorous ethical justification.

4.3. Penetration Capacity

Multiple technical parameters, such as the bandwidth, the energy (e.g., from additional emitters), and the number and kinds of sensors being used, determine how far a static system can 'see.' These parameters could be used to ensure that only specified spaces are under surveillance.

These parameters can also be used to limit the technology from seeing through walls - or to determine the number of walls that will be penetrated, which is helpful to address concerns about privacy and consent concerns as well as give users more autonomy if they are given the option to fine-tune the penetration capacity themselves.

4.4. Visualization

While it is tempting to think of Innovation I as something like a camera, it's also important to understand that not all applications will result in human-readable images. The technology itself is more concerned with analyzing the three-dimensional sensor data, and, in some contexts, there might be no need to visualize the data. Yet, it is essential to recognize that there are multiple ways to visualize the data: the visualization can be two or three-dimensional, and we could use colors, including indicators, for the certainty of the data. The system could highlight changes or produce a complete image of the space under surveillance.

While it is too early to give specific recommendations, it is essential to recognize that each visualization will have a different impact on how users interpret the visualization.

4.5. Passive Tags

Finally, we would like to mention passive tags, which have been explored as an option to identify points, objects, and people of interest. They could be an alternative for contexts where people and items can be provided with tags, which are relatively easy to detect with RF technologies. These could give users more control over specifying what the technology is targeting - or, in other scenarios, may at least allow users to recognize and question the system.

However, one could also be tagged against their will or given someone else's tag. Given that the system is supposed to be more privacy-preserving than typical cameras, there appear to be multiple layers where tags could be misused. Tags should not be a solution to high-risk scenarios as they are controlled externally by the system, but they affect what is deemed to be true within the system.

5. Example Design and Implementation

During the development of this report, the final application for Innovation I Static Holography was chosen and detailed in D6.1. This application is People/Object Detection in Restricted Areas. This report concludes with preliminary design requirements based on the technical considerations of static holography technology.

First, we need to acknowledge that VSD is not helpful to determine if there is a valid claim to restrict access to a specific area. Rather, we must assume a legitimate use case such as airport security, while being aware that the same technology can be used by criminals to, e.g., secure their drug business. In this respect, security technology is a neutral instrument, because the “bad guys” may use the very same technologies as the “good guys.” [16]

Assuming a legitimate use case, our discussion so far suggests a **stationary solution**, which allows a more tailor-made approach, but also **minimizes the risk of unintended use and function creep**.

We further may assume that the extend of the restricted area is known and can be clearly communicated, since this would enable us to inform users about the site of surveillance and the kind of information collected, thus, **enhancing their autonomy** in decision-making. Such a design would also support informed consent procedures.

If the environment is known and the emissions of electro-magnetic waves can be controlled, ideally the systems can be calibrated in such a way that only the restricted area is monitored. This includes that the owner or operator of the build infrastructure needs to be aware that adding new emitters (e.g., adding another WiFi router) will influence the technological capabilities of the detection system. Through such measures we can **protect the privacy of people outside the restricted area**.

Depending on the specific use case, placing the antennas on the ceiling might be a preferred option (e.g., if the design requirement is to detect the presence of individual persons in a dedicated area), which would be in line with the **principle of data minimization** and, thus, again in line with **protecting privacy while promoting security and safety**.

Finally, we need to decide if a visualization of the data is needed or if a different form of output (for example, an acoustic alarm) would be more suitable. Here, we also must consider questions of **accountability**. Users should be able to predict how well the technology will work for their given environment. Moreover, there should be a way to assess if the system has stopped working properly. Thus, we need to decide if visualizations could be helpful to make the system **verifiable** and **transparent**.

There are certainly more aspects which require our attention when working towards the final application, including questions of data storage, energy consumption and sustainability (e.g., reparability). Further research will also include the incorporation of existing guidelines, such as EDPS Video Surveillance Guidelines [6]. However, the preliminary design considerations demonstrate that the application of the VSD methodology is helpful to identify and choose the most fitting alternative design options.

References

- [1] 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.
- [2] 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.
- [3] R. S. Lewis, "Technological Gaze," in *Perception and the inhuman gaze: perspectives from philosophy, phenomenology, and the sciences*, 1st ed., A. Daly, F. Cummins, J. Jardine, and D. Moran, Eds., in Routledge studies in contemporary philosophy. , New York, NY: Routledge, 2020.
- [4] P.-P. Verbeek and D. Tijnk, "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>
- [5] T. Swierstra, D. Stemerding, and M. Boenink, "Exploring Techno-Moral Change: The Case of the ObesityPill," in *Evaluating New Technologies: Methodological Problems for the Ethical Assessment of Technology Developments.*, vol. 3, P. Sollie and M. Düwell, Eds., in The International Library of Ethics, Law and Technology, vol. 3. , Dordrecht: Springer Netherlands, 2009. doi: 10.1007/978-90-481-2229-5.
- [6] European Data Protection Supervisor, "THE EDPS VIDEO-SURVEILLANCE GUIDELINES," Brussels, Mar. 2010. [Online]. Available: https://www.edps.europa.eu/data-protection/our-work/publications/guidelines/video-surveillance_en
- [7] H. Nissenbaum, "Privacy as contextual integrity," *Wash. Law Rev.*, vol. 79, pp. 119–157, Feb. 2004.
- [8] B. Friedman and D. G. Hendry, *Value Sensitive Design: Shaping Technology with Moral Imagination*. The MIT Press, 2019. doi: 10.7551/mitpress/7585.001.0001.
- [9] P. Hustinx, "Privacy by design: delivering the promises," *Identity Inf. Soc.*, vol. 3, no. 2, pp. 253–255, Aug. 2010, doi: 10.1007/s12394-010-0061-z.
- [10] European Commission. Directorate General for Research and Innovation., *Values for the future: the role of ethics in European and global governance*. LU: Publications Office of the European Union, 2021. Accessed: Nov. 23, 2024. [Online]. Available: <https://data.europa.eu/doi/10.2777/595827>
- [11] M. Nagenborg, "Ethik als Partnerin in der Technikgestaltung," in *Sicherheitsethik*, R. Ammicht Quinn, Ed., Wiesbaden: Springer Fachmedien Wiesbaden, 2014, pp. 241–252. doi: 10.1007/978-3-658-03203-6_16.
- [12] J. Van Den Hoven, P. E. Vermaas, and I. Van De Poel, Eds., *Handbook of Ethics, Values, and Technological Design: Sources, Theory, Values and Application Domains*. Dordrecht: Springer Netherlands, 2021. doi: 10.1007/978-94-007-6994-6.
- [13] S. Lehtinen, D. O.-Leerkes, and M. H. Nagenborg, "The Right to participate: Beyond the instrumental use of stakeholders in imagining the lived experience of the city," presented at the Reinventing the City Conference, 2024. Accessed: Nov. 25, 2024. [Online]. Available: <https://research.utwente.nl/en/publications/the-right-to-participate-beyond-the-instrumental-use-of-stakehold>
- [14] D. Ozkaramanli and M. Nagenborg, "Moral Engagement in Design: Five Considerations for Unpacking the Ethical Dimensions of Design Methods," *Des. Issues*, vol. 40, no. 3, pp. 37–48, Jul. 2024, doi: 10.1162/desi_a_00774.
- [15] M. H. Nagenborg, "My privacy is your noise: Notes on a bias within Value-Sensitive Design," presented at the 10th Biennial Surveillance Studies Network / Surveillance & Society Conference,

SSN 2024: Surveillance in an age of crisis, 2024. Accessed: Nov. 25, 2024. [Online]. Available: <https://research.utwente.nl/en/publications/my-privacy-is-your-noise-notes-on-a-bias-within-value-sensitive-d>

- [16]M. Nagenborg, "Security, concept and history," in *Ethics, Science, Technology and Engineering: A Global Resource*, Macmillan Reference USA, 2014, pp. 116–118. Accessed: Nov. 26, 2024. [Online]. Available: <https://research.utwente.nl/en/publications/security-concept-and-history>