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Possible Development Paths of Tactile Internet:
Ethical Perspectives

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1. Aim of the basic research in Technology Assessment

In this article, we will reflect on the methodologies of ethical technology assessment (TA cf. Grunwald 2010), accompanying research projects focusing on tactile internet solutions with humans in the loop (TaHIL). We outline how TA might be oriented towards a set of prima facie values (Beauchamp & Childress, 2013) that address possible implications and consequences of technology use. This framework shall be applied to the development of tactile Internet technology treating such technology as a special kind of cyber-physical system. Because the impact of technical developments and their unintended consequences cannot be anticipated from the outset, it is all the more important to address ethically relevant aspects right from the start in research projects that develop TaHIL-applications.

2. TA as an integrative part of the iterative research approach

A framework for Technology assessment has a supportive and yet necessary function for scientific practice. It is common sense that reason and evidence are the most basic condition for the work of Scientists and that the exchange of arguments are the most important element for scientific progresses (Grunwald, 2019a; Fontrodona, 2013), which needs to adress ethical, legal and social aspects of developments (Boden et al., 2018).

So instead of giving limitations through ethics, the desire for the construction of a more just, more sustaining and freedom supporting future is settled at the heart of the framework for Technology assessment which is outlined in this contribution. Important elements of the framework first and foremost include a focus on Responsible Research and Innovation (RRI Lindnder et al., 2016).

RRI has the goal that promising structural targets are actively pursued in the research process. This goal faces one central dilemma in technological developments: When hurdles, problems or dangers become obvious, alterations and adaptations can be locked by pathdevelopments or hindered for the sake of established business models. An evolutionary model of pathways (Dietrich et al., 2010) aims to overcome this problem by providing room for maneouvers in conflicting situations through the resulting transparency in Technology Assessment.

The Assessment of research in high tech applications needs some sort of values as a goal towards which the development is oriented. Freedom, security or justice (Beauchamp & Childress, 2013) as "prima facie values" serve as an intuitive starting point to concretize RRI in TaHIL-projects. To provide orientation, when problems arise and adaptation becomes necessary in Research and Development processes, these

values need deliberation and specification by researchers in regard of their individual methodology, research targets and desired outcomes. It is often challenging for researchers to take responsibility for the outcome and actual use of their work. Therefore, this process supports researchers to take responsibility for their work and to foster synergies in interdisciplinary cooperations. In consequence of defining a set of specific values and of identifying how to technologically support them, it becomes possible and necessary to outline trending-, worst- and best-case-scenarios of developments. Besides the definition of values and the reflection of their specific meaning in practice, the development of scenarios is a separate step, in which the actual use of technologies to perform certain tasks is anticipated (Boden et al., 2018). A foundation for the ongoing assessment of TaHIL developments is the framing of their implementation in Use-Cases, based on Work-Systems.

If this methodological order and the individual steps are performed, this method provides a holistic environment that puts human beings, including researchers and their visions as well as potential users and their needs e.g. humans as creative beings, at the centre of all developments and therefore needs to be part of each and every iteration of the research process.

The provided framework for TA in TaHil projects goes with such an integrative approach beyond the state of the art by opening the assessment process for individual perspectives, that vary for instance according to disciplinary cultures, instead of creating regulations on a merely structural or practical level. Regarding the complexity and diversity of large scale research projects, such an integrative research and evaluation approach in applied ethics also helps to streamline ongoing technological research towards the benefit of society as a whole, based on fundamental human rights and needs, while assuring the diversity and responsibility of individual researchers. With this very aim, TA shall not give an objective norm to evaluate developments ex post. It is rather an integrative part of the iterative research approach putting the human at the centre of all developments.(Fontrodona, 2013)

3. Responsible Research and Innovation: three dimensional Path Developments

TaHIL projects can only function, if they are structured by the interaction of different academic disciplines. Therefore they need some structural targets on the one hand as well as research targets on the other hand. For the goal setting and structuring in the research of TaHIL applications, the democratization of skills was namend as an examplary guiding principles that leads developments. To fulfill this promise, the development of Use cases should be focused on the promotion of democratic processes in skill transfer. Before this can happen, the meaning of the "democratization" in specific terms must be reflected in research practice so that it can subsequently be incorporated into the use cases. If the research practice is to be adapted and aligned with the targets of such a proposal, the claim that the development supports the democratization of skills can be held true. Therefore it is logical that research practice and results require

from the very beginning on active anticipation, reflexivity, deliberation and responsiveness by reserachers and legal entities. These practices are state of the art in "Responsible Research and Innovation". (c.f. RRI Tools)

However, large scale research projects focussing on TaHIlL are per se interdisciplinary, integrative, and therefore complex in their approach and design. This counts on the one hand for smaller interdisciplinary projects as well, but it is on the other not always excplicit nor actively pursued in research practice. The resulting complexity from the collaboration of diverse disciplinary cultures and practices leads to the emergence of unintended consequences and undesirable side effects. Such side effects that occur in ongoing research are influenced by structural conditions (for example administrative structures and existing relationships between different disciplines) as well as systemic constraints (the scope of the research project and the given possibilities to transfer results into existing practices or routines). Subsequently, research into complexity becomes mandatory for TaHIL-Projects, so that limiting factors and room for maneuvers are taken into account.

When insights from basic research are transferred to practical applications, unforeseen challenges are likely to emerge while the establishment of industrial applications and their mass use may bring undesirable side effects as well. Historical examples include the changes in mobility to cars in the twentieth century, the use of nuclear research in warfare or environmental pollution through the mass usage of polymers in single-use products. It is logical that such unintented consequences must be analysed in order to reflect stabilising and destabilising aspects of development. To operationalise this reflection process, it is recommended to focus on three dimensions:

1. objective dimension: potential material, energetic and informational effectiveness of the materials, means, products, processes, and systems used.

2. In a spatial dimension: spreading of effects into increasingly complex spheres of action from direct human-machine interaction to cross-domain system cooperation in open natural, social and human environments.

3. In a temporal dimension: short- and medium term impacts, the development of the complexity of the different, interwoven life and reproduction cycles of technologies.

Applying these three dimensions into the reflection process is a basic condition to pay respect to the dynamic self organisation of innovation processes. It is state of the art in high level political discourses to investigate and model such developments as Pathways, where bottom-up innovations influence overall developments while top-down social systems of action limit developments. Both are interrelated and should be modeled in an evolutionary concept of path development that goes beyond the state of the art, requiring an iterative and reflected research approach.

4. Dilemmata in the democratization of skills

Those promising results towards which research should be oriented in iterations, such as democratization, equity or inclusion, are closely related to freedom, Justice and Security as abstract "prima facie values". These abstract prima facie values are, as state of the art, the very legitimization for the conducted research and innovation process but can lead to contradictory and conflicting developments. For example, the design of intuitive interfaces eases the use of TaHIL technologies and serve the spread of such technologies which is associated with democratization. The orientation towards economically sustainable business models and use cases is then a necessary condition for long lasting basic or disruptive innovations. On the other hand the effort to learn exactly how machines work and how adaptations can be made implicitly becomes superfluous while users become more and more dependent on Informations and engineers. Furthermore, the development of use cases and a focus on start ups can hamper the desire to spread gained knowledge, to make blueprints publicly available or to build open source code, which is a basic condition to make innovative approaches reproducible by others who research in TaHIL technologies. Therefore it is logical that abstract mission statements and values must be translated in the course of research into specific values and attitudes that can be achieved through technological developments. This translation of an abstract canon of values into concrete approaches must – having systemic and synergetic dynamics in mind – be at least refelcted on 1. the individual level, 2. the level of teams, companies and organisations, 3. on a societal level and 4. on an environmental level. To develop and implement such a discursive model of values and attitudes in TaHIL projects is the current challenge and takes formalised ethics way beyond the current state of the art.

5. Work systems within the framework of TaHIL technologies

If the developments of TaHIL projects aim to change the economy, these technologies in co-adaptation or co-augmentation must be constructed as working systems that are effectively human centred (Schmauder & Spanner-Ulmer, 2014; Ulich, 2013). It goes beyond the state of the art to investigate work systems by modelling personas and use cases. The task is to adopt this concept to TaHIL developments with the relevant influencing factors in order to understand how our daily life or local markets are structured by the use of new haptic codecs and robotics, and to ensure a holistic analysis and evaluation for the developed technological environments.This includes in particular taking into account the partial change from the formally "inactive" role of work and equipment in the work system to an active role by adapting the assessment criteria. For this, it is necessary to stimulate an interactive process of critical reflection with the different groups of actors (Steen, 2021).

As an extension from the point of view of a comprehensive ethical evaluation, the interaction of several work systems and the interaction with the customer, society and the environment is included. This allows a more differentiated representation of the outputs with regard to their target group and the identification of the influences of

society and environment on the work system, as is the case with cross-company value-added processes and globalisation. The elements of the work system (work equipment, work object, work task, management, corporate culture, …) are underpinned with features which, under the conditions of digitalisation, currently have a major influence on the functionality of the work system and which are therefore included as influencing factors in the scenario analysis.

6. Implementation process

Technology assessment is a complex, long-term and iterative process that must also be secured on the process side (Grunwald, 2019b). In an iterative, participatory assessment process, all research actors must be involved, regardless of their function or professional focus. It is also desirable to involve potential users of the technologies to be developed at an early stage. The evaluation process necessarily requires the interdisciplinary exchange of information and discourse, and measures to empower researchers for evaluation may also be necessary. And last but not least, the questions of responsibility for process initiation and rules for the implementation of the assessment results must be answered pragmatically for the concrete framework conditions.

The specific instruments to address these issues can vary according to individual preferences as long as the main factors remain central for the selection of measures that support anticipation, reflection and adaptation throughout ongoing iterations.

7. Conclusion

As a logical conclusion, the analysis of ongoing research activities, Systemic limitation and synergetic bottom-up innovations must be synthesized with specific values and opportunities, so that these values and ideas allow us to distinguish positive from negative developments. In accordance to such specific values best case and worst case scenarios are developed with sufficient evidence, ensuring a value driven and responsible Research and Innovation process.

Having thought through this framework for technology assessment the conclusion is given: The developments in the field of Tactile Internet require a concrete ethics. This means that mission statements need sufficient evidence to become a plausible result of the research practice. Therefore these promising results and the ongoing research itself must be actively reflected by researchers, so that consequences are deliberated and evidently anticipated before lock-Ins gain ground and room for maneuvres vanishes. The required reflectiveness must subsequently be adressed with clear and transparent options to react to emerging dangers and problems so that the research practice can be adapted to desired effects, so that starting from the concretization of indisputable prima facie values, evident worst and best case scenarios can be developed, depicted and pursued.

Disclaimer

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