Embedding Ethics and Social Science Into Telemedicine Research, Development, and Implementation

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In order to anticipate and address the challenges of introducing robotics and AI into healthcare, related research and development needs to attend closely to the intricacies of healthcare practice, including its ethical, social, and political dimensions. Our work employs an 'embedded ethics and social science' (EESS) methodology, in which ethicists and social scientists are integrated into technological research projects and work closely together with the engineers. The aim of this collaboration is to reflect upon and address ethical and social aspects of the projects throughout the research, development, and implementation process. In this paper, we propose two research foci and conceptual lenses for empirical research on the social and ethical dimensions of AI and robotics for healthcare. Attention should be paid to engineers' imaginaries of AI and healthcare, and to processes of boundary drawing in interdisciplinary research on healthcare robotics and AI. To illustrate these points, we present preliminary insights into our case study of haptic telemedicine.

CCS Concepts: • **Applied computing** → **Sociology**; • **Human-centered computing** → *Ethnographic studies.*

Additional Key Words and Phrases: embedded ethics, healthcare robotics, telemedicine, AI ethics, responsible robotics

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1 INTRODUCTION

Interactions with artificial intelligence (AI) systems increasingly shape practices in a variety of medical fields. In healthcare robotics, researchers tout the use of AI as a means to enable assistance in care tasks. AI promises to make predictions even in "the wildness of the daily life in healthcare", an environment that is seen as much messier than those for industrial robotics [13, p. 157]. Implemented into healthcare, robotics and AI can monitor, diagnose and document the health of a patient. Ground-breaking shifts in the work practices, professional cultures, and expertise of healthcare practitioners are possible. Yet, the challenges arising from novel divisions of labour between humans and intelligent machines need to be addressed proactively if robotics and AI are to be implemented into healthcare successfully and responsibly.

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In order to anticipate and address the challenges early on, research and development of healthcare AI needs to attend closely to the intricacies of healthcare practice, including its ethical, social, and political dimensions. Our work employs an 'embedded ethics and social science' (EESS) methodology, in which ethicists and social scientists are integrated into engineering projects and work closely together with the projects' engineers to reflect upon and address ethical and social aspects of the projects throughout the research, development, and implementation process. Our project team consists of researchers with backgrounds in mechanical engineering (KR), medical ethics (DT), and science and technology studies (STS) (MB and SB). It is embedded in engineering projects of a German research institute working on robotics and AI for elderly care and medicine.

This paper draws on our current use case, haptic robotic telemedicine. We view haptic robotic telemedicine applications as complex sociotechnical systems that afford particular kinds of human-machine-human interactions. They create a novel, triangular relationship between AI, healthcare practitioners, and patients, with the latter being potentially in vulnerable states of reduced capacity and wellbeing. Their implementation might reconfigure not only the experiences and practices of healthcare practitioners and patients, but also our very idea of what good healthcare is.

Based on our experiences and drawing on related STS scholarship, we propose two promising research foci and conceptual lenses for research on the social and ethical dimensions of AI and robotics for healthcare. First, we highlight the role of engineers' imaginaries of healthcare in creating future robotic and AI applications. Secondly, we discuss processes of boundary drawing and boundary crossing in interdisciplinary research on healthcare robotics and AI. We now begin by outlining our EESS approach and give an introduction into our telemedicine case study.

2 EMBEDDED ETHICS AND SOCIAL SCIENCE IN HEALTHCARE ROBOTICS AND AI

With important social, ethical, political, and legal questions in mind, the aim of our embedded ethics and social science (EESS) approach is not to satisfy these challenges in an effort to proceed with development. Instead, our project has the much wider aim to further understand the complex, societal aspects of technology. In concert with research in engineering, we empirically study new AI-based healthcare technologies as they are being researched, developed and implemented in healthcare practices from a social scientific perspective. We aim to encourage ethicists, social scientists and engineers to "think more like partners in a team" [14, p. 311-12] and to inspire reflexivity. As EESS researchers, we become acquainted with the details of the technical tasks through collegial interactions with the engineers in site visits. Creating relationships and trust, these close collaborations allow for ethical and social questions to arise naturally, and for effective ways of thinking about these aspects through regular interactions. We also conduct in-depth qualitative "peer-to-peer interviews" [8], in which we aim to learn about the engineers' motivations, their ethical and social concerns and also their understanding of the current political and legal context that surrounds their research. These conversations create an intimate and safe atmosphere that allows engineers to reflect on the societal relevance of their own work.

At a later stage, our project builds practical tools and interventions such as workshops that address particular ethical and social aspects that emerged in the course of our project. We also work to create dialogues between a variety of crucial stakeholders, such as project funders, test users involved in the projects, healthcare educators, practitioners, and patients who may one day use AI and robotic technologies. Taking an 'embedded' approach, we ultimately aim at interdisciplinary co-designing of healthcare robotics and AI applications, whereby ethical, social, legal and political analyses constitute integral elements of the robotics and AI product design process as well as its workplace integration.

3 CASE DESCRIPTION: HAPTIC ROBOTIC TELEMEDICINE

In our current case study, we are looking at research projects on telemedicine. Their aim is to enable healthcare practitioners to remotely control robot manipulators to perform examinations and treatments that involve physical human-interaction with haptic feedback. A setup with a leader robot on the practitioner's side and a follower robot, mirroring the leader's motions, on the patient side allows bi-directional force-feedback [10]. If the practitioner moves parts of the robot in her practice, the robot on the patient's side makes the same movement. Conversely, interaction forces on the patient's side are transmitted to the practitioner via a designated haptic layer of communication. The range of possible applications includes diagnostics like auscultation and interventions like physiotherapeutic tele-rehabilitation.

This technology is currently being researched for application in a variety of contexts. GARMI, a service robotics platform to support elderly at home [12], can be teleoperated in an avatar mode, which allows a remotely connected practitioner to control the arms of another robot in the patient's home. Another scenario looks at a dedicated teleoperated treatment room that is equipped for examination of potentially infectious patients within healthcare facilities. These projects are currently in their prototyping phases, with pilot user tests underway.

The project consortia consist of multiple partners, lead by electrical engineering and informatics researchers, joined by researchers from education, sports, health, medicine and nursing sciences,mechanical engineering, and robotic systems manufacturers. The wider project landscape of associated partners includes clinical practitioners, care providers, data security consultants, as well as scholars in ethics, law, nursing, and social science.

In the following sections, we draw on STS perspectives to reflect upon our experiences as embedded ethicists and social scientists in these telemedicine projects.

4 ENGINEER'S IMAGINARIES OF TELEMEDICINE IN/AND HEALTHCARE PRACTICE

Way before new technologies reach a stage where they are implemented into real-world environments such as hospitals or people's homes, engineers' ideas of the reality of these settings and their future potential shape the trajectory of their innovations. A rich body of STS research has shown that imagination and envisioning of the future play a significant role in the practices of research and technology development [4–6, 9]. In the case of healthcare robotics and AI, imaginations of what healthcare looks like in practice, or should look like, influences design choices engineers make. In turn, their research renders real certain "worlds of significance" and 'figures them forth' into the future [1, p. 317][2]. Part of our analytical engagement with our case is predicated upon an "aware[ness] of the 'circuits' between the discursive and the material"[1], between the stated visions, promissory announcements, and wider cultural imaginaries tied to AI and robotics and the actual engineering achievements of healthcare robotics and AI. We use "imaginaries" as a lens [7] to grasp the engineers' conceptions and visions of healthcare more broadly and of haptic telemedicine specifically.

From our ethnographic observations at user tests, as well as interviews with the engineers and reviews of their publications [10], we have learned that the engineers we work with envision their telemedicine system as a solution to certain problems of the healthcare system. The problems most prominently mentioned are the following two.

- Healthcare practice bears a risk of infection for healthcare practitioners and patients. Telemedicine is seen as a solution as it creates a physical distance between practitioner and patient and thus protects them from infections, an argument that has increasingly been mobilized in times of the COVID-19 pandemic.
- Access to healthcare is not sufficiently ensured in some areas. The engineers' concern lies with rural areas, where there is a shortage of skilled workers in medical and nursing professions, and a high need for healthcare resulting

from the high proportion of older residents. Telemedical applications are seen as a means to redress this deficit by providing access to medical care remotely.

While telemedicine technologies are envisioned to bridge or create distance between healthcare practitioners and patients, the physical and haptic examination of patients is nevertheless seen as an important feature of medical care, which they aim to enable through their telemedical applications. Projects on haptic telemedicine systems promise a robot-assisted remote performance of diagnostics like auscultation, ultra-sound, and palpation [10]. Their particular vision of 'remotifying' healthcare relies not only on the seamless real-time transmission of various streams of sensor data, but also on aspirations to translate this data back into something meaningfully perceptible by human senses. They try to realize this through designing applications with force feedback and, among others, streaming of video and auscultation sounds.

This approach figures forth a path for healthcare that constitutes an alternative to purely data-centric practices that healthcare AI often entails. It places the human actors as operators of the system at the center. In their application scenario, healthcare practice, while being highly mediated through sensors, data, algorithms etc., is reconfigured to maintain physical/embodied practices across a distance for both the patient and the healthcare practitioner.

It remains to be seen in situ how exactly these technological and data mediations will influence healthcare practitioners' and patients' interactions and experiences once workplace integration of the system is further advanced. However, looking at engineering projects through an 'imaginaries' lens can help us open up these ideas for debate early on. Making visible commitments to particular futures the engineers invest their efforts in, we facilitate reflections that go beyond the focus on technological functionalities, which existing debates in both engineering and ethics have often been limited to [13].

5 SYSTEM BOUNDARIES, DISCIPLINARY BOUNDARIES, AND SOCIOTECHNICAL SYSTEMS

The definition of system boundaries of the technical system is an important practice in designing and engineering systems. It helps to identify interfaces between subparts and the environment, to gain a system overview by zooming out, and als to zoom in on certain parts that need further refinement. A telemedicine by teleoperation application can be very coarsely subdivided into the leader and follower robot system which are connected via a network interface. In such a setup the leader robot is operated by a healthcare practitioner, who is considered part of the environment. Each of the subparts could be refined for example on structural or functional levels. Systems engineering, as a field of engineering, formalizes these considerations with the goal to organize the work with complex systems.

Limited to their primarily technical worldview, these engineering approaches often fall into what Selbst et al. call the "Framing Trap" [11], where their system boundary definitions often exclude social actors and interactions. This very technical perspective can be fruitfully complemented with Human-Computer Interaction (HCI) or sociotechnical perspectives. It becomes necessary to change system boundaries to adequately include these important factors into design considerations that allow the real-life functioning of the system.

Telemedicine as a case study illustrates very well the importance of including social activities within a system's boundaries. This became evident in the user tests we observed, conducted by two of the engineers. The test users had no medical training and no prior experience in operating robots and were asked to control the leader robot of the telemedicine station. When something did not work out smoothly in the operation, we repeatedly saw the engineers encourage the test users by saying "this just needs a little training". The idea of training was discussed frequently in the context of the test, indicating that the engineers are well aware of the efforts needed from both patients and medical practitioners to accommodate the setting and ensure successful interaction. On the one hand, the engineers worked on solutions regarding technical parts of the system, suggesting that it is important to make the interface ’intuitive’. But on the other hand, they went beyond their own immediate work on the robots by suggesting that training for operators is needed.

Since we are dealing with complex human-machine-human interactions, work within disciplinary boundaries will not suffice to bring these sociotechnical systems to realization in healthcare practice. To effectively integrate a diversity of perspectives, we aim to facilitate fluid crossing, redrawing or dissolving of boundaries, both in terms of the sociotechnical systems we work on and the disciplines we bring together. However, this is not always easy. It takes time and effort to challenge boundaries that are still rigidly enforced throughout most of our education. In larger team meetings in engineering research projects, it feels like a forced separation when we are regularly called "the ethics people". While the engineers are tackling the technical challenges of implementing capable telemedicine robots, we are seen as responsible for anything beyond. Within our EESS project team, we had the chance to grow together over the course of initial months of intense study and reflection over relevant theory and perspectives. We see the work to open this space of interdisciplinary exchange to the projects we are embedded in as an ongoing experiment in interdisciplinary collaboration.

Zooming out again, to look at the intentions of these intertwined projects, reveals the boundaries of the search space for solutions that is considered. In the projects we are embedded in, some fundamental questions are already answered and taken as a given, namely the decision to pursue a *technological* solution to a problem. Limiting the pool of solutions in this way is a practice that has been tied to "technological solutionism" [3] or described as falling into the "Solutionism Trap" [11]. Shaking or overthrowing this commitment to technological solutions of our partner projects is not something that our role as embedded collaborators would allow us to do. Nevertheless, we make efforts to help widening the search space to find more optimal solutions, for example by engaging in conversations where we invite the engineers and project partners to zoom out from their everyday work practices and consider the projects’ wider societal relevance. Going beyond our direct engagement with the engineering teams, we also pursue research that gives voice to affected actors who, as we have seen in our interviews with healthcare practitioners and nursing scientists, call for solutions beyond technology and give valuable insights from a needs-centered perspective, which can point us to ways of employing technology that meets important needs.

6 CONCLUDING REMARKS

We have presented our embedded ethics and social science (EESS) methodology as a contribution to the research landscape of human-machine interaction. We stress the importance of imaginaries and boundaries as units of analysis in interdisciplinary research on healthcare AI and telemedicine specifically. These perspectives can provide points of reflection in interdisciplinary collaborations where ethics and social science are embedded into healthcare robotics and AI research. As such, they can help to assure that emerging healthcare technologies are developed and implemented in a way that they are adjusted to ’the wildness’ of healthcare practice and align with users’ values.

In closing, we should caveat that our EESS project and its involvement in the telemedicine projects are in their early phases; our suggestions should be seen as tentative and open to future revision. Given the many challenges that researching the complex sociotechnical space of healthcare robotics and AI entails, we wish to see and partake in frequent exchanges across the boundaries of temporary, ’projectified’ research efforts, and to create a network of support for ethicists, social scientists, and engineers alike to reflect together on the challenges they face.

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