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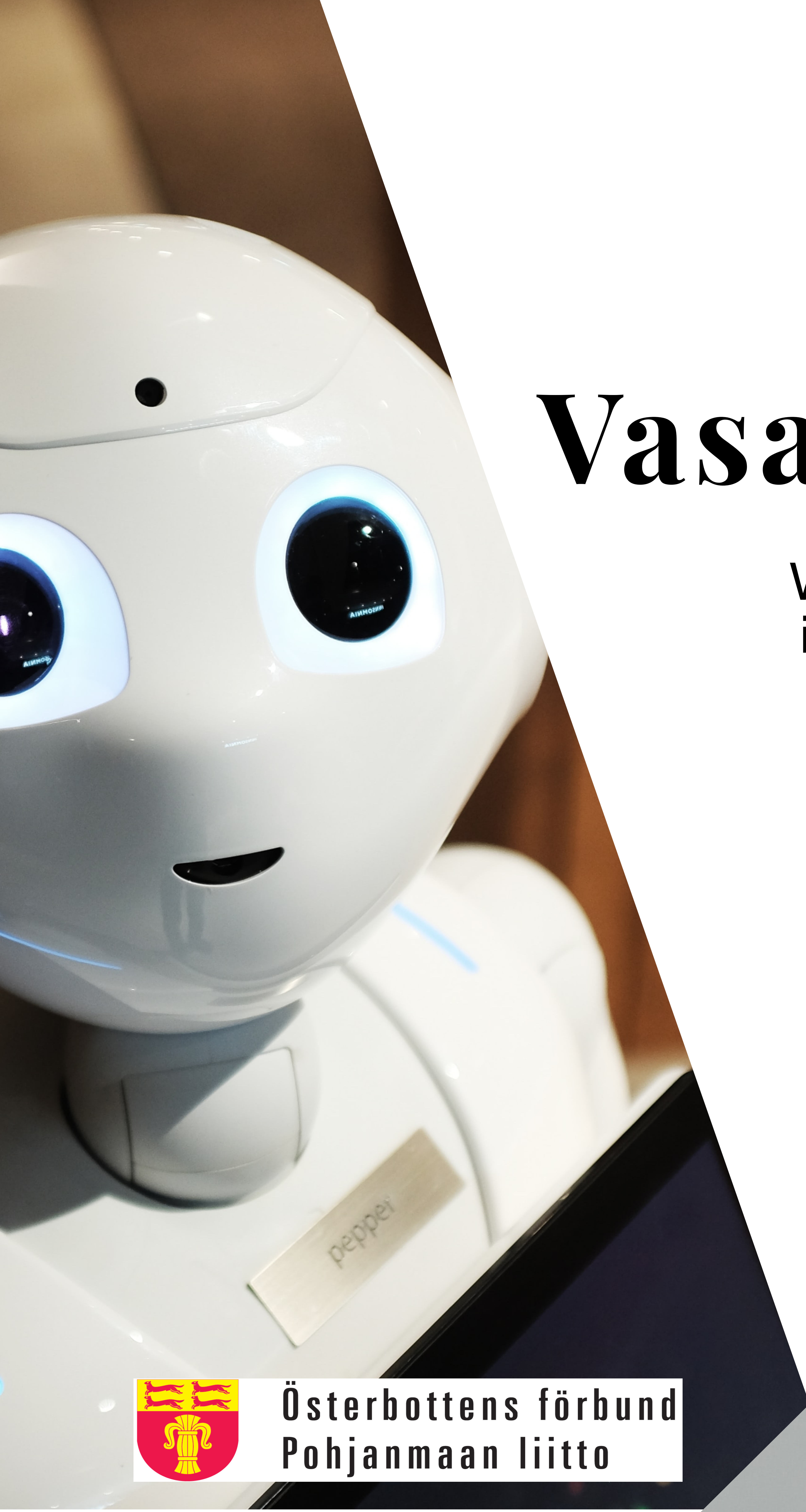

Vasa InnoCare

Welfare technology innovations on the Pepper platform

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Österbottens förbund
Pohjanmaan liitto

Abstract

This report presents three robotic applications for the Pepper platform, co-designed not only to and for but with patients and healthcare staff during two years in the Ostrobothnia region, Finland. Videos of the applications offer glimpses into the robot behaviour, script, and human-robot interaction in a simulated care encounter. We also describe the participatory process employed in the research and design phase and touch upon main findings in the evaluations of the HRI. Lastly, we present best practice recommendations to Finnish actors considering social robots in healthcare.

Content

- Background of the Vasa InnoCare project
- Rationale of the social robotics applications
- Participatory design process with stakeholders
- Three robot programs for robot-supported care
- Experiences of the human-robot interaction
- Best practice recommendations

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Background - Vasa InnoCare project

Welfare technology carries potential to assist in adressing the grand challenges in healthcare, such as equality in health and good care and well-being for all. We wanted to explore the potential of social assistive robots (SARs) and Virtual Reality (VR) being part of this important work. We set out to co-create together with stakeholders, thus adopting a trans-disciplinary approach. As a basis for discussions, we iteratively designed robotic applications for care encounter scenarios in Ostrobothnian care contexts. This document reports on the work with SARs.

Running time: 1.8.2019-31.7.2021

Project partners: Åbo Akademi University & Novia University of Applied Sciences. PI Linda Nyholm, ÅAU.

Supporting partners: Vaasa Central Hospital, City of Vaasa, non-profit organization Folkhälsan and vocational education school Vamia.

Funding bodies: European regional development fund (ERDF), participating partners.

Total budget: 159 436 EUR (of which ERDF funding 127 545 EUR)

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Transdisciplinary approach

A multi disciplinary project team carried out the RnD activities. We are experts in technical development, in co-creation and user experience design, health science/gerontology, and caring science. This is a strength, for example, in internal and continuous self-assessment of the work and in bringing multiple perspectives to the design process.

The stakeholders, invited as co-creators in the process, represented patients, patients' relatives, and care staff in various roles (e.g., leaders, clinical nurses, preventive health workers, teachers and students).

From left to right: Robot Pepper, Dennis Bengs, Melanie Rydgren, Linda Nyholm, Susanne Hägglund, and Anne Hietanen.

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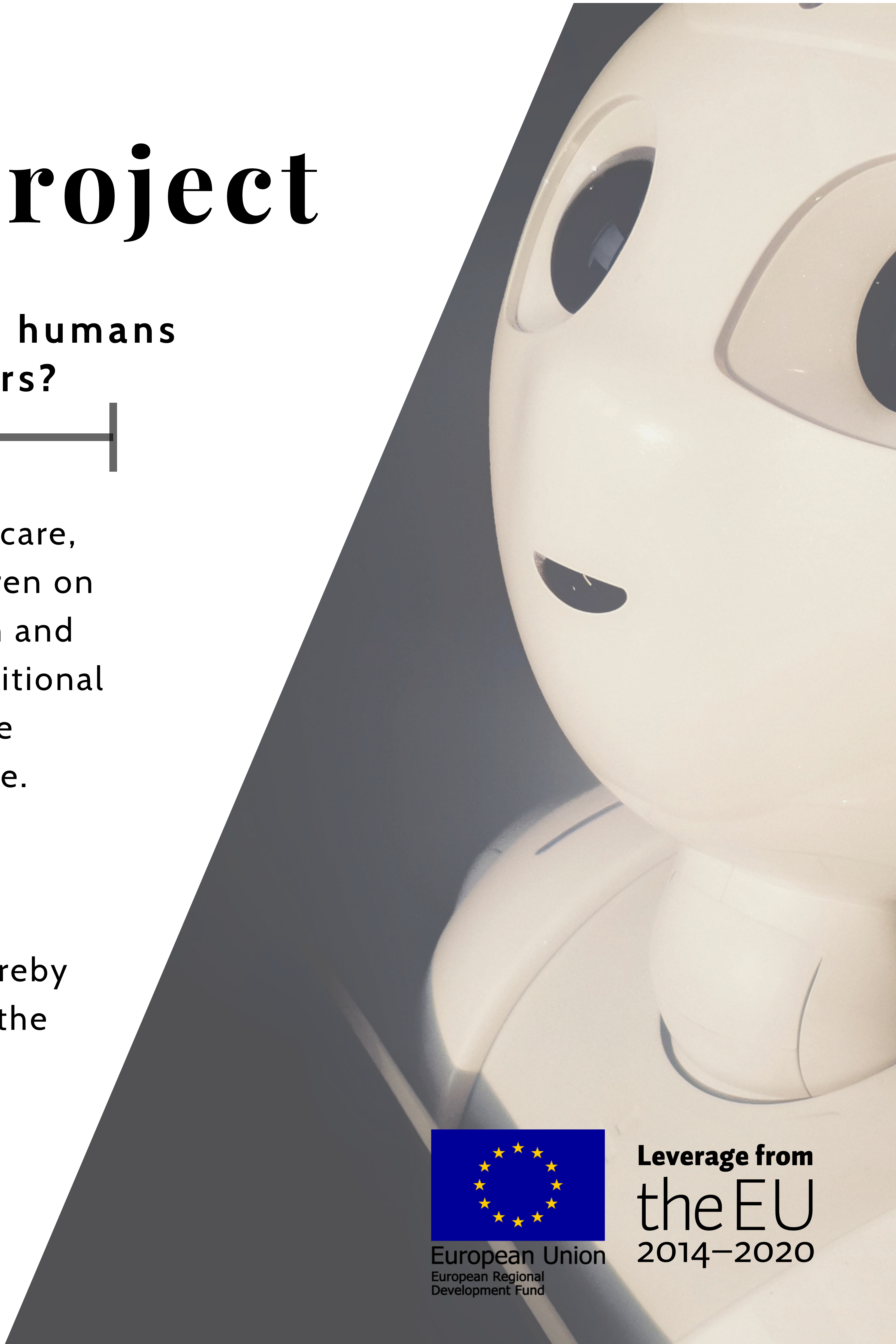
Rationale of the project

Which is the potential of a robot in assisting humans in their activities and goals in care encounters?

Benefits of SARs in care contexts such as therapy, elderly care, rehabilitation, and training of social interaction with children on the autistic spectrum have been acknowledged in research and in clinical practice. During the covid-19 pandemic, the additional aspect of robots' potential to strengthen patients' and care workers' safety was raised in media and academic literature.

There are only a few RnDnI projects that co-create robotic applications with relevant stakeholders in healthcare, whereby our project contributes to generating more knowledge on the potential of SARs in care encounters.



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Rationale of the project

SARs assisting in communication in care encounters between patients and care staff

Our mission was to co-design ideas for robot-assisted social conditions in health care, to prototype them and iteratively test them in simulations, mainly in the laboratory setting Experience Lab. The covid-19 pandemic haltered the aim of field trials to a greater extent, though a few were carried out prior to the coronavirus breakout.

The goal of the robot behaviors was three modes of communication; 1) logistics 2) rapport and acknowledging the patient, and 3) providing knowledge and/or information to the patient, intended for all patients.

Recommendations based on the experiences of the co-design process of the project are outlined below. Another important goal of the co-creation process was to raise awareness of the potential of social robots in health care.

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Methods employed

One of the core interests in the project was humans' trust in social robots. Trust is a complex and multi-faceted concept including both attitudes towards a trustee and the trustor's decision to trust the other.

Several factors influence on whether a patient or a care worker chooses to entrust a social robot to assist in reaching a goal. Some are contextual, relating to the place where the robot is situated, whereas others relate to the maturity level, perceived competence, and appearance of the robot. Societal attitudes, organizational culture, and individual preferences and values influence as well.

Context and environment characteristics	Conditions and restricitions of the technical platform
Organisational and societal regulations and norms	Personality and attitudes of the human being

Table 1. Some of the variables influencing the experience of human-robot interaction.

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Methods employed

We employed a mixed methods approach when iteratively testing the prototypes. The toolbox included observations, interviews online with the project team and the co-located, embodied robot, surveys, and written evaluations based on videos.

This multi-method approach served us well during lock down of society, putting halt face-to-face meetings for a long time. Through this, we hope to cover at least some of the factors that influence the experience of human-robot interaction.

Surveys
RoSAS scale, TIPI scale, Technology Experience Profile Survey, Trust in Assistance Checklist.

Written evaluations
Written evaluations based on videos of the applications.

Observations
Observations of human-robot interaction.

Interviews
Semi structured focus group interviews offline and online.

Table 2. The methods used for measuring experiences of the human-robot interaction.

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How did we go about it?

	Casual Chat	Wound Care	Pandemic Reception
Task	To welcome and acknowledge the patient upon arrival to clinic.	To give information on how to take care of a wound.	To show the way
Versions	6	3	6
Participants	58	46	81
Methods	Focus group interviews, surveys, written evaluations, observations	Focus group interviews, written evaluations, observations	Focus group interviews, surveys, written evaluations, observations
Presence	Physical, co-located robot; online live interviews and video based evaluations	Physical, co-located robot; online video based evaluations	Physical, co-located robot; online live interviews and video based evaluations

Table 3. Study level documentation of the co-creation events of the three applications. 185 informants participated in the co-creation design process. Workshops and testing rounds were conducted where participants evaluated the existing robot interactive behaviour and commented on improvements in dialogue scripts, needs, and potential use cases, for example.

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Ethical frameworks employed

Self-assessment processes in addition to co-creation processes with stakeholders.

Neither active machine learning techniques nor other AI methods were designed in the applications (see below). Still, they are integrated in the platform, such as face and speech recognition, and imperative for the applications to operate correctly.

Therefore, we chose to continuously mirror our work against the ALTAI framework for trustworthy AI, and the European Charter of fundamental human rights. These include parameters beyond the technical domain of AI, such as accountability, diversity, and ecological footprint.

Further, the team experts in caring science and health science guided the design work out of care ethics. Design strategies were made in the beginning where constraints and challenges were identified.

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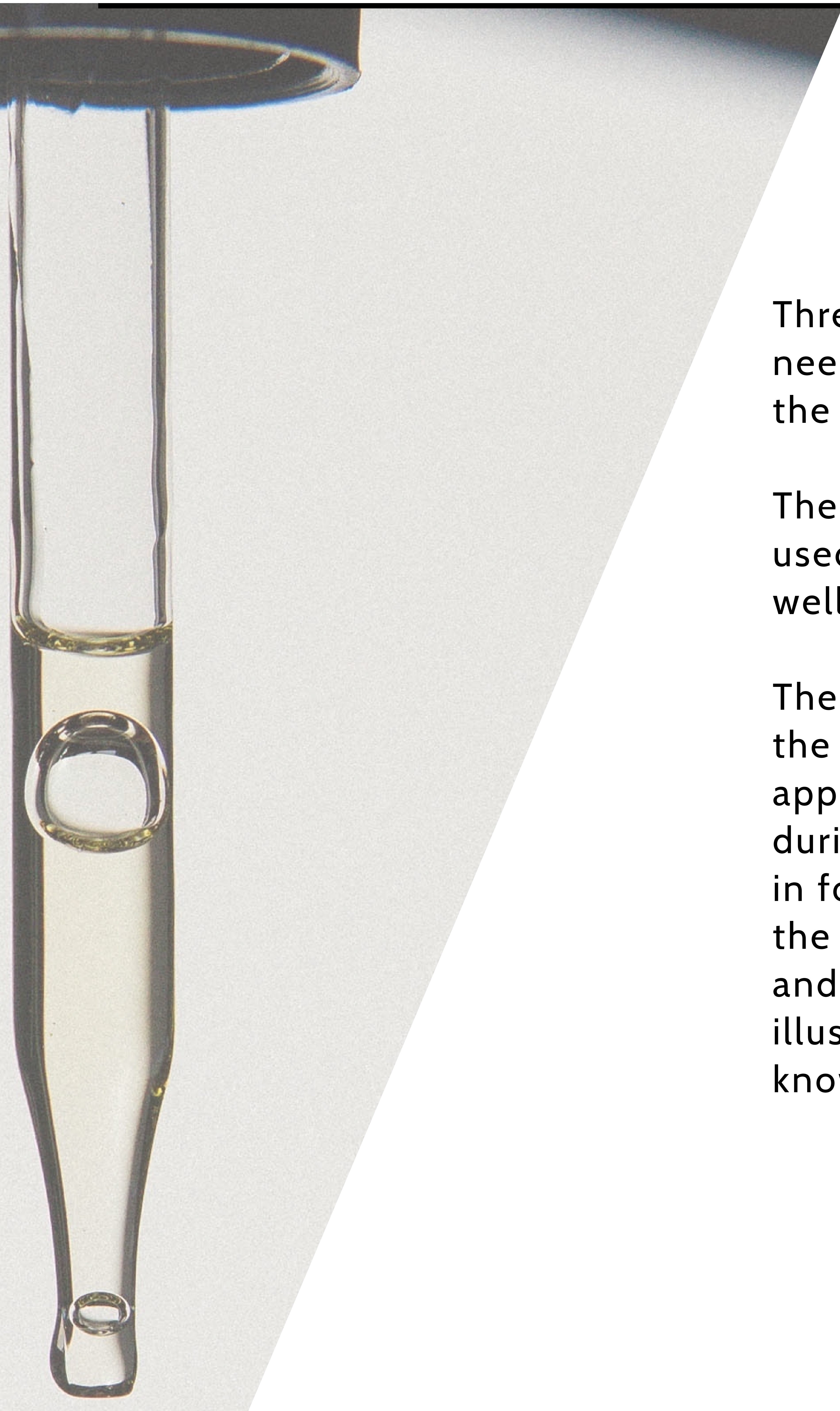

Outputs: content

Three robot applications were iteratively co-designed, based on needs expressed in workshops with patients and care staff and on the experience in health practice of the research team.

The applications were interactive and communicative, inteded to be used in care encounter scenarios. The Pepper robot platform is also well adapted for social interaction.

The applications represent three aspects of communication. Firstly, the Pandemic Reception is supporting the client in choosing the appropriate way in to a care facility, where local restrictions apply during the covid-19 pandemic. The logistic side of communication is in focus here. Secondly, Casual Chat focuses on building rapport with the patient entering a care unit. The core of the application is to see and acknowledge the patient upon arrival. Lastly, Wound Care illustrates the aspect of communication, where information and/or knowledge is transmitted between parties.

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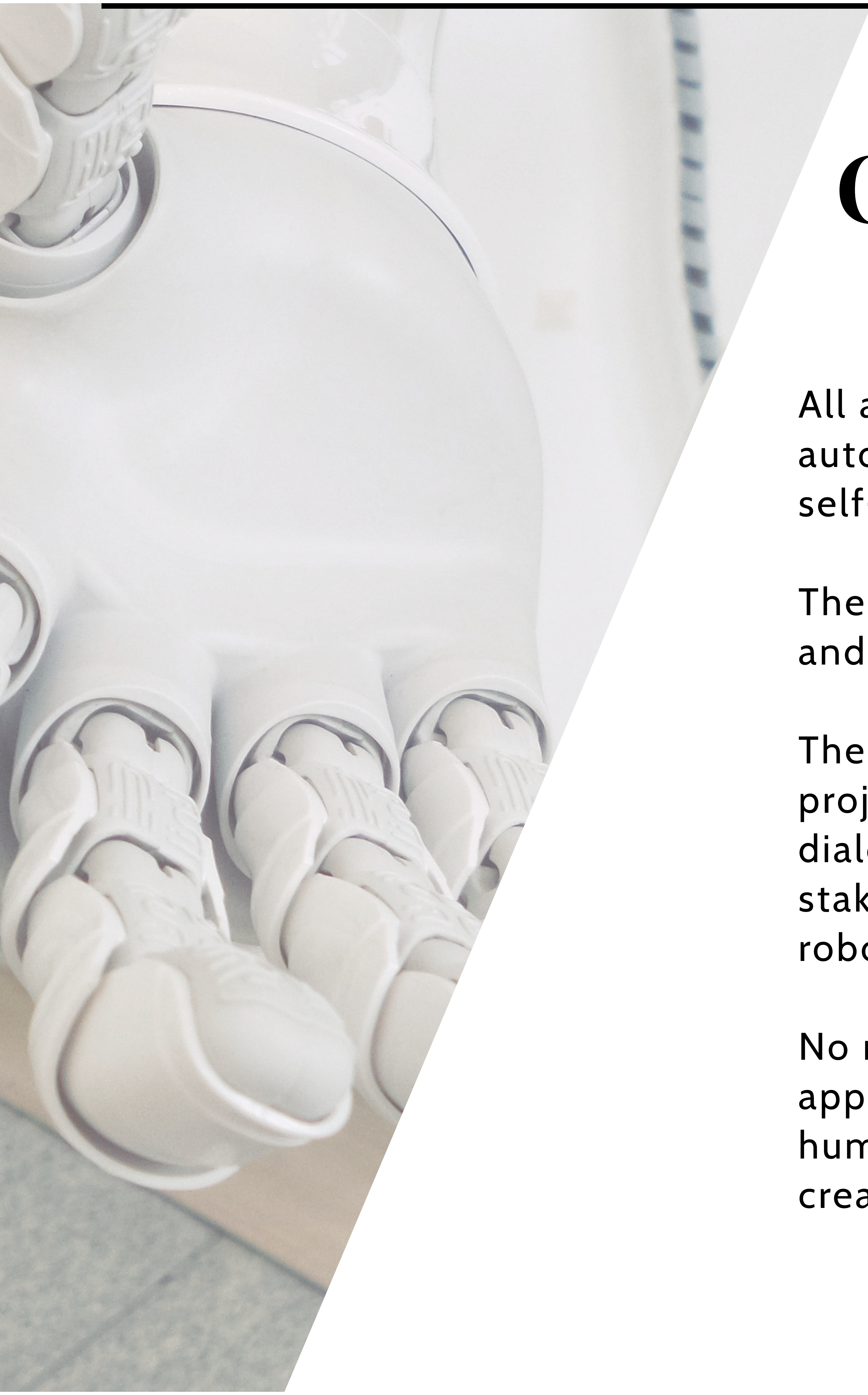

Outputs: technical specs

All applications are pre-programmed and rule-based systems. No autonomous, algorithmic decisions are made and no autonomous self-learning systems are in use.

The speech recognition used is integrated in the Pepper platform and Swedish, Finnish, and English are the available options.

The dialogues of the human-robot interaction co-created in this project were targets of vivid discussions in the workshops. The dialogues were edited and improved in line with feedback by the stakeholders, as was the behaviour of the robot, the use case, the robot's role in the care practice as well as its appearance.

No means of reporting feedback was implemented in the applications as they were never meant to be used without any humans out in the field, but always with the research team in co-creation processes.

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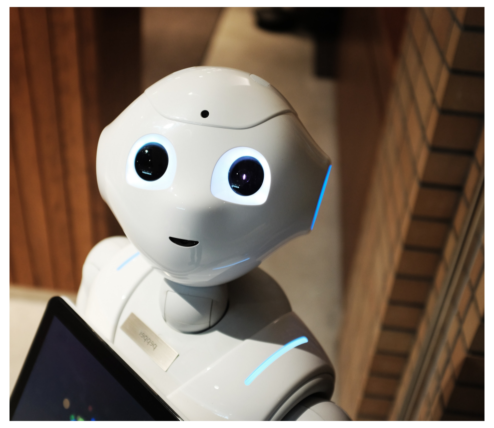
Application #1: Pandemic Reception

This application is made for two use cases, a hospital unit and a caring home or similar. The task of the robot is roughly the same however, as is the goal of the human being, and the backdrop of covid-19 restrictions. The goal of the human is to enter the building - either as a visitor to a relative/friend or as a patient - and the robot's task is to assist in guiding the patient or visitor, according to regulations currently in place in the covid-19 pandemic.

The robot is the first agent that the patient or visitor meets. A human care worker is intended to be available close by, however not in immediate closeness (>2 meters), for support, instructions, and for service when opting out of interacting with the robot.

The videos illustrate examples of the dialogue, though many more are possible, depending on the answers of the human being. One video shows the robot advising the human not to enter the care home due to risks of coronavirus transmission. Another shows the robot welcoming the visitor in. In the hospital scenario, the videos show how the robot is advising on what lines or doors to take.



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PANDEMIC RECEPTION VIDEOS

Care home

The visitor is adviced not to enter. In Finnish.

Care home

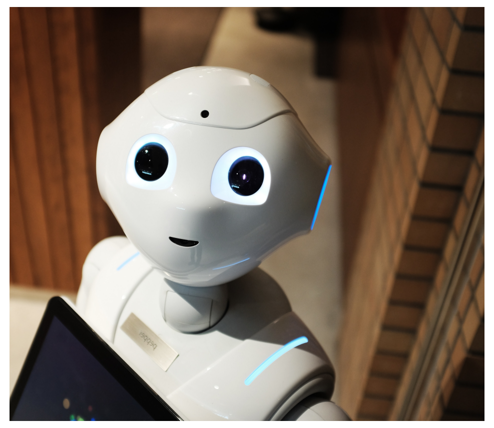
The visitor may enter. In Finnish.

Hospital unit

The patient reports covid-19 symptoms. In Swedish.

Hospital unit

The patient does not report covid-19 symptoms. In Swedish.



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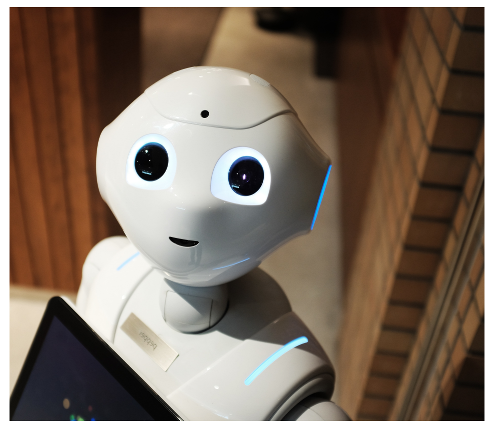
Pandemic Reception - feedback

Many elements of the application and its role in healthcare were discussed in the co-creation workshops, where the current version was evaluated and improvements were suggested. As the application is not a stand-alone solution without a human in the loop, but instead embedded in a team of care workers and situated in a context with vulnerable people in vulnerable situations, the discussions did not only revolve around the behaviour of the robot or its dialogue. Long-term societal implications of introducing socially assistive robots were discussed, as were tasks and roles of humans and artificial agents, ethics and morals, and data protection issues, to name but a few topics that were treated. A rule of thumb in design is to consider the artefact in a larger context and that was employed in our workshops as well.

For example, the right to consent to talking - or not talking - to the robot should be highlighted and easy to use. Design choices were mirrored against human rights such as autonomy, integrity, and dignity.

Further, the co-design team stresses that robots must be able to support and strenghten equality in care, minority rights, linguistic diversity, non-discrimination and integration of persons with disabilities. Challenges clearly remain in this area.



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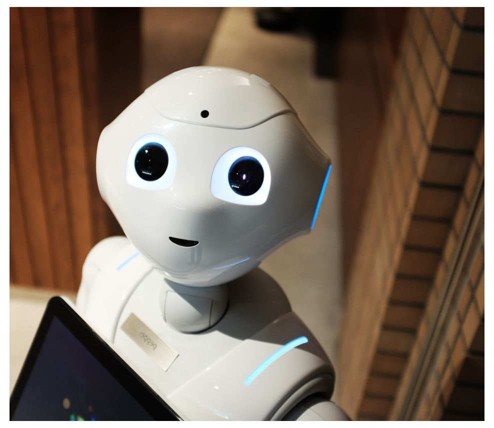
Pandemic Reception - feedback

Particularly care staff, but also participants representing patients, highlighted robots' potential to protect them during the pandemic, allowing for safer working conditions. Many felt that the robot is a good alternative to having a printed note with current restrictions or guidelines on the door, as long as it is easy to talk to the robot and provides an overall positive experience.

Negative attitudes towards the task of the robot in this scenario were also expressed, based on ethical values, little faith in the competence of the robot to perceive human speech, and on practical constraints. These include too long/slow and too fast dialogue of the robot, low explainability of how the robot assists the human in her goal at the moment, and too long response time which creates confusion.

The co-creation team stresses in general that increasing awareness of why the robot is there and how one interacts with it is key. Increasing transparency and explainability of the robot is very important, both when making informed choices as to whether one wishes to interact with the robot and for continuous information regarding data collection and data privacy while interacting with it.



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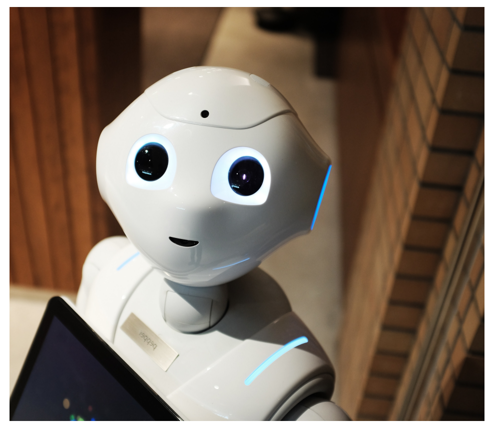
Application #2: Casual Chat

Some participants note that sometimes, there is no one to greet and welcome patients, when they enter a care unit for an appointment. The core aim of this application is to acknowledge the patient that arrives to the unit and invite to the care meeting. The goal of the patient is oftentimes, in this situation, to announce one's presence to the staff and/or system. The tasks of the robot is also to introduce the human to the facility's localities, e.g., to the water cooler and to the human care worker for registration.

Needs for this type of simulation of cognitive and/or emotional intelligence were often expressed in the workshops. Many had experience of intelligent virtual assistants and saw potentials for such a use case in healthcare, for instance in this scenario upon arrival, in elderly care or at the dentists' clinic to mitigate anxiety or negative feelings in relation to the visit.

The videos illustrate examples of the dialogue, though many more are possible, depending on the answers of the human being. One video portraits a patient turning down the robot's suggestion to chat. Another shows a patient talking to the robot when entering the doors.



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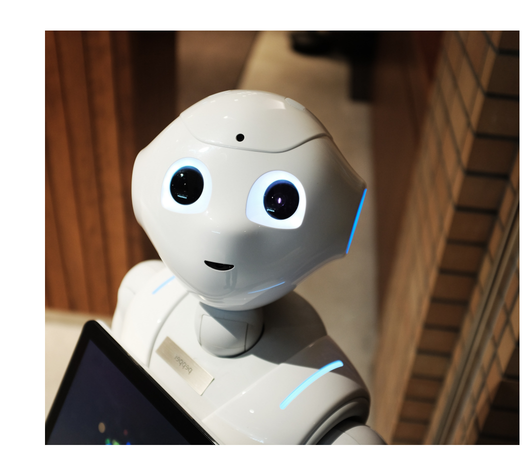
CASUAL CHAT VIDEOS

No, thanks, I prefer not to chat today.

In Finnish. In English. In Swedish.

Sure, why not? Let's chat!

In Finnish. In English. In Swedish.



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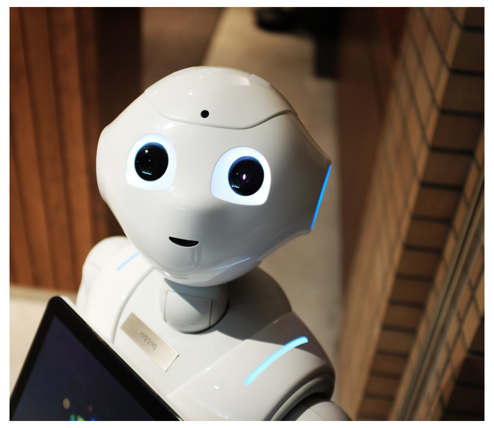
Casual Chat - feedback

The requirements of this application, like Pandemic Reception, are quite challenging as it targets everyone in the population in a general, instead of personalised, manner.

Much like the other two applications, this one gave rise to discussions on multiple levels. In particular, ontological dimensions were discussed vididly regarding the agency and roles of robots on the one hand and humans on the other. The conceptualisation of the robot, what *is* it really?, and its competencies and skills were also contemplated in the design of the application. A scientific paper is under way on this particular topic.

Expectations were high among stakeholders but many were not met. However, opinions are very polarized regarding the chit-chatting application. Some are very enthusiastic and feel that their goals of being acknowledged and calmed and/or energized instead of anxious were met. Others then again feel offended or deceived and left with a confused feeling of something missing in the interaction.

The workshops always deal with the delicate balance of creating an agreeable and nice persona for the robot, all the while emphasising its mechanistic characteristics, without making it too human-like. Challenges are discussed in the design choices, for example over-trusting the robot, attachment to the robot, and anthropomorphism.



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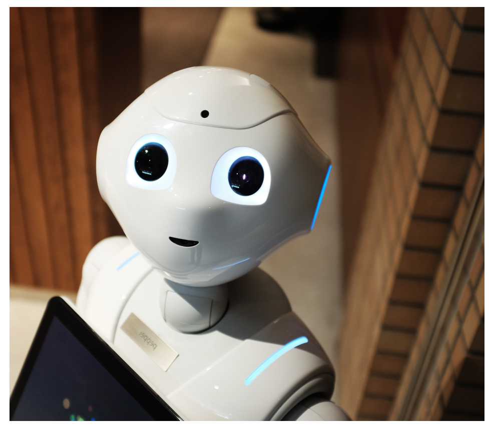
Casual Chat - feedback

The co-design team stresses in this scenario too that robots must be able to support and strenghten equality in care, minority rights, linguistic diversity, non-discrimination and integration of persons with disabilities. Given that this application focuses rather heavily on speech and on a shared language with the patient, the dialogue is extensively worked upon. Risks of miscommunication are discussed and the co-design team stresses the importance of being correctly understood in any HRI.

Multiple language options are seen as a strength but the difficulties to perceive dialectal words in Swedish and Finnish, and even standard Finnish-Swedish, are seen as problematic. It challenges the patient's right to care in one's own language.

Also, the raison d'être of the robot inviting the patient arriving to a care encounter is discussed in the workshops. Some of the patients are in pain, frightened, or emotionally distressed. How does one design for maintaining their right to integrity and dignity in that vulnerable situation? Is it possible to design for a positive experience when simulating emotional and/or cognitive competencies in the robot in these circumstances, albeit the right to consent is designed into the programme? The use cases do merit serious considerations, risk and consequence analysis, and field testing.



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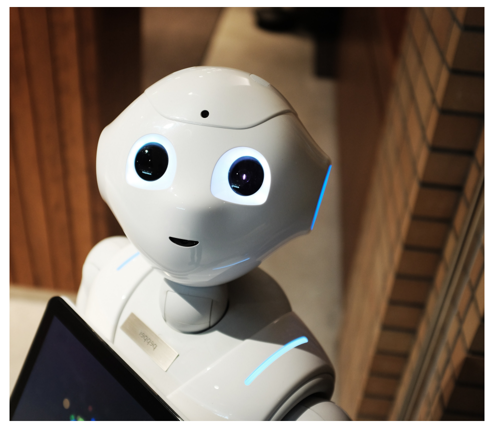
Application # 3: Wound Care

This scenario is the most personalized of all three applications co-created in the project. The core task of this application is to provide a patient being discharged from day surgery information on how to take care of the wound. The care staff offers the patient to receive the information only from them or from the robot as well. Thereby, the option to decline to interact is not present in the dialogue in this application.

The goal of the patient is to get information on wound care. The task of the robot is to assist in providing that knowledge, in this case throguh a series of questions, in a quiz. This application deals with the core aspect of communication, transmitting information to one party to another.

The videos illustrate the quiz in three languages.



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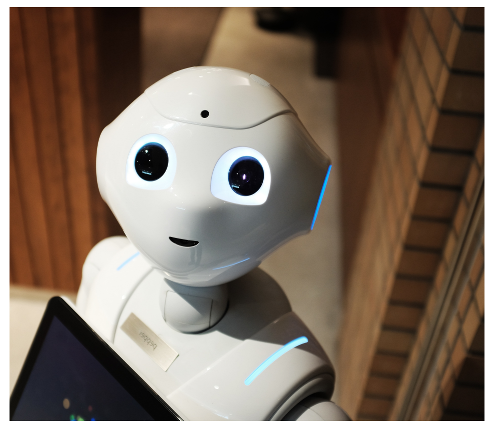
WOUND CARE VIDEOS

Being briefed on wound care

In Finnish. In English. In Swedish.



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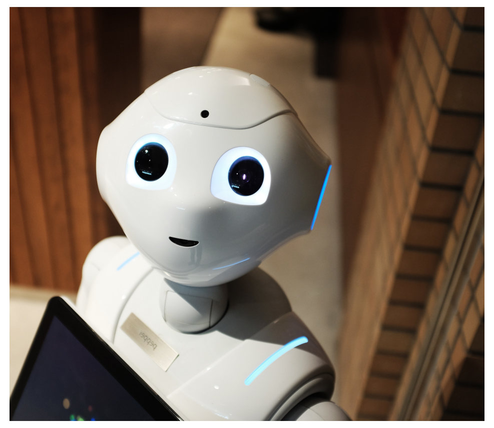
Wound Care - feedback

The co-creation team finds it challenging to match the competence of the robot with the individual's social and cognitive skills determining the motivation and ability to access, understand, and finally use health information, i.e., digital health literacy. There are worries that many do not know how to talk to a robot and calls are made for instructions and awareness of the do's and don'ts in human-robot interaction.

One concrete example discussed in relation to the application Wound Care was multimodal communication. Will the interaction design benefit from announcing the information vocally as well as on the tablet of the robot, all the while the robot is gesticulating with its arms to emphasize the message? Or is it merely confusing for the patient to focus on all output modalities at once, while also cognitively processing the message of the robot on how to treat the wound? This relates to the risks of the robot application potentially negatively discriminates against patients on the basis of language and disabilities.

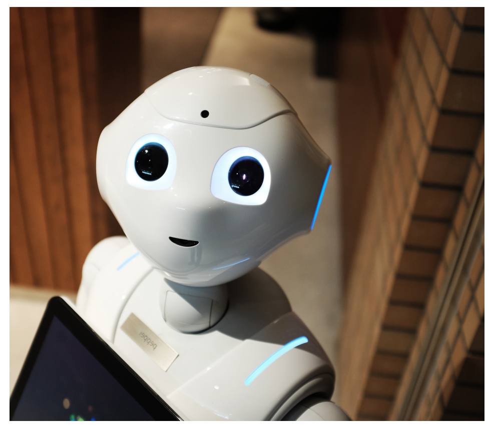
The question of bias in human communication was raised as well. In general, many trusted that medical professionals wrote the dialogue of the robot and appreciated the identical, neutral message given to all interactees with the robot.



Wound Care - feedback

The co-creation process also expressed different opinions on the degree of personalized information/advice on wound care in relation to trustworthiness. Some would trust a robot giving pre-programmed advice on *my* wound, while others would not. Doubts about privacy and data governance were mentioned as reasons to not entrusting a robot to personalized care advice. There are accountability concerns as well, as the co-creators ponder who's reliable for mistakes or risks arising in robot-supported medical advice?

At the same time, many share their high expectations of and enthusiasm for a future where time and place independent hybrid models of providing care are possible. Future use cases are brainstormed, for instance, one where the robot would act as a link between a doctor and the patient and even one where the robot is examining the wound and providing decisions for care. A scientific paper on the topic of health care workers' mental models of SARs in care scenarios is under way.



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Best practice recommendations

The project team of Vasa InnoCare offers a set of best practice recommendations in the design and integration of health care applications for robot platforms, based on the experiences of the co-creation processes. While the intended target group is Finnish actors, others may find the best practices valuable as well as they're quite general in character.

- Adopt a human centred design approach and make sure to include stakeholder groups such as care and organization staff, patients, and relatives. Note, however, that other aspects need to be addressed in the design phase too. Examples include technical and/or legal constraints, ethical challenges, risks that may challenge data protection and integrity, ecological sustainability and responsible energy consumption, and accountability. Therefore, it’s worthwhile to include experts in these areas in the design and assessment phases.

- Estimations of risk and/or consequences must be carried out. Everyone's right to care without discrimination based on disabilities or languages, for example, must not be violated. Ask *What’s the harm* in every design choice made and consider physical harm, but also economic and societal harm, as well as violation of human rights.

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- Assess all three dimensions of sustainability (ecological, economic and socio-cultural) and whether a social robot strengthens these goals.

- Mirror the robot solution against ethical frameworks and conduct self-assessment, and together with others outside the team, based on, for example, the ALTAI, Z-Inspection, Care Centred Value-Sensitive Design framework, or the Charter of Fundamental Rights of the EU.

- Keep up to date with ongoing legislative work on artificial intelligence, both nationally and on a European level, for example, the European Commission's proposal for regulation 2021/0106 (COD) and coming updates to GDPR. Also address accountability, that is who is responsible if, and when, things go wrong.

- Review current technical infrastructure and inform yourself of the requirements and limits of the robot platform. Social robotics is not a fully mature technology yet but is continuously evolving and developing. Apply user-friendly ways to report identified risks and malfunctions. Keep the robot in offline mode to increase resilience to attacks and security.

- Include the entire workflow and care service when considering integrating social robots into healthcare. Rather than viewing a social robot as a stand-alone technique, it is worthwhile reflecting upon what team task the robot may perform in a trustworthy and ethical way.

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- Make sure to inform about the social robot and its tasks and activities. Transparency is important. The persons who will interact with it will want to be informed of the robot's competences, skills, and mission in the workflow. They will want to know why it is there, how to interact with it, and whether any data is being recorded and stored while interacting with the robot. The right to opt in to and out of human-robot interaction and individual autonomy are important. Keep humans in the loop, should there be misunderstandings in the communication.

- Address that robot literacy, i.e., the skills required to interact successfully with a social robot, is still limited in most groups. Many human beings have never met a social robot before and cannot be expected to intuitively know how to approach a robot, interact with it to achieve one's goal in healthcare. Explainability is important and information about human-robot interaction is needed prior to meeting with the robot and close-by the robot.

- Address contextual and environmental requirements of the robot. For the Pepper robot, for example, optimal conditions for human-robot interaction include 1:1 interaction in quiet environments with soft lighting.

- Support disabled persons, for example persons with hearing impairments or vision loss, in their robot communication by applying multimodality, appropriate contrasts in colour, large graphical elements on the tablet if used, to name but a few special accommodations.

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Field integration of the applications

The aim of the project was never to design launch-ready applications to the market. Instead, the aim was to develop, test, and evaluate use cases. The results include three human-centred designs, co-created with relevant stakeholders. As our approach in the Vasa InnoCare project was truly empowering and participatory, meaning that comments, wishes, and suggestions raised in the workshops were implemented where possible in the applications, the applications are human centered to their nature. They may serve as a valuable ground to further design the thing right, and the right thing.

We're happy to share the source codes through licensing, if the licensing party is willing to commit to ethical use of the code, to continuous self- and external assessment through frameworks such as ALTAI, Z-inspection, and/or care-centered value sensitive design and others.

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Future directions of SARs in healthcare

Co-create and work trans-disciplinary
Our intended field work was hindered by pandemic restrictions. We acknowledge the difference between safely evaluating and co-creating SAR applications in a laboratory setting on the one hand, and in real life scenarios on the other. Both are needed.

Think holistically
Address social, environmental, and energy consumption consequences of integrating SARs into healthcare. Pose the question *What's the harm?* to our planet's ecological resources and climate.

Trust is key
Trust is one of the bottle necks. If humans don't trust SARs, they will not turn to them for care support in care either.

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