

ROBODY CARES

ROBOTIC HELPERS IN THE HOME – ENABLED BY TELEPRESENCE.

by Rafael Hostettler

IN SHORT

- The increasing ageing of our society and the shortage of caregivers requires an alternative solution for dignified elderly care.
- Caregivers can control Devanthro's Robodies to care for the elderly from a distance.
- The advantages: Elderly people receive help when they need it and not only when the care team is on site.



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The demographic development in large parts of the world confronts our society with the great challenge of providing an increasing number of people with dignified care that meets their needs with the help of a limited number of caregivers. This whitepaper explains and plausibly presents Devanthro's approach to this challenge and its vision regarding robodies.

THE FUTURE SCENARIO

„It was the little things that almost forced Fränzi Fröhlich (74 years) to move into a nursing home. Still fit in the head, alas, the body doesn't want to go on like before. But then, fortunately, she came across Devanthro's Robodies, cooperative humanoid service robots with a telepresence system, operated by a care service. Every day, Fränzi lets her Robody help her get dressed and do all the little everyday tasks, saving a professional caregiver from having to travel to her home.

The Robody is remotely controlled by a carer. This way, Fränzi always has help when she needs it and not only when the care service is on location. Thanks to the intuitive telepresence interface with haptic feedback, through which the carer perceives the world from the Robody's perspective, the Robody can naturally imitate the complex movements of everyday life. Fränzi's safety is guaranteed by the cooperative control algorithm used. This makes Fränzi feel well taken care of, just like when the caregiver visits her in real life."



Fig. 1 - Robody 3.0 assists, for example, in opening sealed jars of pickles, but is also a social contact at dinner. (Vision film by Sunrise Communication AG on future applications of 5G in Health Care, Switzerland)

ROBOTS & CARE

A 2020 study¹ shows that lack of product customisation, poor usability as well as lack of integration into the target scenario are the main reasons for the failure of robotics start-ups. Devanthro addresses exactly these problems in its go-to-market strategy. To address usability issues, the system is developed in close consultation with users. Hereby, the caregiver is placed in the robody's position auditorily, visually and haptically and can control the robody intuitively with the whole body. This contrasts with classic teleoperation approaches, where a robot is controlled via a joystick and various camera images on the

screen. In combination with the control of the Robody by professional caregivers, this leads to a suitable integration into the target scenario.

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According to current research, it cannot be assumed that autonomous systems will act flexibly, quickly and reliably enough in the foreseeable future to be used autonomously in outpatient care. The biggest obstacle to achieving a satisfactory level of performance and safety is the highly unstructured environment. A novel concept to combine the strengths of autonomous functionalities and human expertise is therefore currently indispensable for marketable systems.

¹ <https://www.freshconsulting.com/insights/white-papers/why-robotics-companies-fail/>

ROBODIES AS AN OPPORTUNITY

The system can counteract the current nursing shortage in Germany by establishing the teleoperation centre outside of Germany and thus opening up new labour markets. In view of declining quality of care, excessive demands and dissatisfaction of those involved, robot-based teleoperation is an important Ambient Assisted Living technology with great potential. By using a cooperative telepresence approach, the concept still enables human interaction between caregiver and those in need of care. Since care recipients often benefit greatly from this interaction, this is a very big advantage over purely autonomous robotic systems and leads to increased user acceptance. Outside of the care context, the telepresence system can be used in industry, construction, factory monitoring or the hospitality sector. In addition, the system allows contact avoidance and risk minimisation in pandemics.

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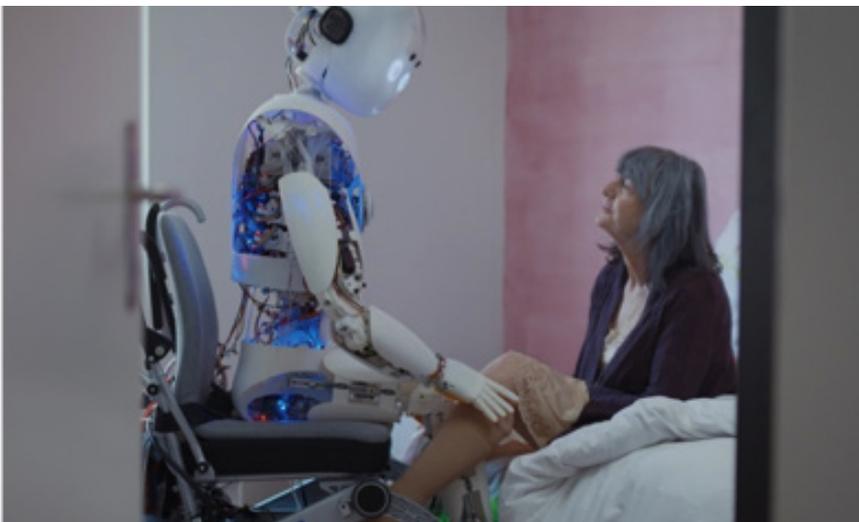


Fig. 2 - Roboy 3.0 assists in putting on support stockings. (Vision film by Sunrise Communication AG on future applications of 5G in Health Care, Switzerland)

STATE OF THE ART

The emerging demographic trend requires innovations to improve the quality of life of elderly people. Robotic technology can support the elderly in a variety of aspects, such as

- mobility,
- independent living,
- or even well-being and self-monitoring (e.g. of blood sugar).

The systematic review by Bedaf 2015 [2] identified 107 robots designed for elderly people, only six of which are commercially available. Telepresence robots such as «Double» and social robots such as «Paro» are gaining commercial distribution, but are limited in their functional scope. Service robots that go beyond this and are able to perform generic manipulation tasks are rare on the market. Some examples are «Care-o-Bot» [9], «Robot-Era» [3] and «Lio»². Besides reliability, guaranteed safety is of utmost importance when using service robots in practice, as such systems are intended to work in close cooperation with humans [6] [7].

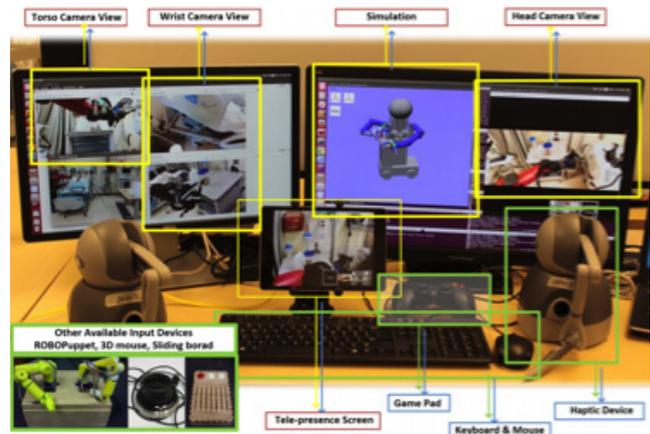


Fig. 3 Teleoperation interface ¹¹

The autonomous capabilities of available service robots are not sufficient to enable socially and physically competent behaviour. The addition of an operator to remotely control the robot can significantly improve robot performance. However, until now the use of teleoperation in personal service robotics has been severely limited. User studies [10] [11] that focus on care using classical teleoperation usually recruit professional caregivers as teleoperators. The results show that a non-intuitive user interface is one of the main obstacles to the use of such systems in practice. Complex user interfaces as well as caregivers' difficulties to understand the limits of robotic joints, end-effector rotation or camera perspectives, lead to imprecise manipulation and significantly increase the time needed to complete the task [11]. An example setup to illustrate the complexity of current user interfaces is given in Fig. 3.

An approach for combining the advantages of autonomous robots and human expertise is given in methods from the research area of cooperative control. In the application presented in this whitepaper, the strengths of humans, such as situational awareness, transfer of knowledge and adaptability, are combined with the strengths of automation, such as precision and high availability [4]. The factors mentioned in [15] for the profitable use of cooperative control are also present for the use case described in the example scenario:

The operating environment of the robot – the private home of the person to be cared for – is highly unstructured and therefore difficult to capture for complete automation. In contrast, the use of cooperative control can support a teleoperator with regard to various aspects of the task. In addition to increasing efficiency on the part of the teleoperator (caregiver), the safety of the person in need of care can also be guaranteed. In order to enable a profitable use of

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² <https://www.fp-robotics.com/en/care-robotics/>

cooperative control procedures, the further development of existing teleoperation user interfaces is indispensable. Currently, immersive approaches are being researched and developed as a priority. Human whole-body motion mapping is particularly well suited for a humanoid robot to control motion coordination [1] [8]. For example, Triantafyllidis and colleagues [19] report that regardless of the complexity of the manipulation task, stereoscopic vision with virtual reality goggles increased performance by 40 percent on all measurements compared to monocular vision on a monitor.

ETHICAL ISSUES

In the context of the development of this innovative robotic and telepresence technology, including user-centred engagement, legal, social and ethical issues must also be considered. The following ELSI issues are addressed:

- A vulnerable target group (1),
- who interacts socially with a robot (2),
- lives at home and requires outpatient care (3).

The degree of care and the respective effort required by this target group is often lower than for those in need of inpatient care. However, outpatients suffer from a wide variety of illnesses that limit them physically and cognitively in their daily routine (personal hygiene, activities of daily living). The Robody is intended to provide relief and support, which must be developed under the highest safety aspects (e.g. responsibility in the event of failure of the robot system) due to the close contact with the person in need of care. Throughout the project, the requirements of outpatients in need of care are always taken into account, in accordance with § 14 SGB XI, with a focus on autonomy, self-organisation and quality of life.

INNOVATION AND NOVELTY

Devanthro's Robodies are the first cooperative immersive telepresence system for use in ambulatory care. The cooperative control enables the performance of near-body care services that are not manageable with today's fully automated procedures. By combining a novel immersive teleoperation interface with cooperative control techniques, (outpatient) caregivers are enabled to perform care tasks more efficiently. Technologies such as stereoscopic vision, full-body motion mapping, haptic feedback and bidirectional audio connection are used to enable human interaction between a caregiver and a care recipient. This leads to an increase in the safety of robot operation by reducing previous problems, such as mechanical limitations of the robot as well as operator fatigue. By eliminating travel time to the patient, one caregiver can care for more patients.

OPPORTUNITY IN THE MARKET

Nursing homes are very costly for those affected. A stay in an inpatient care facility costs an average of 1,691 euros per month (care, hotel and investment costs), which is an additional payment to the care insurance. Devanthro's Robodies enable those affected to cope with everyday life independently for longer, which can mean a considerable gain in quality of life for them and their relatives. For this solution to be economically attractive, the total cost of the system must be less than the average monthly cost of residential care. The biggest cost items are the prime costs for the system and the personnel costs for the teleoperators.

For the first customers, the system represents an economically demanding solution whose advantages lie mainly in social factors. With the onset of economies of scale, a broad applicability is given from approx. 100 units, which is also economically superior to stationary accommodation. The Robodies' target market in Germany alone comprises 1.65 million outpatiently cared-for people with care degrees 2 and 3. The market for outpatient care services in Germany is worth over 20 billion euros in 2020. The system can be internationalised with little effort, so that further markets are open. In addition, the benefits of the system can be increased through further features. For example, a social network connecting patients with other patients or a connection to relatives would be possible. Other everyday tasks can also be taken on, which can be processed flexibly in terms of time, in order to optimise the utilisation of the teleoperation systems and at the same time to open up a lucrative additional business field.

« **One possibility would be a social network connecting patients with other patients or a connection to relatives.**

ADVANTAGES OVER COMPETING SOLUTIONS

Through the principle of teleoperation, Devanthro's Robodies can guarantee a higher level of safety [6], reliability and competence coverage compared to the autonomous service robots prevailing on the market. Compared to other teleoperated service robots, the system offers a better user experience for the caregiver and the patient due to the immersive and intuitive operator interface with haptic feedback and the friendly appearance of the robody.

BEYOND CARE

Although the first generation of Robodies is designed for care, the technology can be extended to other user groups and use cases. This includes, for example, people with disabilities or patient care during a pandemic. In addition, the Robody can be equipped with further sensors (e.g. to measure vital parameters) that provide information for remote patient diagnosis.

Another important aspect is that robotics allow data to be collected on robotic actions and interactions in a real home environment. This data is very valuable and can be used as training data for the gradual development of autonomous functions. Subsequently, semi-autonomous systems will further reduce costs and increase the value of such care robots. Such robotic systems can then also be used outside the care sector, leading to a further increase in acceptance, reduction of costs and ultimately penetration of daily life.



Fig. 4 Roboy 3.0 and telepresence HW setup

DEVANTHRO GMBH

Devanthro GmbH was founded in 2018 to further develop the results from the Roboy project³ and has its core competence in the development of musculoskeletal, tendon-controlled robotic systems. The focus is on a series of humanoids, starting with Roboy Junior (2013) through Roboy 2.0 (2018) to Roboy 3.0 (2020). Since 2019, the company has also been developing an immersive telepresence system to control its robots.



³ <https://www.robey.org/>

ABOUT THE AUTHOR

Rafael Hostettler

Making robots as versatile as human bodies – that’s what Rafael Hostettler has been working on for over 10 years. After studying computational science and engineering at ETH Zurich, Hostettler started the «Roboy Project» in 2013, which aimed to develop a humanoid robot. Since then, he has continuously developed his first prototype, «Roboy Junior». In 2018, Hostettler founded the Devanthro GmbH. Their goal: every 6 months, the robot should be able to do something new.

WEBSITE [robey.org](https://www.robey.org/)

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