Service robotics for the nursing sector

As part of the Serodi project (Service Robotics for Personal Services), Fraunhofer IPA (Germany) collaborated with other research and application partners to develop service robotics solutions for the nursing sector.

Figure 1: The "intelligent care cart" uses some modules of the Care-o-Robot IV platform (Source: IPA Fraunhofer)

Service robots in healthcare are gaining importance. In the European Serodi project, "intelligent care carts" and the "robotic service assistants" were used in real-world trials in a hospital and at two care homes. This enabled the project partners to confirm the benefits of the robots for reducing the workload of nursing staff.

Not enough nurses for too many patients or residents: this is a familiar problem in the nursing sector. To address this, there is a need for solutions that not only reduce the physical and information-management workload of the staff, but also free them up to spend more time with those in need of care. The use of state-of-the-art nursing aids to assist the staff also makes it possible to add to the attraction of the nursing profession while maintaining an adequate quality of care also under challenging conditions. This is where service robots of the kind developed by Fraunhofer IPA and its partners under the Serodi project can be of benefit. The project received funding from the German Federal Ministry for Education and Research.

"Intelligent care cart" summoned at the press of a button

To cut down the legwork of the nursing staff and reduce the time spent keeping manual records of the consumption of medical supplies, Fraunhofer IPA in collaboration with the MLR company developed the "intelligent care cart". Using a smartphone, the nurse is able to summon the care cart to the desired room, whereupon it makes its own way there. ▷

Figure 2: The robotic service assistant is capable of operating in common rooms at care homes and hospitals, where it serves drinks and snacks to the residents or patients (Source: IPA Fraunhofer)

If the room is on a different floor, the care cart can use the lift. A 3D sensor along with object recognition software enables the care cart to automatically register the consumption of medical supplies. If an item is running low or the battery needs recharging, the care cart travels autonomously to the storage area or charging station once this the staff has approved.

Being of modular design, the care cart can be adapted to different application scenarios and practical requirements. While it served for the transport of laundry items at the care homes, it was used to carry wound treatment materials in the hospital. A further feature of the "intelligent care cart": it was always locked, the nurse opening it by logging in on the tablet. This also made it possible for the care cart to transport items that would otherwise have to be stored in a locked room and fetched only when needed.

The "intelligent care cart" makes its own way to the desired room and is also capable of using a lift. The nurse can summon it from a smartphone, which means less legwork for staff.

Testing in coordinated real-world trials

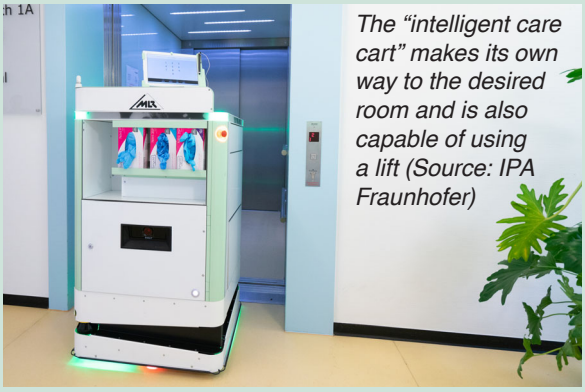
The care carts developed as part of the project were used in two coordinated multi-week trials at the participating establishments in Mannheim (Germany), the University Clinic as well as the Waldhof and the ▷

Service robotics for person-related services

Fraunhofer IPA has developed two robot solutions for inpatient care as part of the Serodi project. The aim of both is to relieve the strain on staff and thus give them more freedom for the actual care activities. The “intelligent care cart” navigates autonomously, i.e. the nurse can order it to the desired location via smartphone, thus saving long walking distances. The automatic recognition of the removed objects also reduces the effort required for the manual documentation of used care utensils. The second robot in the practical test was the “robotic service assistant”. It also navigates autonomously in common rooms, recognizes people and offers them drinks. Here too, the use of robots is intended to relieve the strain on staff and increases the residents' fluid intake through regular reminders, as well as promoting their independence.

The care cart uses the mobile platform of the Care-O-bot 4 service robot (see also the article in the March issue of CAN Newsletter 2016) with a new body that can be stocked with care utensils. The mobile platform uses for low-level communication CANopen networks.

If the care cart is connected to the call system of the care home or hospital, it can travel automatically to the room from which the patient has rung. The built-in touchscreen allows the care staff to confirm their presence and, once the robot is no longer required, to free it up for its next assignment.



The “intelligent care cart” makes its own way to the desired room and is also capable of using a lift (Source: IPA Fraunhofer)

Some service robot sub-systems use embedded CANopen networks in conjunction with ROS (Robot Operating System) software. The open source ROS (BSD license) comprises libraries and tools to help software developers create robot applications. They can be downloaded from the ROS website. It provides hardware abstraction, device drivers, libraries, visualizers, message passing, package management, and more. The CANopen library of ROS complies with CiA 301. It features a high-level object dictionary for all simple types (except Boolean), SDO client function, PDO subscriber/publisher capability, EMCY handling, and NMT with Heartbeat support. Node-guarding is not supported. A plug-in provides node synchronization my means of SYNC services. To simplify system design, the parser for EDS/DCF compliant with CiA 306 can be used. A library for CiA 402 compliant motion controllers is also available.

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Figure 3: The service assistant can hold up to 28 cups or various snacks (Source: IPA Fraunhofer)

Ida Scipio senior citizens' homes. Whereas, at the care homes, the robot was stocked with laundry items directly by the nursing staff on the ward, the care cart used at the University Clinic was integrated into the hospital’s extensive logistical processes. The modular baskets containing the dressing materials were restocked at the hospital’s central logistics facility and sent to the wards, which meant that all the nursing staff had to do was to replace empty baskets with pre-packaged ones, with no need to put all the items together themselves. To further reduce the workload of the staff, Fraunhofer IPA is currently working on a solution also to automate the changing of the modular baskets.

Findings from the trials

One important finding from the real-world trials concerned the navigation of the care cart. As the “intelligent care cart” is based on the navigation processes of a driverless transport vehicle, it travels primarily along fixed predefined paths. For use in public spaces, it is possible to make minor deviations from these paths in order, for example, to dynamically negotiate obstacles in the way. The real-world trials revealed that efficient navigation requires extensive knowledge of the internal processes in order, among other things, to guarantee that the desired destination is actually accessible.

The initial trials also showed that it makes a difference whether the corridors have a single lane for both directions or separate lanes, i.e. one for each direction. A single lane proved more advantageous, as it was then unnecessary to keep so much space clear along the narrow corridors – even if this meant the robot not stopping immediately outside every room and sometimes having to travel with the drawers towards the wall and not turning until at the destination. For the residents and staff, however, this made it clearer where the robot was going. In addition, restricting the care carts to a single lane ensured that they did not have to make major detours in order, for example, to switch from one side of the corridor to the other.

The robotic service assistant is capable of operating in common rooms at care homes and hospitals, where it serves drinks and snacks to the residents or patients. ▷

Robot arm as well as control and operator module

The service robotics modules support the open source ROS software framework and the control module features CANopen functionality (Source: Pilz)

Pilz (Germany) has expanded its product portfolio by sub-systems for service robots. The products include initially the robot arm, the control module and the operator module. The essential features are openness, i.e. due to the open source ROS (Robot Operating System) software, user-friendly operation and fast commissioning according to the plug-and-play principle.

Robot arm, control module, and operator module together form a package certified by the German statutory accident insurance association (DGUV) in accordance with EN ISO 10218-1 "Robots and robotic devices" and they provide the requirements for the implementation of safe robot applications. This simplifies the way to the obligatory CE marking. The areas of application also include pick-and-place applications and modular semi-automated small robot cells in industry.

The robot arm enables a machine load of 6 kg. Due to six aces, a weight of 20 kg and a 24-V_{DC} voltage supply it is suitable for use in mobile applications, for example combined with an automatic guided vehicle (AGV).

The PRCM (Pilz robot control module) unit takes care of the movement and safety control of the robot. With the plug-and-play capability, users can connect the modules and use them without configuration. The control module supports CANopen and other communication networks. The PRCM unit can be programmed with PLC (programmable logic controller) languages compliant with IEC 61131-3 and via the ROS framework.

Pilz developed software modules for the control of robots based on the ROS software framework. This software offers functions for sensor processing, evaluation, planning, and controlling of robots.

The PRTM operator module enables the operation of the robot via a graphical user interface, due to an operator and visualization system developed by Pilz. The panel offers the functions of operating mode selection, emergency stop and diagnostics. It permits setup and teaching of the robot arm via a sensitive touch display.

"Pilz is a technology company that offers complete solutions for safe robotics", explained Susanne Kunschert from Pilz. "As a system supplier for service robotics, we can support users when implementing their individual robot applications, including the requires safe sensor technology and the required services on the way to CE marking", she added. *hz*

This not only reduces the workload of the staff, but also promotes the independence of those in need of care.

Evaluating the real-world trials, the participating nursing staff confirmed that, by reducing the amount of legwork, along with the associated timesaving, the "intelligent care cart" represents a potential benefit in their day-to-day work. Also, the faster provision of care, with no interruptions for restocking the care cart, results in an improvement in quality for patients and residents. The nursing staff described the control of the care cart using a smartphone and touch screen as straightforward. In addition to the nursing staff, the residents and patients as well as their relatives showed great interest in the new technology. "Having hit upon the idea of an "intelligent care cart" already some years ago, and with many potential users having shown great interest in the idea, I was delighted finally to see the care cart in operation as part of the Serodi project in the corridors of the hospital and care homes," emphasizes Dr. Birgit Graf, who heads the Domestic and Personal Robotics group at Fraunhofer IPA.

Robotic service assistant serves drinks to residents

Alongside the "intelligent care cart", the robotic service assistant is another result of the Serodi project. Stocked with up to 28 drinks or snacks, the mobile robot is capable of serving them to patients or residents. Once again, the goal is to reduce the workload of the staff, in addition to improving the hydration of the residents by means of regular reminders. Using the robot also has the potential to promote the independence of those in need of care.

At the Waldhof home for elder people, where the robotic service assistant was trialed for one week in a common room, it made for a welcome change, with many residents being both curious and interested. Using the robot's touch screen, they were able to select from a choice of drinks, which were then served to them by the robot. The service assistant can hold up to 28 cups or various snacks. Once all the supplies had been used up, the service assistant returned to the kitchen, where the staff restocked robot before being sent back to the day room by the use of a smartphone.

This robot, too, received great interest from the participating nursing staff, who also discussed a host of possible improvements and additions to the robot in the course of the trial. Interaction with the residents was successful in the majority of cases, it merely sometimes being necessary for them to be shown how to use the touch screen. The synthesized voice of the robot was especially popular and even motivated the residents to converse with the robot.

The service assistant can recognize individuals, take up a position next to them and serve them with a drink while making use of its synthesized voice. The patients or residents can use the touch screen to select a drink, which they then take from the delivery compartment.

Results of trials pave the way for further improvements

"For us, the real-world trials provided valuable knowledge, enabling us to further optimize the robots and even better adapt them to the needs of users," said Graf, summing up. For instance, the Serodi project has given a major boost to the use of new robotic solutions in the nursing sector. The medium-term goal is to make the improved prototypes ready for series production in collaboration with interested companies. At the same time, Fraunhofer IPA is continuing its long-standing work to open up new applications, including the development of robotic solutions for the nursing sector. ◀

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