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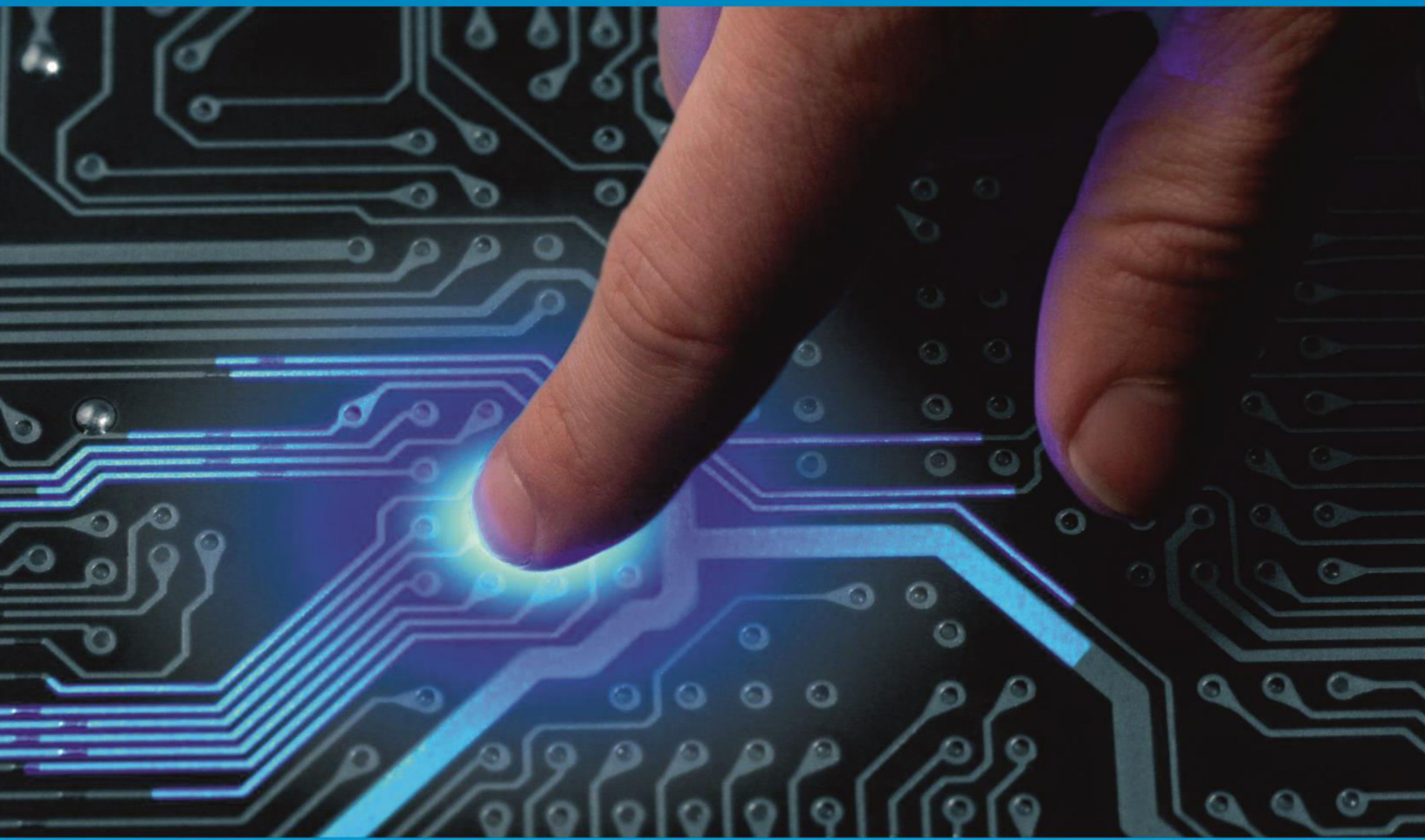

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Medical Assist Robot for Isolated Ward Patient in Hospital

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ABSTRACT: Lio is a mobile robot platform with a multifunctional arm explicitly designed for human-robot interaction and personal care assistant tasks. The robot has already been deployed in several health care facilities, where it is functioning autonomously, assisting staff and patients on an everyday basis. Lio is intrinsically safe by having full coverage in soft artificial-leather material as well as having collision detection, limited speed and forces. Furthermore, the robot has a compliant motion controller. A combination of visual, audio, laser, ultrasound and mechanical sensors are used for safe navigation and environment understanding. The ROS-enabled setup allows researchers to access raw sensor data as well as have direct control of the robot. The friendly appearance of Lio has resulted in the robot being well accepted by health care staff and patients. Fully autonomous operation is made possible by a flexible decision engine, autonomous navigation and automatic recharging. Combined with time-scheduled task triggers, this allows Lio to operate throughout the day, with a battery life of up to 8 hours and recharging during idle times. A combination of powerful on-board computing units provides enough processing power to deploy artificial intelligence and deep learning-based solutions on-board the robot without the need to send any sensitive data to cloud services, guaranteeing compliance with privacy requirements. During the COVID-19pandemic, Lio was rapidly adjusted to perform additional functionality like disinfection and remote elevated body temperature detection. It complies with ISO13482 - Safety requirements for personal care robots, meaning it can be directly tested and deployed in care facilities.

I. INTRODUCTION.

Recently robots have been gaining popularity outside the factory floors and entering unstructured environments such as homes, shops and hospitals. They range from small devices designed for internet-of-things (IoT) applications to larger physical robots which are capable of autonomously navigating in indoor and outdoor environments, sharing the workspace with people and even interacting with them. Given the issue of ageing population and shortage of medical and nursing staff in many countries, this naturally leads to attempts to use robotics and automation addressing this problem [1] [2]. For example, in Switzerland, the number of people over 80 years of age is expected to double from 2015 to 2040 [3]. It will result in nearly triple nursing costs for the Swiss healthcare sector. Furthermore, healthcare employees are experiencing severe working conditions due to stress, underpayment and overtime. For example, Between 8% and 38% of health workers suffer physical violence at some point in their Authors are with F&P Robotics AG, Z¨urich, Switzerland, info@fp-robotics.com, www.fp-robotics.com careers [4]. A possible staff shortage of 500’000 healthcare employees is estimated in Europe by the year of 2030 [5]. Care robotics is not an entirely new field. There has been significant development in this direction. One of the most known robots is Pepper by SoftBank Robotics, which was created for interaction and entertainment tasks. It is capable of voice interactions with humans, face and mood recognition. In the healthcare sector Pepper is used for interaction with dementia patients [6]. Another example is the robot RIBA by RIKEN. It is designed to carry around patients. The robot is capable of localising a voice source and lifting patients weighing up to 80 kg using remote control [7]. The Sanbot Elf robot by QIHAN has numerous sensors allowing it to monitor the health condition of patients and residents. A recent study with Sanbot Elf even tested its capability to detect fallen elderly residents [8]. However, the robot is not capable of handling and manipulating objects. Another robot is WALKER by UBTECH. It can manipulate objects, climb stairs and do yoga [9]. The COVID-19 crisis has given an increase in robots applicable to the health care sector. Most of them are not able to manipulate objects, they are optimised for autonomous driving and delivery of objects. Robots like Peanut from Keenon Robotics Co., the SAITE Robot or the NOAH Robot have been deployed to assist with it. The Care-o-bot 4 by Unity Robotics and Fraunhofer IPA is used in four shopping centres. It can recognise faces, provide daily news and handle objects [10]. Despite the initial focus on the healthcare market, the existing applications are limited to pilot projects only. One more healthcare oriented robot is Moxi by Diligent Robotics. Compared to previously described robots, the focus of Moxi is not interacting with people, but rather lies in the logistic of hospitals. The robot can deliver medical samples, carry laundry, bring supplies and greet patients [11]. It uses a mobile platform, arm, gripper and an integrated lift to adjust its height. Moxi is mostly capable of completing the tasks in an end-to-end manner. Door

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opening and closing procedures are not in the range of its capabilities, it relies on automatic door systems or places the packages outside the room. Furthermore, the robots of PAL Robotics, primarily the REEM-C and TIAGo robots, could be used in the healthcare sector. They are developed with research and industry in mind but no specific application. Open platforms allow users to freely explore possibilities, such as gesture recognition 12 packages outside the room. Furthermore, the robots of PAL Robotics, primarily the REEM-C and TIAGo robots, could be used in the healthcare sector. They are developed with research and industry in mind but no specific application. Open platforms allow users to freely explore possibilities, such as gesture recognition [12].
Fig. 1. Overview of Lio: sensor and hardware setup

In the market of social robots, there are more platforms focused on interaction without manipulation capabilities such as PARO, KIKI, AIBO, Buddy, Kuri, Mykie and Cozmo. While such robots often achieve their goal of creating positive emotions, or even therapeutic progress, they are incapable of assisting or solving tasks. In this paper, a personal robot platform - Lio, shown in Fig. 1, is presented. The robot is specifically designed for autonomous operation in health care facilities and home care by taking into account the limitations of other robot platforms and improving upon it. Lio is intrinsically safe for human-robot interaction. It is the next iteration robot platform built upon the experience of creating a P-Care robot, which was a well-accepted personal robot developed for Chinese markets [13]. First of all, the system is described from the hardware point of view, explaining the functionality and capabilities of the robot. Then software, interfaces and existing algorithms are presented followed by the challenges of operating a robot in hospital environments. Eventually, existing use cases and deployments of Lio are presented incorporating evaluation and current limitations of the system. The paper is concluded with an overview of Lio in the context of personal care and research applications followed by current developments and future work.

II. SYSTEM DESCRIPTION

Lio, a personal assistant robot for care applications can complete a wide variety of complex tasks. It can handle and manipulate objects for applications in health care institutions and home environments. Furthermore, it operates autonomously in an existing environment without requiring significant adaptations for its deployment. The design of Lio evolved as an iterative process. During the deployments, observations and interactions with staff and patients were taken into account for further development. A set of heterogeneous sensors are embedded in the robot. It provides Lio with the capabilities of navigating, understanding and interacting with the environment and people. A combination of in-house developed robot control and programming software myP together with algorithms based on the Robot Operating System (ROS) introduces a nodebased system functionality communication between all the modules and an easy overview, control and interchangeability of all the software modules. For custom development, full access to the sensor data and control of the robot is provided. A. Robot Hardware Overview Lio consists of a robot arm placed on top of a mobile platform. The robot was designed by keeping in mind the workspace of the robot arm. It enables Lio to combine arm and mobile platform movements to grasp objects from the ground, reach table-tops and be at a comfortable height for interaction with people in wheelchairs. It was a necessary measure to ensure that the robot is not too tall in order not to be intimidating to people who are sitting. Padded artificial-leather covers ensure that Lio will not cause injuries in the event of a collision but also providesignificantly more cosy and friendly appearance compared to hard-shell robots. Majority of the body has a soft-feel to it, which helps with the acceptance of the robot. In any health care environment, data privacy is at the utmost importance. Lio was specifically designed to have enough processing power to be able to run complex algorithms, including deep learning based ones, entirely locally without the need for cloud computing or transferring data outside of the robot. Lio has four embedded computing units: Intel NUC, Nvidia Jetson AGX Xavier, Raspberry Pi and an embedded PC with Atom processor. Each of the computing units is responsible for running separate modules with constant communication using an\ internal secure Ethernet network. Communication is based on ROS topics, meaning that additional modules could be integrated into the system by using standard ROS communication protocols and make use of sensor data.

III. ROBOT OPERATION

Lio is an autonomous robot proactively performing tasks. On a high-level, this proactive autonomy is controlled by the decision engine system, which gathers information about the robot status and environment to choose the best-suited action to perform at a given moment [18]. Operation of Lio is ensured by a combination of perception, memory and planning components. Perception of the environment ranges from low-level sensory inputs up to high-level information delivered by AI algorithms. This real-time feed, together with introspective information and robot memory,

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serves as the information pool for the decision engine - the core component ensuring reactive autonomous behaviour of the robot. It is a high-level component deciding The decision engine uses the SWI Prolog logic programming language to model relations in the environment of Lio [19]. In addition to pre-defined common-sense rules, the users can define their reasoning mechanisms tailored to their application. All information available to the robot is evaluated by the set of decision rules to produce the most suitable action proposal at the given moment. This proposal is compared with inputs from manual user commands and scheduled actions from the calendar. Based on a priority system the most important action is selected for execution. This priority selection is also able to interrupt running skills to start more important ones. Commonly the deployment of Lio in a facility is connected with a set of project-specific routines. For example, in some institutions, Lio is distributing mail around the clinic and collecting blood samples to be delivered for analysis. A routine may require special equipment, material or tools. Lio can have custom holders for the tasks. The robot requests the staff to place a specific holder before starting the routine .

IV. EXPERIMENTS AND USE CASES

Lio robots have been deployed in seven different health care institutions in Germany and Switzerland. Some robots already operate for over a year. Robots have daily routines such as collecting lab samples from different wards and bringing them to the pick-up point at the reception and then delivering the mail to those same wards in a rehabilitation clinic. In the remaining time, Lios entertain patients and visitors with stories of former patients or encourages to join in on a few simple exercises. Robots also remind residents about their scheduled activities by knocking on their door, opening it, saying out loud information about upcoming events and closing the door when leaving. Staff can control Lio using a tablet to schedule reminders and start high-level commands like playing the music and offer snacks. Robots are also capable of driving to the rooms of the residents and taking the menu orders. This information is sent to the catering service. In one of the projects, Lio was deployed in the home of a person with paraplegia for several weeks. The robot allowed he woman to have more independence by assisting with her daily tasks like taking and opening a bottle using a builtin automatic bottle opener and handing it over. She could manually control Lio over her smartphone to assist with more complex tasks such as taking off the jacket.

V. CONCLUSIONS AND FUTURE WORK

Lio is considered an all-in-one platform suitable for human-robot interaction and personal care tasks. Its design has evolved, both in hardware and software, to address the limitation of similar platforms and ensure the requirements of health care institutions, as well as home care, are met. Lio is intrinsically safe due to the padded artificial-leather covers covering the majority of the robot, limited forces and speed, soft mode, advanced navigation and behavior algorithms. The robot complies with ISO13482 standard - safety requirements for personal care robots. Lio has a robotic arm placed on a moving platform; it is capable of both, assisting and interacting with people. Lio has been proven during multiple deployments in health care institutions and had positive feedback regarding functionality as well as acceptance by patients, residents and medical staff. Currently, the majority of the robots were sold as products, while the remaining deployments are part of the on-going projects. Autonomous operation capability ensures that Lio can be easily deployed with just a brief training Time for staff on how the robot operates and how it should be used. What differentiates Lio from other service robots are the manipulation capabilities of the large arm and gripper which allows opening doors, grasping, bringing, and handing over water bottles, and handling tools for UV-C disinfection. Combined with large and customisable inventory space, it allows Lio to carry and operate a large variety of tools. All the basic functionalities, as well as some advanced navigation, perception and AI algorithms, are deployed on the robot. Algorithms can be easily enabled and disabled depending on the project needs making it easy for researchers and developers to use existing algorithms and focus on their field of expertise for improvements. According to customer feedback, Lio is constantly being updated both, in terms of hardware and software. The development is focused to improve upon identified issues and to increase the level of autonomy. Multi-floor mapping and elevator use is planned, as well as marker-less identification and localisation of objects like door handles, elevator buttons and light switches to allow the robot operation in larger areas of the facilities. Lio can manipulate a variety of objects and have them in inventory. Motion planner will be adapted to take items held on the gripper or on the back of the robot into consideration when calculating the collision-free path. Another goal is to make Lio more proactive in terms of interaction. It means advanced behaviour models to allow the robot to find specific people around the facility, actively approaching them and enabling scene understanding to determine if certain expected actions occurred. For example, if a glass of water was handed to a person, to ensure that he or she drank the water to stay hydrated. Additionally, hardware adjustments are planned to include advanced 3D sensor in the gripper, as well as to update the appearance to convey emotional responses in user communication. Improvements on natural language processing are planned as well to enhance the communication with wakeword recognition and chatbot capabilities. To enhance the robot behaviour

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development, improve testing and evaluate capabilities of Lio before acquiring the robot, a full-feature realistic simulation is being developed with full support of ROS and ROS2, including all the interfaces described in this paper.

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REFERENCES

[1] P. Flandorfer, “Population ageing and socially assistive robots for elderly persons: the importance of sociodemographic factors for user acceptance,” International Journal of Population Research, vol. 2012, 2012.
[2] D. Oliver, C. Foot, and R. Humphries, Making our health and care systems fit for an ageing population. King’s Fund London: UK, 2014.
[3] Credit Suisse, “Die Zukunft des Pflegeheimmarkts,” Pf¨affikon: Schellenberg Druck AG, 2015.
[4] World Health Organisation, “WHO — Violence against health workers,” https://www:who:int/violence injury prevention/violence/workplace/en/, (Accessed on 05/13/2020).
[5] R. Heinz, M. Rolf, and U. Rainer, Themenreport “Pflege 2030” Was ist zu erwarten was ist zu tun? Bertelsmann Stiftung, 2014.
[6] T. Ikeuchi, R. Sakurai, K. Furuta, Y. Kasahara, Y. Imamura, and S. Shinkai, “Utilizing social robot to reduce workload of healthcare in Aging, vol. 2, no. suppl 1, pp. 695–696, 2018.
[7] M. Goeldner, C. Herstatt, and F. Tietze, “The emergence of care roboticsA patent and publication analysis,” Technological Forecasting and Social Change, vol. 92, pp. 115–131, 2015.
[8] J. Bauer, L. Gr¨undel, J. Seßner, M. Meiners, M. Lieret, T. Lechler, C. Konrad, and J. Franke, “Camera-based fall detection system with the service robot sanbot ELF,” in Smart Public Building 2018 Conference Proceedings, Stuttgart, DE, 2018, pp. 15–28.
[9] “UBTECH Shows Off Massive Upgrades to Walker Humanoid Robot - IEEE Spectrum,” https://spectrum:ieee:org/automaton/robotics/
humanoids/ubtech-upgrades-walker-humanoid-robot, (Accessed on 05/19/2020).
[10] R. Kittmann, T. Fr¨ohlich, J. Sch¨afer, U. Reiser, F. Weißhardt, and A. Haug, “Let me introduce myself: I am Care-O-bot 4, a gentleman robot,” Mensch und computer 2015–proceedings, 2015.
[11] E. Ackerman, “Moxi Prototype from Diligent Robotics Starts Helping Out in Hospitals,” IEEE Spectrum. https://spectrum.ieee. org/automaton/robotics/industrial-robots/moxi-prototype-fro mdiligent- robotics-starts-helping-out-in-hospitals, 2018.
[12] S. Pfeiffer and C. Angulo, “Gesture learning and execution in a humanoid robot via dynamic movement primitives,” Pattern RecognitionLetters, vol. 67, pp. 100–107, 2015.
[13] M. Fr¨uh and A. Gasser, “Erfahrungen aus dem Einsatz von Pflegerobotern f¨ur Menschen im Alter,” in Pflegeroboter. Springer, 2018,pp. 37–62.
[14] C. Stachniss, U. Frese, and G. Grisetti, “OpenSLAM,” URL: http://www. openslam. org, vol. 2, 2007.
[15] D. Fox, W. Burgard, F. Dellaert, and S. Thrun, “Monte carlo localization: Efficient position estimation for mobile robots,” AAAI/IAAI, vol.1999, no. 343-349, pp. 2–2, 1999.
[16] D. Fischinger, P. Einramhof, K. Papoutsakis, W. Wohlkinger, P. Mayer, P. Panek, S. Hofmann, T. Koertner, A. Weiss, A. Argyros, et al.,
“Hobbit, a care robot supporting independent living at home: First prototype and lessons learned,” Robotics and Autonomous Systems,
vol. 75, pp. 60–78, 2016.
[17] “Thermal Imaging for Detecting Elevated Body Temperature — FLIR Systems,” https://www:flir:com/discover/public-safety/thermalimaging-for-detecting-elevated-body-temperature/, (Accessed on 05/05/2020).
[18] T. Niemueller, G. Lakemeyer, and A. Ferrein, “Incremental task-level reasoning in a competitive factory automation scenario,” in 2013 AAAI Spring Symposium Series, 2013.
[19] J. Wielemaker, T. Schrijvers, M. Triska, and T. Lager, “SWI-Prolog,” Theory and Practice of Logic Programming, vol. 12, no. 1-2, pp. 67–
96, 2012.
[20] Food, D. Administration, et al., “Applying human factors and usability engineering to medical devices: Guidance for industry and Food and
Drug Administration staff,” Washington, DC: FDA, 2016.

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[21] L. Wirth, J. Siebenmann, and A. Gasser, "Erfahrungen aus dem Einsatz von Assistenzrobotern f¨ur Menschen im Alter," in Mensch-Roboter-Kollaboration. Springer, 2020, pp. 257–279.
[22] A. Gasser, S. Steinemann, and K. Opwis, "A Qualitative View on Elders Interacting with a Health Care Robot with Bodily Movements," Masters thesis presented to the Department of Psychology of the University of Basel for the degree of Master of Science in Psychology, 2017.
[23] O. Bendel, "Co-Robots as Care Robots," arXiv preprint arXiv:2004.04374, 2020.
[24] D. Fischinger, P. Einramhof, W. Wohlkinger, K. Papoutsakis, P. Mayer, P. Panek, T. Koertner, S. Hofmann, A. Argyros, M. Vincze, et al.,"HOBBIT-The Mutual Care Robot," in RSJ International Conference on Intelligent Robots and Systems, Tokyo (November 2013), 2013
[25] E. Broadbent, R. Stafford, and B. MacDonald, "Acceptance of healthcare robots for the older population: Review and future directions,"International journal of social robotics, vol. 1, no. 4, p. 319, 2009.
[26] D. S. Syrdal, K. Dautenhahn, M. L. Walters, and K. L. Koay, "Sharing Spaces with Robots in a Home Scenario-Anthropomorphic Attributions and their Effect on Proxemic Expectations and Evaluations in a Live HRI Trial." in AAAI fall symposium: AI in Eldercare: new solutions to old problems, 2008, pp. 116–123.
[27] E. Broadbent, R. Tamagawa, A. Patience, B. Knock, N. Kerse, K. Day, and B. A. MacDonald, "Attitudes towards health-care robots in a retirement village," Australasian journal on ageing, vol. 31, no. 2, pp. 115–120, 2012.

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