A Robotic Assistant for Logistics and Disinfection in Health Centers

Christian Tamantini[1], Francesco Scotto di Luzio[1], Francesca Cordella[1], Martina Lapresa[1],
Giuseppe Pascarella[2], Felice Eugenio Agrò[2], and Loredana Zollo[1]
[1]Research Unit of Advanced Robotics and Human-Centred Technologies,
[2]Unit of Anaesthesia, Intensive Care and Pain Management, Department of Medicine,
Campus Bio-Medico University of Rome, Rome, Italy
Corresponding author: c.tamantini@unicampus.it

***Abstract*—The COVID-19 pandemic has pushed robotic researchers to develop various robotic solutions applied to healthcare, to contribute to face the worldwide emergency. In this paper the UCBM-COVID robotic platform, which relies on the service robot TIAGo, is described, and its 2-month use inside the UCBM-COVID treatment centre is discussed. The platform was used to perform logistics and disinfection tasks by exploiting the autonomous navigation and interaction capabilities of the robot.**

***Index Terms*—COVID-19, robotic assistant, Service Robots, Medical Robots and Systems**

I. Introduction

In the first months of 2020, the COVID-19 pandemic put a strain on the health systems all over the world. Robotic researchers started thinking how they could contribute to face the worldwide emergency, developing robotic solutions that can be grouped into three main categories [1]: i) patient care solutions; ii) automation solutions, especially for the logistics; iii) disinfection solutions of environments. The Vici robot [2] (InTouch Health) and Tommy [3] are humanoid robots used in clinical settings to welcome the incoming patients and visitors and monitor some vital parameters of the patients. Automation solutions for logistics and for handling contaminated material were also developed. The Zipline company provided fixed-wing drones to reduce human involvement in delivering blood to hospitals and clinics [4]. Special attention was paid to the disinfection of the hospital environment. Infected materials play a paramount role in the contamination and infection of people. Ultraviolet-C (UV-C) radiations emit enough energy to destroy DNA and RNA of microorganisms exposed to the light. Mobile robots equipped with UV-C lights autonomously moved to sanitize the environment [5].

In this paper, the 2-month use of the robot TIAGo (PAL Robotics S.L., Barcelona, Spain) at the COVID treatment centre of University Hospital Campus Bio-Medico (UCBM) of Rome, Italy, is described. The effectiveness and reliability of the proposed solution for logistics and disinfection scenarios are evaluated. To the best of our knowledge, the UCBM-COVID robotic platform is the first robotic solution introduced inside a COVID treatment centre capable of performing medical stuff delivery and disinfection according to the specific needs: small hardware modifications are required to let the robot work in one scenario rather than the other.

II. Materials and Methods

The UCBM-COVID robotic platform was installed at the UCBM-COVID treatment centre in May 2020. It relies on the service robot TIAGo [6]. The robot autonomously navigates in the environment thanks to the embedded sensors, by exploiting the Simultaneous Localization and Mapping (SLAM) algorithm. The Gmapping [7] strategy was implemented to solve the SLAM problem. It is the most robust in indoor environments allowing low estimation errors and limited computational burden.

For addressing the logistics and disinfection scenarios with the same platform, a modular system was developed to be adapted as needed.

For the logistics scenario, the UCBM-COVID robotic platform was equipped with a box behind the head (Fig. 1A) to deliver materials (drugs, blood products and small portable instrumentation) up to 5 kg. The robot navigated autonomously from a starting point to a target one, selected by an operator through a purposely developed Graphical User Interface (GUI) running on a laptop mounted on the back of the robot that could communicate with the robot via an Ethernet port. Once the robot reached the desired position, it informed the operators about its arrival through a voice message. The robotic system transported materials from the the ambulance access (Hot Cell) towards the the intensive care unit (Red Area), the sub-intensive care unit (OBI Area) and a medical ward with 26 beds (Holding Area), and vice versa (Fig. 1C). Moreover, it returned autonomously to its Charging Station whenever the battery level was lower than 15%. The time required to fully recharge the platform was approximately 2 hours.

For the disinfection of the hospital environment, the UCBM-COVID robotic platform was equipped with the OnReal UV-C lamp (Fig. 1B), powered by a portable power generator. It can efficiently treat 10 m^2 every 15 minutes and a maximum time of treatment of 60 minutes can be reached. The disinfection procedure could be launched by one operator through another GUI. The first disinfection phase required the robot to stop for 20 min in each point of interest (PoI) (Fig. 1D). When

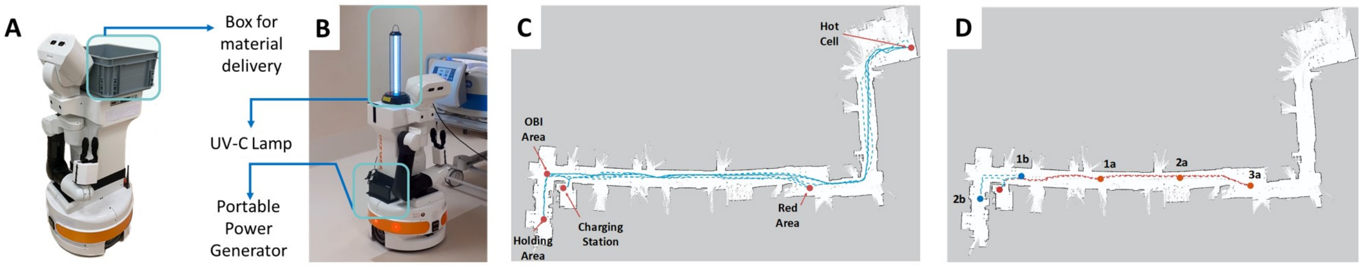

Fig. 1. TIAGo robot for the A) logistics and B) disinfection scenario (Ph: Luigi Avantaggiato 2020). The red dots in C) represent the target points the robot had to reach for the Logistics scenario. The dashed blue lines are the trajectories the robot performed during a day. In D), the dots represent the target points the robot had to reach for the Disinfection scenario. The orange and blue dotted lines are the paths of the two disinfection phases implemented. The points where the robot stopped to treat the environment are marked with dots.

the robot stopped in the first PoI, a human operator turned on the lamp with an infrared remote controller maintaining a 20 m safety distance. The lamp started disinfecting after 10 seconds of delay. At the end of the first disinfection the robot returned to the Charging Station and the second phase could be launched. In these other PoI, the robot stayed for 30 min.

III. Results and Discussion

The UCBM-COVID robot was used in the logistics scenario for 43 days, about 7 hours per day (from 8:00 am to around 8:00 pm). The number of human operators required for the logistics scenario was 3 (one inside the Hot Cell, one in the Red Area and one in the OBI or Holding areas). Each user had the role to charge and discharge the box on the robot, according to their needs, and command the target location to be reached by the robot. For the disinfection scenario, the estimated working time was about 2 hours. The disinfection was carried out during the night, generally from 2:00 am to 4:00 am for safety reasons, and was performed 35 times in two months. The mean time spent disinfecting was 125.6 ± 3.4 min.This scenario was easier to be booted: only 1 healthcare operator was involved.

The introduction of a robot transporting materials from one area to another enabled to parallelize the activities inside the COVID treatment centre, to help the healthcare operators (who must watch over the patients) and limit their movements from one environment to another. The automation of the disinfection procedure allowed treating the entire area of interest without the human intervention and in safe conditions. Despite this, the use of the robot in this context also has some weaknesses: i) the platform runs on battery power with an energetic autonomy of 4 hours and needs to be recharged periodically; ii) medical personnel must be adequately trained to properly work with the robot in hospital settings; iii) it is better to preliminary record the map during the first installation of the robot.

IV. Conclusions

In this paper, the 2-month experience about the use of the UCBM-COVID robotic system inside the UCBM-COVID treatment centre is described. The robot was used to assist healthcare operators during logistics and disinfection procedures. The proven effectiveness and ease of use of the system led the operators to exploit the robot during the working day. Being TIAGo a robot capable of interacting with humans in multiple modalities, future works will be devoted to implement different interaction strategies (e.g. voice commands).

Acknowledgment

This work was supported partly by Campus Bio-Medico University of Rome Strategic Projects (Call 2018) with the SAFE-MOVER project, partly by HeAL9000 project (CUP: B84I20001880002), partly by the Italian Institute for Labour Accidents (INAIL) with the PPR AS 1/3 (CUP: E57B16000160005) and partly by the SENSE-RISC project (CUP: B56C18004200005).

References

[1] G.-Z. Yang *et al.*, “Combating covid-19—the role of robotics in managing public health and infectious diseases,” 2020.

[2] A. Matyus. Meet the robot helping doctors treat coronavirus patients. [Online]. Available: https://www.digitaltrends.com/news/meet-the-robot-helping-doctors-treat-coronavirus-patients/

[3] M. E. Romero. Tommy the robot nurse helps italian doctors care for covid-19 patients. [Online]. Available: https://www.pri.org/stories/2020-04-08/tommy-robot-nurse-helps-italian-doctors-care-covid-19-patients

[4] E. Ackerman. Zipline wants to bring medical drone delivery to u.s. to fight covid-19. [Online]. Available: https://spectrum.ieee.org/automaton/robotics/drones/zipline-medical-drone-delivery-covid19

[5] E. Ackerman *et al.* Autonomous robots are helping kill coronavirus in hospitals. [Online]. Available: https://spectrum.ieee.org/automaton/robotics/medical-robots/autonomous-robots-are-helping-kill-coronavirus-in-hospitals

[6] J. Pages *et al.*, “Tiago: the modular robot that adapts to different research needs,” in *International workshop on robot modularity, IROS*, 2016.

[7] G. Grisetti *et al.*, “Improved techniques for grid mapping with rao-blackwellized particle filters,” *IEEE transactions on Robotics*, vol. 23, no. 1, pp. 34–46, 2007.