I-RIM

PhD Course in ROBOTICS AND INTELLIGENT MACHINES

Curriculum: Robotics and Intelligent Machines for Healthcare and wellness of persons

Research themes

The main goal of the curriculum "Robotics and Intelligent Machines for Healthcare and Wellness of Persons" is to contribute to improve people wellness and quality of life, as well as preventing risk of injuries or professional pathologies. This curriculum tackles the following challenges:

1. New algorithms for human-robot interaction in application including: diagnosis, therapy, rehabilitation, assistance, and support to healthcare personnel;
2. Increasing role of robots in the overall process involving prevention, diagnosis, therapy, recovery and home assistance, to increase social participation and involvement of people, reducing social isolation, monitoring daily activities and identify emergency situations;
3. New methods and techniques for human-machine interfaces, including bidirectional human-machine communication;

4. Innovative solutions per health, through integration of mechatronic devices, new materials and tissues;
5. Innovative solutions to improve efficiency and safety of medical personnel to reduce healthcare costs;
6. Innovative solutions to foster adoption of robotic solutions in the workplace, for prevention and reducing risks of work-related pathologies;
7. New methods for physical and social human-robot interaction, for wellness of people in various contexts, including education.

Projects in the curriculum will develop and experimentally validate methods, conventional, biomimetic and bio-inspired models, components, subsystems, systems and intelligent strategies for information analysis and telemedicine for:

- Medical robotics with imaging support;
- Rehabilitation robotics;
- Assistive robotics and functional replacement;
- Robotics for health and safety in the workplace;
- Innovative medical devices;
- Human-robot interaction.

The quality of research and its impact will be evaluated through specific indicators monitoring:

- Scientific Excellence;
- Industrial impact;
- Economic impact;
- Social Impact;
- Improvement to people health and wellbeing.

The ideal candidates are students with a Master (or equivalent/higher) STEM (Science, Technology, Engineering, and Mathematics) degree and possibly a specific background in Robotics.

The students will perform their research project at the Hosting Institution (described in the research project sheet). Interested applicants are encouraged to contact the tutors and/or the Unit's Principal Investigators for clarifications before submitting their application.

International applicants are encouraged and will receive logistic support with visa issues, relocation, etc.

1. Motion and action prediction for human-robot collaboration facilitated by body signals and context – Univ. of Bolzano

Curriculum: Healthcare and wellness of persons

Hosting Institution
Free University of Bolzano

Department:
Science and Technology

Tutor(s):
Angelika Peer
Renato Vidoni

Description:
For achieving seamless human-robot interaction, proper prediction capabilities play a major role. In this project, we aim at developing a robotic architecture capable of predicting human motions and actions based on a multimodal approach combining movement information, EMG, EEG and eyetracking information as well as context. While lots of literature focuses on action recognition that requires observing the full action, we aim for developing algorithms for motion and action prediction to facilitate the early triggering of proper assistive/collaborative robot behaviors. The resulting motion and action prediction capabilities will not only allow to enhance human-robot collaboration in scenarios involving sequential actions to be performed in alternation of human and robot, but also scenarios involving parallel actions with physically coupled bodies as typically found in exoskeleton or orthoses applications. More specifically, we aim at investigating how eye-tracking information, EMG and EEG signals as well as context (e.g. objects located in the environment, their type and affordances as well as knowledge about plans) can contribute next to human motion tracking to motion and action prediction. To be able to handle context more easily and to allow for its incorporation into a computational approach, we will investigate its transformation into different latent spaces. We aim for testing the developed algorithms with healthy subjects in applications involving an active lower-limb exoskeleton in the laboratory as well as in the field.
Specifically the work will involve:

- recording datasets with typical activities by incorporating motion tracking, EMG, EEG and eyetracking information
- developing a multimodal approach for motion and action prediction
- evaluating the performance of the proposed algorithm based on the recorded dataset and investigate the contribution of the individual modalities and context
- validating the approach in real-time robotic assistive experiments

Requirements:
Applicants are expected to have strong interests in multidisciplinary research and should ideally come with previous experience in processing body signals as well as strong programming skills in C++, Python and Matlab.

References:

- Y. Zheng, Y. Yang, K. Mo, J. Li, T. Yu, Y. Liu, K. Liu, L.J. Guibas, GIMO: Gaze-Informed Human Motion Prediction in Context, arXiv:2204.09443v1, 2022
- E.A. Kirchner, M. Tabie, A. Seeland, Multimodal Movement Prediction - Towards an Individual Assistance of Patients, Plos One, 9, 2014.
- M.S. AL-Quraishi, I. Elamvazuthi, S.A. Daud, S. Parasuraman, A. Borboni, EEG-Based Control for Upper and Lower Limb Exoskeletons and Prostheses: A Systematic Review, Sensors, 18, 3342, 2018.

Number of positions available:
1

Main Research Site
Free University of Bolzano, NOI Techpark, Via Volta 13, 39100 Bolzano

Contacts:

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2. Chaotic Recurrent Neural Networks to Study the Brain Basal Ganglia-Thalamo-Cortical System – CNR ISTC

Curriculum: Healthcare and wellness of persons

Hosting Institution
Consiglio Nazionale delle Ricerche (CNR)

Department:
Istituto di Scienze e Tecnologie della Cognizione (ISTC)

Tutor(s):
Gianluca Baldassarre

Description:
Reservoir computing is an approach of artificial intelligence based on recurrent neural networks. These networks are in particular formed by a core neural '*dynamic reservoir*' that is activated by input patterns and produces output patterns through 'readout neurons' that can possible feedback to the reservoir. This kind of networks are capable of keeping a temporal trace of the input patterns and of modelling nonlinear systems. For these reasons, reservoir neural networks have been used to simulate the complex dynamics of the brain cognitive and motor cortex. In addition, reservoir computing has been used to learn to solve complex AI problems and to guide robots in manipulation and navigation tasks.
The PhD research project will be highly interdisciplinary. First it will aim to study, through computational models, the advantages and implications of using *deterministic chaos* to guide exploration and learning in reservoir networks in ways similar to what happens in the brain (e.g., with *echo state networks*, Hoerzer et al., 2014; Matsuki & Shibata, 2020). Then it will use the produced knowledge and models to study the brain basal ganglia-thalamo-cortical system underlying the selection and dynamic performance of manipulation actions in both physiological and pathological conditions (Mannella & Baldassarre, 2015). Finally, the models will be applied to control simulated and real autonomous camera-arm-gripper robots that should be able to autonomously acquire and perform behaviours directed to manipulate objects.

Requirements:
Applicants are expected to have a strong background in computational neuroscience, a good knowledge of the scientific literature on basal ganglia and cortex, knowledge on AI and machine learning and in particular on neural networks, possibly knowledge on reservoir computing, the capacity to build computational models within a brain-AI interdisciplinary framework, and interest to apply the models to control motor

behaviour in autonomous robots. Applicants are expected to have both speaking and writing English capabilities, and good analysis/synthesis capabilities, for reading, understanding, and writing scientific papers on the relevant topics. Applicants are expected to have interdisciplinary interests and a strong commitment to study and work on natural and artificial intelligence, a professional attitude towards work, the capacity to work in autonomy, and the capacity to collaborate within an interdisciplinary team and an international context.

References:

- Hoerzer G.M., Legenstein R., Maass W. (2014). Emergence of Complex Computational Structures From Chaotic Neural Networks Through Reward-Modulated Hebbian Learning. Cerebral Cortex 24: 677-690.
- Matsuki T., Shibata K. (2020). Adaptive balancing of exploration and exploitation around the edge of chaos in internal-chaos-based learning. Neural Networks 132: 19-29.
- Mannella F., Baldassarre G. (2015). Selection of cortical dynamics for motor behaviour by the basal ganglia. Biological Cybernetics 109: 575-595.

Number of positions available:
1

Main Research Site
Istituto di Scienze e Tecnologie della Cognizione, Consiglio Nazionale delle Ricerche,
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Contacts:

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Funding Scheme:

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"*EBRAINS-Italy - European Brain ReseArch INfrastructureS-Italy - CUP B51E22000150006*"
supported by the:
"*Piano Nazionale di Ripresa e Resilienza (PNRR), Missione 4, Componente 2, Investimento 3.1 "Fondo per la realizzazione di un sistema integrato di infrastrutture di ricerca e innovazione*".

3. Non-verbal Human-Robot Interaction through social signals – Univ. of Genova

Curriculum: Healthcare and wellness of persons

Hosting Institution
Universita' degli Studi di Genova

Department:
Department of Computer Science, Bioenginering, Robotics and Systems Engineering
www.dibris.unige.it

Tutor(s):
Prof. Antonio Sgorbissa, Carmine Recchiuto

Description:

Autonomous robots for elderly care are becoming increasingly popular, as shown by the success of recent systems available on the market, as well as the number of research projects in the field (such as the CARESSES project led by the University of Genova, caressesrobot.org).

However, despite their incredible "appeal" and superior capabilities, social robots still lack many capabilities, including interpreting non-verbal signals that would allow them to interact better with humans.

Human body posture and movement, gestures, the direction of the gaze, distance from the robot, pauses in speech, the volume of the voice, or even the desire to have physical contact with the robot are signals conveying a huge amount of information. The robot should consider these signals to serve human needs better, but they are often neglected. Indeed, social interaction is mostly focused on speech-to-text conversion and language processing that, however, do not provide all the necessary information to understand the user's engagement and attitude towards what the robot says and does [1].

Indeed, the objective of capturing non-verbal interaction signals and using them to adapt the robot's behavior poses several interesting research questions:

- What non-verbal signals can be more easily detected given the available technology in sensing and recognition, and with what sensors and algorithms?
- How can the recognition process be implemented using learning algorithms, i.e., through neural networks properly trained to recognize the users' attitudes depending on non-verbal signals fed to the network as inputs?
- How can the detected attitude of the user be used to adapt the robot's behavior, e.g., to understand if the user is happy/unhappy with what the robot is saying or doing and behave accordingly?
- How can theories of emotions, e.g., the Appraisal theory, provide the basis for improved computational models for emotion recognition compared to standard Robotics and AI approaches?

This Ph.D. research will explore one or more of the research questions above through theoretical investigation and practical implementation and testing.

Requirements:

Applicants are expected to have good programming skills (possibly including Python), and have a strong motivation and attitude to problem-solving.

References:

- Rich, C., Ponsleur, B., Holroyd, A., Sidner, C.L. Recognizing engagement in human-robot interaction (2010) 5th ACM/IEEE International Conference on Human-Robot Interaction, HRI 2010, pp. 375-382.2.
- Lazarus, R. S. (1991). Emotion and adaptation. New York: Oxford University Press.
- NAOqi Developer guide:http://doc.aldebaran.com/2-5/index_dev_guide.html3.

Company name and link (for industrial projects): N/A

Number of positions available:
1

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Funding Scheme: This doctorate grant is fully funded by the proponent research institution.

4. Culture-aware Artificial Intelligence and Robotics – Univ. of Genova

Curriculum: Healthcare and wellness of persons

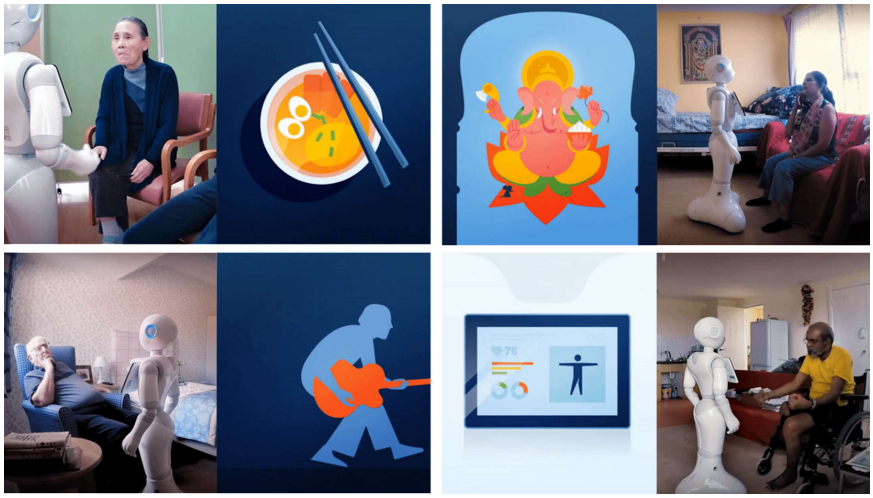
Hosting Institution
Universita' degli Studi di Genova

Department:
Department of Computer Science, Bioenginering, Robotics and Systems Engineering
www.dibris.unige.it

Tutor(s):
Prof. Antonio Sgorbissa, Luca Oneto Carmine Recchiuto

Description:

Artificial Intelligence, in the last decade, has become pervasive in all aspects of our lives, experiencing a fast process of commodification and reaching society at large. This process includes the development of a new generation of robotic and embodied intelligent systems equipped with the capability to interact and cooperate with humans not just visually and vocally but also physically.



Video from the CARESSES project (http://caressesrobot.org)

In this general scenario, AI-based systems will need to be able to integrate themselves not only in a functional way (i.e., delivering what they are requested) but also in a culture-aware way (i.e., adapting to the cultural background of people in order to deliver their services with cultural sensitivity). This requires the definition of algorithms able to behave differently based on the particular cultural context (or a mix of cultural contexts) in which they are placed while avoiding a stereotyped representation of people and culture. At the same time, knowing the cultural biases that affect human beings in interpreting perceptions, making decisions, and interacting with each other, will allow computer scientists and engineers to design new AI-based systems to improve their performance by exploiting the experience gained from different cultural environments.

Please notice that the concept of a culturally-competent robot, i.e., able to adapt its behaviour to the cultural identity of the person it is interacting with, has been recently proposed by CARESSES, an international project coordinated by the DIBRIS department. However, the broader concept of culturally competent Artificial Intelligence is proposed here for the first time.

Requirements:
Applicants are expected to have good programming skills (possibly including Python), have followed a course in Machine Learning for Robotics, and have a strong motivation and attitude to problem-solving.

References:

- M. Rehm, "From multicultural agents to culture-aware robots," in Lecture Notes in Computer Science, 2013, pp. 431-440.
- Bruno, B., Recchiuto, C.T., Papadopoulos, I., Saffiotti, A., Koulouglioti, C., Menicatti, R., Mastrogiovanni, F., Zaccaria, R., Sgorbissa, A., Knowledge Representation for Culturally Competent Personal Robots: Requirements, Design Principles, Implementation, and Assessment (2019) International Journal of Social Robotics, 11 (3), pp. 515-538.
- Shalev-Shwartz, S., & Ben-David, S. (2014). Understanding machine learning: From theory to algorithms. Cambridge university press.

Company name and link (for industrial projects): N/A

Number of positions available:
1

Main Research Site
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Funding Scheme: This doctorate grant is fully funded by the proponent research institution.

5. Magnetic multi-robot system control – Sant'Anna School of Advanced Studies, Pisa

Curriculum: Healthcare and wellness of persons

Hosting Institution
Sant'Anna School of Advanced Studies, Pisa

Department:
The BioRobotics Institute

Tutor(s):
A. Menciassi

Description:
Robots are still often regarded as large machines with links, gears, and electric motors, autonomously interacting with the surrounding environment. Despite the great research efforts in robotics and human-robot interaction (HRI), the way we design, use, and control robots has not fundamentally changed in the past 20 years.
We see in small-scale wireless multi-robot systems and cognitive HRI a revolutionary answer to nowadays robots limitations. Instead of large, tethered machines, that are difficult for the human user to control, we propose an innovative set of AI-powered, modular, microsized swarms of robots. They are wirelessly steered by electromagnetic fields as well as able to react to other external stimuli, and then naturally controlled by humans through intuitive dexterous interfaces and interaction techniques. Taking advantage of AI multi-robot control strategies, these robots can team up and collaborate to fulfill complex tasks in a robust and unprecedented flexible way.
The candidate will deal with the design of a magnetic multi-robot control strategy and with the design of a millimeter scale carrier able to release, control and stimulate a swarm of nanorobots responsible for task execution.
The candidate will carry on this research project in the framework of a European Project (REGO – Cognitive robotic tools for human-centered small-scale multi-robot operations – 101070066) with the possibility to collaborate and interact both with academic partners (University of Twente, Centre hospitalier universitaire de Rennes) research centers (CNRS, Italian Institute of Technology, Helmholtz-Zentrum Dresden Rossendorf) and companies (Haption).

Requirements:
Applicants are expected to have a background in control, mechatronics, mechanical, biomedical engineering or related fields.

References:

- Ciuti, G., Valdastri, P., Menciassi, A., & Dario, P. (2010). Robotic magnetic steering and locomotion of capsule endoscope for diagnostic and surgical endoluminal procedures. *Robotica, 28*(2), 199-207.
- Iacovacci, V., Ricotti, L., Sinibaldi, E., Signore, G., Vistoli, F., & Menciassi, A. (2018). An intravascular magnetic catheter enables the retrieval of nanoagents from the bloodstream. *Advanced Science, 5*(9), 1800807.

Number of positions available:
1

Main Research Site
The BioRobotics Institute, Pontedera (PI), Italy

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Funding Scheme: This doctorate grant is fully funded by the proponent research institutions.

6. Microrobots able to move through body tissues – Sant'Anna School of Advanced Studies, Pisa

Curriculum: Healthcare and wellness of persons

Hosting Institution
Sant'Anna School of Advanced Studies, Pisa

Department:
The BioRobotics Institute

Tutor(s):
Stefano Palagi

Description:
Microrobots are microscopic, mobile, and untethered robotic devices envisioned to revolutionize minimally invasive medicine. They are expected to enable highly targeted and localized delivery of drugs, thus minimizing side effects, and non-invasive procedures. We envisage their use in delicate tissues and organs (e.g. brain) where reducing invasiveness, tissue damages and side effects is particularly important.
Whereas most current microrobots are rigid microstructures moved by external fields (e.g.: magnetic fields), we aim at developing microscale robots that can move inside soft body tissues. At this aim, the microrobots will have an ultra-deformable body (to squeeze through tissue gaps) and will be guided with novel control approaches and spontaneous responses to local conditions. To do so, inspiration will come from immune cells, and the microrobots will be endowed with the ability to move and change shape, locomote in complex 3D environments, harvest energy, perceive chemo-physical stimuli, and navigate (semi)autonomously in unknown environments.
This research is funded by the European Research Council (CELLOIDS: Cell-inspired particle-based intelligent microrobots, GA: 948590).

Requirements:
Applicants are expected to be passionate about pursuing frontier interdisciplinary research at the intersection of autonomous robotics, swarm intelligence, and the natural sciences, within a multidisciplinary and diverse research team.

References:

- Palagi, S., & Fischer, P. (2018). Bioinspired microrobots. *Nature Reviews Materials*, *3*(6), 113-124.

Number of positions available:
1

Main Research Site
The BioRobotics Institute, Pontedera (PI), Italy

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Funding Scheme: This doctorate grant is fully funded by the proponent research institutions.

7. A platform to understand and monitor sensorimotor deficits in multiple sclerosis – Univ. of Genova and NeXtage

Curriculum
Healthcare and wellness of persons

Hosting Institution
Università degli Studi di Genova

Department
Department of Computer Science, Bioengineering, Robotics and Systems Engineering
www.dibris.unige.it

Tutor(s)
Tutor M. Casadio, M. Fato, M Inglese
Company Tutors (Nextage srl): Luca Corradi, Luca Brayda

Description
Sensory-motor deficits, especially in the lower limbs, are among the most frequent and disabling symptoms in people with multiple sclerosis and with peripheral neuropathies. These deficits often do not respond to drug therapies and require rehabilitation treatments supported by monitoring tools. Thus, there is a strong need to understand and quantify the mechanisms of functional and structural damage that underlie the sensory-motor deficits and to develop tools that allow continuous monitoring of the evolution of the disease and of the response to treatment on a time scale finer than that of periodic clinical visits.
The main scientific hypothesis of this project is that somato-sensory deficits, including those not yet detectable without appropriate instrumental evaluation, not only affect movement skills and daily life activities, but can also be good descriptors and predictors of disease evolution.
The first objective is developing quantitative measures based on tools that are simple, low-cost and usable in the home environment, ensuring continuous monitoring of the residual abilities and lifestyle habits (mobility, diet, drugs). The second objective is identifying predictive models that further support the physician in the sensorimotor assessment, by creating a database of temporal fine-scale, home-based measurements correlated with large-scale, clinical measurements (e.g. magnetic resonance of the brain). The expected technological result is a platform, designed specifically for people affected by multiple sclerosis, based also on the use of smartphones and wearable sensors as data collectors.
If the project is successful, this platform and the related models will allow a better optimization of pharmacological and rehabilitative interventions in people with multiple sclerosis and the proposed approach could be extended to other neurological diseases.

Requirements
Applicants are expected to be passionate about pursuing advanced interdisciplinary research at the intersection of rehabilitation engineering, computer science and neurology within a multidisciplinary research team. Applicants should also ideally come with previous experience in processing body signals as well as strong programming skills.

References

[1] Iandolo et al. Position sense deficits at the lower limbs in early multiple sclerosis: Clinical and neural correlates; Neurorehabilitation and Neural Repair 34 (3), 260-270
[2] https://nextage-on.com/en/prodotti/colibri/#sub_menu1

Company name and link (for industrial projects)

Nextage srl https://nextage-on.com

Number of positions available

1

Main Research Site

1. Nextage srl, Piazza della Vittoria 12/12, Genova

2. Universita' degli Studi di Genova
Department of Computer Science, Bioengineering, Robotics and Systems Engineering
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Contacts

UNIGE: M Casadio (maura.casadio@unige.it)
Nextage: L. Brayda (luca.brayda@nextage-on.com)

Funding Scheme

This doctorate grant is fully funded by Nextage srl and Regione Liguria.

8. Robotics enhanced by IoT and AI for healthcare 4.0

Curriculum: Healthcare and wellness of persons

Hosting Institution
Università Campus Bio-Medico di Roma

Department:
Facoltà dipartimentale di Ingegneria

Tutor(s):
Loredana Zollo and Nevio L. Tagliamonte

Description:
Healthcare 4.0 is a collective term for concepts derived from Industry 4.0 like data-driven digital health technologies, smart health, mobile health, wireless health, e-health, online health, medical IT, telemedicine, digital medicine, health informatics, pervasive health, and the health information system [1]. The new approach to the delivery of care is expected to enhance the quality and effectiveness of healthcare services, paving the way for a more direct relationship between providers and patients as well as clinical operators [2]. Moreover, the analysis of Healthcare 4.0 implications reveals that the effects of the technological revolution are progressing in both medicine itself and in the management of healthcare organizations, especially in hospitals, which are the foundation of the healthcare system [3].
Despite several efforts have been already made to increase the efficiency of care in hospitals and to improve patients' satisfaction, substantial organizational restructuring is still possible leveraging on innovative enabling technologies [4]. Medical robotics, together with other novel technologies such as Internet of Things (IoT), and Artificial Intelligence (AI) but also wearable sensors, big data, extended reality, and 3D printing, are spanning the digital transformation of health and healthcare, by radically transforming the way users access and interact with hospital services. Using robotics in the healthcare field has been recently demonstrated to enable a high level of patient care, efficient processes in clinical settings, and a safe environment for patients and workers. Healthcare organizations often rely on robotics because of their ability to assist with critical needs such as disinfection, telepresence, and delivery of medication and medical supplies, creating safe environments while freeing up staff to spend more time with patients.
Historically, robotic systems have been used in hospitals for surgical assistance. Over the years, AI-enabled computer vision and data analytics have transformed medical robots, expanding their capabilities into many other areas of healthcare. Indeed, robots can now be employed also in clinical settings to support healthcare workers and enhance patient assistance. Medical robots support customized and frequent monitoring for patients with chronic diseases, intelligent therapeutics, and social engagement for elderly patients.
Autonomous mobile robots simplify routine tasks, reduce the physical demands on human workers, and ensure more consistent processes. These robots can address staffing shortages and challenges by keeping track of inventory and placing timely orders to help make sure supplies, equipment, and medication are in stock where they are needed. Streamlined workflows and risk reduction provided by robotics offer value in many areas. For example, robots can also help with cleaning and disinfection by using UV light, hydrogen peroxide vapors, or air filtration to reduce infection and to sanitize reachable places in a uniform way. Cleaning and disinfection robots enable hospital rooms to be sanitized and ready for incoming patients quickly, allowing workers to focus on value-driven work and helping limit person-to-person contact in infectious disease wards. Moreover, hospitals are recently

deploying robots to help reduce exposure to pathogens during the COVID-19 pandemic [5]. Robots with AI-enabled medicine identifier software reduce the time it takes to identify, match, and distribute medicine to patients in hospitals.

To help keep healthcare workers safe, autonomous and service robots are used to transport supplies and linens in hospitals, also in case of pathogen exposure, and to relieve the daily burden on healthcare workers by handling routine logistical tasks. Many of these robots function autonomously and can send a report when they complete a task. These robots set up patient rooms, track supplies and file purchase orders, restock medical supply cabinets, and transport bed linens to and from laundry facilities. Having some routine tasks performed by service robots gives healthcare workers the opportunity to focus on immediate patient needs and can help with increasing job satisfaction. Autonomous robots can self-navigate towards patients allowing clinicians to interact with them remotely. Potentially, robots could eventually evolve in terms of autonomy until ideally being able to perform certain tasks entirely on their own. As a result, since robots alleviate workloads, medical doctors, nurses, caregivers and other healthcare workers will be able to spend more time providing direct patient care and focus on more delicate activities and can offer patients more empathy and human interaction, which can promote long-term well-being.

Within this research theme the PhD candidate will work on programming intelligent and advanced robots to be delivered in novel smart hospitals with the final goal to reduce the effort of the clinical staff, by overcoming some practical difficulties in the wards, and to improve the comfort perceived by the patients during hospital care.

In particular, this research theme is grounded around the implementation of control algorithms for a robotic mobile robot and the integration of sensory information (from the environment and from sensors worn by patients), in different use cases to support healthcare workers in their activity and improve patients' care experience. Use cases will include:

- Robot-aided support for logistics and patients experience, with particular focus on the automatic meal delivery to patients and to the monitoring of food assumption to prevent undernutrition. The PhD student will work on algorithms to be implemented on the robotic platform to monitor and support the delivery of the meal, to improve safety for the patients and to increase hospital efficiency and workflow.
- Robot-aided rehabilitation, with particular focus on the prevention from loss of mobility of hospitalized patients. The PhD student will work on algorithms to show patients how to perform physical exercises and on the control of the robot manipulator to assess the correctness of the performed tasks and provide assistance as needed. The ultimate goal is to improve patients' health conditions, provide support to the clinical staff during rehabilitation, increase hospital efficiency.
- Robot-aided therapy monitoring, with particular focus on the supervision of oxygen therapy to prevent hypoxia complications. The PhD student will work on algorithms to recognize the proper positioning of masks for oxygen therapy and the right oxygen delivery and on the control of the robot manipulator to help re-positioning of the mask when necessary. The ultimate goal to optimize oxygen assumption, verify that the prescribed rules for the oxygen therapy are met and provide support to the clinical staff for monitoring and interventions.

Requirements:

Basic qualifications:

- MS in the area of Robotics and Mechatronics Engineering, Biomedical Engineering, Computer Engineering or Computer Science;
- Proficiency in different high-level programming languages (C++), multi-threading and object oriented programming;
- Fluency in English.

Appreciated plus:

- Knowledge of middleware for robotics applications (ROS) and Python;
- Knowledge of DevOps development methodology, ability to review software architecture, identify bugs and perform software quality checks;

Past experience in similar relevant activities.

References:

[1]. Herrmann, M., Boehme, P., Mondritzki, T., Ehlers, J. P., Kavadias, S., & Truebel, H. (2018). Digital transformation and disruption of the health care sector: internet-based observational study. Journal of medical internet research, 20(3), e9498.

[2]. Cavallone, M., & Palumbo, R. (2020). Debunking the myth of industry 4.0 in health care: insights from a systematic literature review. The TQM Journal.

[3]. Unterhofer, M., Rauch, E., & Matt, D. T. (2021). Hospital 4.0 roadmap: an agile implementation guideline for hospital manager. International Journal of Agile Systems and Management, 14(4), 635-656.

[4]. B. Djulbegovic and G. H. Guyatt, 'Progress in evidence-based medicine: a quarter century on', Lancet Lond. Engl., vol. 390, no. 10092, pp. 415-423, 22 2017, doi: 10.1016/S0140-6736(16)31592-6.

[5]. Tamantini, C., di Luzio, F. S., Cordella, F., Pascarella, G., Agro, F. E., & Zollo, L. (2021). A robotic health-care assistant for COVID-19 emergency: A proposed solution for logistics and disinfection in a hospital environment. IEEE Robotics & Automation Magazine, 28(1), 71-81.

Company name and link (for industrial projects):

N/A

Number of positions available:
1

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Funding Scheme: This doctorate grant is funded by the European Project ODIN (Leveraging AI based technology to transform the future health care delivery in leading hospitals in Europe) within the Horizon 2020 research and innovation programme, under grant agreement No 101017331.