

Research Topics for Doctorate in Robotics and Intelligent Machines, curriculum in Robotics and Intelligent Machines for Industry 4.0

For larger companies, robotics has been a key productivity factor for many years; nowadays, thanks to the development of the new enabling technologies of Industry 4.0, such as collaborative robotics and artificial intelligence, robotics is also becoming increasingly relevant for smaller industries, which are crucial for Italy's production and employment capacity. Many drivers are pushing the adoption of robotic technology in industry, such as the need of products customisation, the increase in competitiveness in the global market and the progressive penetration of cobots in human-centred manufacturing scenarios.

The introduction and spread of the Industry 4.0 production paradigm has given more boost to the use of robots, since they are interconnected, highly digitised autonomous agents, equipped with a digital twin, able to improve their performance based on the analysis of data collected in production systems. On the other hand, as also highlighted by the European Economic and Social Committee (EESC), the next transition to Industry 5.0 will be characterised by the shift from coexistence to full cooperation, physical and social, between machines and people.

All these topics are addressed with an integrated and multidisciplinary approach by the projects proposed in this curriculum; they represent cutting-edge technological challenges that can certainly be tackled due to the scientific and technological background of the proposing institutions and the experience of the involved researchers.

The main goals of the Industry 4.0 curriculum are:

- Encourage technology transfer from research to industry, particularly in the industrial sectors that can best exploit the use of robotics.
- Give industry the opportunity to help direct the research of PhD students, as demonstrated by the high number of scholarships in the curriculum funded or cofunded by companies.
- Give PhD students the opportunity to spend some time within the companies participating in the training project.

The ideal candidates are students with a Master (or equivalent/higher) degree in STEM field: a specific background in Robotics or mechatronics will be appreciated.

The students will perform their research project at the hosting institution (as 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 applications are encouraged and applicants will receive logistic support with visa issues, relocation, etc.

Research Topics

1. Cyber-physical social security applied to emergent innovative technologies – Italian Institute of Technology & Univ. Genova..... 2
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Tutors

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Description

The field of cyber security is a fast-growing discipline that impacts on the interaction between people and technology. Even though the effectiveness of security measures to protect personal data is increasing, people remain susceptible to manipulation and thus the human element remains the weakest link: social engineering. Such weakness is often exploited by the use of various manipulation techniques aiming at the disclosure of sensitive information, namely social engineering. The field of social engineering is still in its early stages however the interaction between individuals and new technologies (assistive robotics, robot companion) and new ways of working (smart working) might be exposed to yet unknown risks associated with the misuse of protected data only partially addressed by traditional computer security. The overall aim of the project is to investigate how to prevent disclosure of sensitive information applied to the areas where humans use interconnected technologies (e.g. robotics, IOT, Big Data Analytics systems) especially in the context of human machine interactions (e.g.: robot companion, assistive robotics, home assistance, etc.). The aim unfolds into two goals for the candidate. First, the ideal candidate is required to develop algorithms of human machine interaction relying on cutting-edge machine learning techniques that allow the artificial intelligence to adapt to the person. For example, the assistive robot autonomously adapts the data acquisition strategy to the goal of improving the provided assistance without the acquisition of personal data, which is irrelevant to the assistance. The second goal is to improve the robustness and high integrity of system architectures (cyber-physical security) relying also on computer vision and adopted for above-mentioned cutting-edge technologies. The solutions defined by the candidate can also help the management of security risk and the analysis of social engineering threats. As outcome of the project, such methodologies will be concretely applied to innovative applications especially involving robotics technologies designed at the Istituto Italiano di Tecnologia to make the applications socially aware and socially acceptable.

Requirements

Applicants are expected to have very good skills in at least two of the following areas: software development, computer vision, robot programming, machine learning. Furthermore, good attitude for experimental work is mandatory. The candidates must have: very good programming skills with different languages (including C/C++, Python, Matlab/Simulink); be capable to conduct experiments; attitude to problem solving, and be strongly motivated for team working.

References

- Pasquali D., Gonzalez-Billandon J., Aroyo A.M., Sandini G., Sciutti A., Rea F. (2021). Detecting Lies is a Child (Robot)'s Play: Gaze-Based Lie Detection in HRI. International Journal of Social Robotics
- Pasquali D., Gonzalez-Billandon J., Rea F., Sandini G., Sciutti A. (2021). Magic iCub: A humanoid robot autonomously catching your lies in a card game. ACM/IEEE International Conference on Human-Robot Interaction
- Pasquali D., Sciutti A., Sandini G., Bencetti S., Rea F. (2022); Toward a Human Oriented Social Engineering Defense System; Workshop: AI for Cybersecurity, Second CINI National Conference on Artificial Intelligence (Ital-IA)

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