COMPUTER AND CONTROL ENGINEERING

AI for new generation manufacturing systems

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Context of the research activity	The smart factory is an integral part of the Industry 4.0, where the tremendous amount of heterogeneous data generated by manufacturing processes unleash an increased potential of applications of Artificial Intelligence, with a considerably accelerating impact on automation, working environment and productivity. The challenge addressed by this PhD program is to successfully deploy such potential in the new generation of manufacturing systems (e.g. Additive Manufacturing).

	The main goal of this PhD program is the investigation, design and deployment of state-of-the-art Artificial Intelligence approaches in the context of the smart factory, with special regards with new generation manufacturing systems such as Additive Manufacturing. These tasks include: - quality assurance and inspection of manufactured product via heterogeneous sensors data (e.g., images from visible range or IR cameras, time-series, etc.) - process monitoring and forecasting - anomaly detection - failure prediction and maintenance planning support While the Artificial Intelligence technologies able to address such tasks may already exist and be successfully consolidated in other real-world applications, the specific domain of manufacturing systems poses severe challenges to the effective deployment of these techniques. Among the others: - the complexity and immaturity of the process - the lack of effective infrastructures for data collection, integration, and annotation - the necessity to handle heterogeneous and noisy data from different types of sensors/machines - the lack of annotated datasets for training supervised models - the lack of standardized quality measures and benchmarks This PhD program seeks solutions to the aforementioned challenges, with specific focus on new generation manufacturing systems, such as, but not limited to, Additive Manufacturing (AM). AM includes many innovative 3D printing processes, which are rapidly revolutionizing manufacturing in the direction of higher digitalization of the process and higher flexibility of

Objectives	production. While AM is a perfect candidate for the deployment of Artificial Intelligence, because it involves a fully digitalized process from design to product finishing, to this date it is still a very complex and immature technology, with tremendous room for improvement in terms of production time and product defectiveness. Specific use-cases in this regard will stem from the supervisors' collaborations with the Inter-departmental Center for Additive Manufacturing in PoliTO, as well as with several major industrial partners such as Prima Industrie, Stellantis, Avio Aero, etc. The outline of the PhD program can be divided into 3 consecutive phases, one per each year of the program. - In the first year, the candidate will acquire the necessary background by attending PhD courses and surveying the relevant literature and will start experimenting state-of-the-art techniques on the available datasets, either from public sources or from past projects of the supervisors. A seminal conference publication is expected at the end of the year. - In the second year, the candidate will select and address some relevant use-cases, with real data from the industrial partners, and will seek solutions to the technological and computational challenges posed by the specific industrial application. At the end of the second year, the candidate is expected to target at least a second conference paper in a well-reputed industry-oriented conference (e.g. ETFA), and possibly another publication in a Q1 journal of the Computer Science sector (e.g. IEEE Transactions on Industrial Informatics, Expert Systems with Applications, etc). - In the third year, the candidate will consolidate the models and approaches that were investigated in the second year, and possibly integrate them into a standalone framework. The candidate will also finalize this work into at least another major journal publication, as well as into a PhD thesis to defend at the end of the program.

Skills and competencies for the development of the activity	The ideal candidate to this PhD program has: - positive attitude to research activity and working in team - solid programming skills - solid basics of linear algebra, probability, and statistics - good communication and problem-solving skills - some prior experience in the design and development of machine learning and deep learning architectures. - some prior knowledge/experience of manufacturing processes is a plus, but not a requirement.