



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 3 - Systems and Control

**THEMATIC Research Field: DATA-DRIVEN, LEARNING-BASED APPROACHES FOR
CLOSED-LOOP QUALITY OPTIMIZATION OF LASER CUTTING IN SMART
MANUFACTURING SYSTEMS**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

Laser machining, and laser cutting in particular, is a highly flexible non-contact fabrication method used for an increasing number of applications, and applied to the processing of an extensive range of materials in almost all manufacturing industries. However, the flexibility inherent in the process, e.g., the large number of different wavelengths, pulse energies and pulse lengths makes process optimization challenging. Even when the optimal parameters have been determined, small changes during manufacturing, e.g., in laser power or beam shape, or variations in the operating conditions (e.g., spread in the material characteristics) can result in a final product quality that is below the required standards. What is needed to make laser manufacturing smart, therefore, is a set of defect modelling, real-time quality evaluation and performance control methodologies that can identify the process optimal parameters and provide real-time monitoring and control-regulated quality levels. However, the highly non-linear light-matter interactions make the physics behind laser machining particularly complex, so that physic-based models can hardly be built with the desired precision. On the other hand, data-driven and learning-based approaches offer a promising way to build advanced software-sensing schemes and control



	architectures that can optimize productivity in real-time. Along these lines, this research aims to devise learning-based data-driven techniques for modelling laser machining processes and define quantitative quality indicators, and optimize productivity in real-time thanks to active quality regulation.
Methods and techniques that will be developed and used to carry out the research	As is clear from the above discussion, the design of effective smart laser manufacturing processes requires a multidisciplinary approach, as only a context-informed design of advanced learning-based estimation and control methods can enable the desired results. We will inform the data-analysis with process-based insights, which will make the machine learning (ML) results explainable and interpretable, enabling links with the domain experts and strong cross-fertilization of knowledge.
Educational objectives	The candidate will have a unique opportunity of working on a multidisciplinary research project, combining both control-oriented and process-related aspects that are needed to address the challenging and timely topic presented above. This entails a growth path for the candidate that will make her/him acquire different competencies - mainly technical and technological, in the disciplines mentioned in the methodology description. The research outputs will target publishing on international conferences and journals, with specific attention to all the venues of interest for the different facets of the research.
Job opportunities	Expertise in data analysis, machine-learning and control making certainly makes the PhD candidates very appealing for a wide range of high-end positions. These range from the more control-oriented ones to those more related to the considered technologies. Thus, our candidates might apply for positions both in technical companies and in academia.
Composition of the research group	2 Full Professors 3 Associated Professors 32 Assistant Professors 25 PhD Students
Name of the research directors	Prof.ssa Mara Tanelli, Prof.ssa Barbara Previtali



Contacts

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Additional support - Financial aid per PhD student per year (gross amount)

Housing - Foreign Students

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**Housing - Out-of-town residents
(more than 80Km out of Milano)**

1st year

2500.0 €
per student

2nd year

2500.0 €
per student

3rd year

2500.0 €
per student

max number of financial aid available: 1, given in order of merit ..

Scholarship Increase for a period abroad

Amount monthly

700.0 €

By number of months

6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Premiality:

Premialities will be recognized to the PhD candidate. Up to 1000 euro (gross amount) after the completion of the 2ndst year; Up to 1600 euro (gross amount) after the completion of the 3rd year.

The premialities will be assigned provided that the candidate demonstrates a significant contribution to the growth of scientific excellence, the industrial valorization of research, the networking and communication activities of the Department.

EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student.

TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student.

There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

COMPUTER AVAILABILITY: individual use.

DESK AVAILABILITY: individual use.