PhD in Electrical, Electronics and Telecommunications Engineering

Research Title: Analysis and design of quantum algorithms and technologies for engineering applications

Funded by	TIM

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Contact	

Context of the research activity	**This proposal is addressed to the creation of new specific competences in the framework of Quantum Computing from the engineering point of view. Main target of QC researcher/engineer will be the analysis and development of new algorithms, as well as of new technologies for building quantum computers.** **Several quantum computers are available on the market now. The most important ones are from IBM and D-Wave, but Google, Rigetti, Honeywell, Microsoft. In this proposal IBM and D-Wave will be considered the main reference points.** **Quantum computing is going to be a computer and electronics engineering challenge, since most of the algorithms developed during the last fifty years will undergo to an almost complete redesign, in order to fulfill the completely different hardware architecture of a quantum computer.** **In the last two years IBM (in particular with Qiskit) and D-Wave have tried to create a completely new software architectures able to give to the programmer the typical APIs already available for conventional computers.** **The PhD candidate will be required to use a strong interdisciplinary approach in order to reach the expected objectives. Quantum mechanics and quantum physics technologies, together with electronics engineering methodologies must be considered together with specific computer engineering techniques as well as in connection to industrial applications.**

Objectives	The purpose of the work will be to understand how to apply this quite new technology in the electronics engineering and computer engineering environment. Industrial applications will be seen with particular attention, since industries will be the first to be involved in QC revolution. In particular applications like network problems, the travelling salesman problem and other optimization issues will be of interest for companies. This target will require studying carefully available APIs, which are continuously changing due to the impulsive improvement of QC from the hardware point of view. In the same time the exploration and detailed study of how specific technologies can be more suitable for the implementation of the industrial level algorithms is the connection point with the physical point of view and will be one of the objectives of the research. The work plan is structured in the three years of the PhD program: 1. in the first year the PhD student should improve his/her knowledge of quantum computing and technology, in particular in case quantum mechanics and quantum computing are not in the previous curriculum; he/she should also follow in the first year most of the required courses in Politecnico. At least one or two conference papers will be submitted during the first year. The conference works will be presented from the PhD student him/herself based on the preliminary study of algorithms working on envisioned platforms. 2. In the second year the work will be both on designing and implementing new algorithms, and exploring the possible performance considering the analyzed technologies and on preparing a first work for a journal, together with another conference. Interdisciplinary aspects will be also considered. Credits for teaching will be also finalized. 3. In the third year the work will be completed with at least a publication in a selected journal summarizing the results of the algorithms implementation on platforms and technologies that will be selected as the most promising. The participation to the preparation of proposals for funded projects will be required.
Skills and competencies for the development of the activity	No particular skill is required, even if of course a previous competence in quantum mechanics and QC is very welcome. Python programming is used in all available QC platforms. Capabilities to work with a multidisciplinary approach across the two field of electronics and computer engineering will be a plus for the candidate.