

PhD in Computer and Control Engineering

Research Title: Optimizing Computing and Communication Infrastructure for Service Robotics

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| Funded by | Interdepartmental Centre for Service Robotics (PIC4SeR) Politecnico di Torino |
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| Context of the research activity | <p>Service robotics is expected to grow significantly in the next few years, fueled by the large number of innovations in the field and the decreasing trend in the cost of the hardware. However, it is not yet completely clear how to use such robots, which include drones, rovers, etc., in the most effective way to create innovative services. Furthermore, the problem may become even harder when a multitude of coordinated objects (e.g., <i>swarm</i>) are required.</p> <p>In this context, the activity proposed in this PhD proposal will address the processing, storage and communication issues that may arise in the service robotics scenario, in particular when such objects experience intermittent and/or delayed network connections. This harsh and (often) unpredictable operating context may require specific strategies for service delivery (i.e., to guarantee service resiliency), while optimizing the resource consumption, which include problems such as where to save data, how to communicate with neighbor nodes, how to encode information, how to cope with remote services (e.g., in cloud) that are not always reachable, where to run elementary service components.</p> <p>In this respect, fog computing technologies may represent a fundamental paradigm to be considered, as it proposes to move computational (and storage) loads from the cloud towards the edge of the network, and potentially on-board of the robotic</p> |
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| | <p>devices, and vice versa.</p> <p>Research in this area is ongoing. For instance, in the context of fog computing, it is still an open research question how to automatically perform optimal allocation and migration of computational loads so that application requirements, especially in terms of throughput and latency, are satisfied, as well as costs are minimized. Another example involves data communication protocols that need to address temporary loss of connectivity, as well as prioritization of traffic which is important from the point of view of achieving the goals identified in each specific application scenario.</p> <p>In this PhD proposal, among the many service robotics application fields, a few will be identified, analyzed in details and addressed, in coordination with the activity carried out by the Interdepartmental Center "Pic4Ser". As a starting point, applications will include, but will not be limited to, the so called Precision Agriculture, where efficient coordination and communication between robots (aerial and ground vehicles) and cloud services is required. Moreover, it is also important to perform smart and targeted data acquisition activities in an autonomous or semi-autonomous fashion and timely communicate results to control and supervision operators or centers.</p> |
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| Objectives | <p>The main objective of the PhD activities will be the development of algorithms, technologies and systems that can effectively optimize the performance of the considered systems in terms of traditional communication metrics (e.g., bandwidth, latency) and application-layer metrics (user's utility) which will be defined on a case-by-case basis depending on the application, while at the same time minimizing all costs (e.g., computational complexity, number of required devices and their economic cost).</p> <p>Such objectives will be achieved by using both theoretical and practical approaches. In fact, the adopted methodologies will include the development, wherever possible, of theoretical frameworks to model the whole system, in order to investigate the problem from an analytical point of view. The resulting insight will then be validated in practical cases by analyzing the performance of the system with simulations and real-world experiments. Both proponent research groups have extensive expertise in such fields.</p> <p>In this regard, cooperation with companies will also be sought in order to facilitate the migration of the developed algorithms and technologies to prototypes that can then be effectively tested in real application scenarios.</p> |
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**Skills and competencies
for the development of
the activity**

- Solid knowledge in Computer Engineering
- Knowledge about Computer Networks, Computer architecture, Cloud computing
- Application Layer analytical development skills
- Programming
- Team working capacities