Master Thesis/Internship [multiple positions] in Fog Communication and Computing for Industrial AI

ABB is a global leader in power and automation technologies that enable utility and industry customers to improve their performance while lowering environmental impact. ABB is present in more than 100 countries and employs about 135,000 people. ABB Corporate Research, in close collaboration with varied ABB business areas, is developing the foundations for the next generation of ABB products. In Sweden, ABB Corporate Research, located in Västerås, employs 280 scientists from over 40 countries with expertise in automation and power technologies for manufacturing, consumer and process industries as well as power utilities.

Background

Several application scenarios in industrial automation (e.g. mobile robotics, machine integration, networked vision, etc.) require industrial devices to sense, perceive and act in real-time with a significant level of autonomy and adaptiveness. Within this context, artificial intelligence (AI) and machine learning (ML) technologies are seen as a key differentiator for the development of future industrial systems. While some AI/ML solutions based on cloud computing are already deployed in factories for non-critical applications (e.g. predictive maintenance), the next step can be reached only by integrating AI/ML within local real-time control systems, enabling adaptive and quick reactions to events in the factories. To support this vision, a “Fog”-based architecture is preferable to a cloud-based one, in which the AI/ML takes place in local controllers within the factories that can communicate in real-time with distributed devices. The fog-based architecture requires both real-time and reliable communication networks and customized hardware/software in local controllers to support AI-powered applications.

Task

In this project, you will explore fundamental building blocks to enable fog communication and computing for industrial AIs. In detail, the fog communication architecture requires the deployment of real-time, secure and reliable networks, both wired and wireless, as well as the integration of different networks. The fog computing architecture, instead, requires customized hardware components and software libraries to enable the execution of AI/ML algorithms in industrial controllers. Different positions will explore all these aspects, starting from a preliminary survey phase and theoretical design and following with experimental validation on industrial communication/computing platforms.

Position 1: Real-time wireless networks for fog communication
Tasks: Review the latest progress of real-time wireless networks to be used in industrial scenarios (e.g. customized WiFi, LTE, 5G). Evaluate and compare different technologies through theoretical analysis, network simulations and experimental validation on both off-the-shelf and customized communication platforms. Test the performance in terms of latency and reliability in real industrial environments.
Required Skills: Information and communication theory, wireless communication standards, PHY/MAC layer design and simulation, Matlab/Simulink, C/C++ programming, AI and ML fundamentals, mathematics

Position 2: Real-time wired networks for fog communication
Tasks: Review the latest progress of real-time wired networks to be used in industrial scenarios (e.g. real-time Ethernet networks and TSN). Evaluate and compare different technologies through theoretical analysis, network simulations and experimental validation on both off-the-shelf and customized communication platforms. Test the performance in terms of latency and reliability in real industrial environments.
Required Skills: Information and communication theory, wired communication standards, PHY/MAC layer design and simulation, Matlab/Simulink, C/C++ programming, AI and ML fundamentals, mathematics

Position 3: Integration of wired and wireless networks for fog communication
Tasks: Investigate the problem of integrating real-time wired and wireless networks to support complex scenarios in which mobile and fixed devices must collaborate and synchronize. Consider best practices and required features for wireless networks to be integrated with wired ones in terms of timing, determinism and reliability. Develop an hybrid setup with wired and wireless network segments and test its real-time performance.
Required Skills: Information and communication theory, wireless communication standards, wired communication standards, computer networks, Matlab/Simulink, C/C++ programming, AI and ML fundamentals, mathematics

Position 4: Hardware support for AI in the fog
Tasks: Investigate latest hardware for acceleration of AI functionality such as machine learning and neural networks. Implement an experimental AI application (e.g. computer vision application) which exploits the benefits of such hardware. Evaluate and compare the performance of using the acceleration hardware in an industrial setting.
Required Skills: Cloud/Fog computing platforms, C / C++ / C# / Python programming, OpenCV or other computer vision frameworks, GPU programming, AI and ML fundamentals

Position 5: Software frameworks for fog-based AI
Tasks: Explore the state-of-the-art fog software platforms that can be used for industrial applications. Special focus should be on support for AI functionality such as machine learning and neural networks, e.g. computer vision. Compare the benefits and challenges of different technologies. Implement a prototype that shows how fog can be used for real-time industrial applications.
Required Skills: Cloud/Fog computing platforms, C / C++ / C# / Python programming, OpenCV or other computer vision frameworks, AI and ML fundamentals

Shared requirements

Despite the diverse requirements of different tasks, all these positions are seeking candidates with both deep theoretical knowledge and strong practical skills (coding, debugging, and testing), excellent scientific writing, good English presentation skills, and team working. The preferred internship candidate is a PhD student in the communications or computing field. However, other profiles will be also evaluated, including master students looking for an MSc thesis. At the end of the internship, the candidate will be expected to produce high quality presentations, paper manuscript(s) aiming for IEEE journals, and workable demonstrator(s).

Career opportunity

If you can eventually deliver all the results with expected quality, as most of our students have done in recent years, you will be superiorly competitive for both academic positions and job hunting. There are also opportunities in ABB and our collaborators.

How to apply

Email with a subject of **"[Internship] <name>-<university >-<position>".** Attach cover letter, CV, transcripts, and bachelor/master thesis (if present). More evidence of competence is not mandatory but desirable e.g. publications, patents (only non-confidential information), reports, pictures or videos of demos, recommendation letters, etc.

Supervisors

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