ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

DET - Development and metrological management of wireless sensor networks for industrial and biomedical applications

Funded By	Dipartimento DET
Supervisor	CORBELLINI SIMONE - simone.corbellini@polito.it
Contact	CARULLO ALESSIO - alessio.carullo@polito.it VALLAN ALBERTO - alberto.vallan@polito.it
Context of the research activity	The research focuses on improving the reliability of production processing in industrial plants and the acquisition of biomedical signals through the development of electronic devices based on wireless sensor networks. In the industrial field, the emphasis is on metrological strategies to enhance the reliability of measurements within food processing systems and automation technologies; in the biomedical domain, the research addresses the challenges of sampling and analyzing vocal signals, which leads to the project of measurement systems to provide reliable data for clinical evaluations, with the ultimate goal of improving diagnostic tools.
Objectives	The research activity will include an initial evaluation of critical quantities of interest related to the performance and quality assurance of the industrial processes. Examples include parameters such as temperature, humidity, and other environmental factors within food processing environments, as well as quantities relevant to process efficiency and product quality in automation systems, with particular attention to the traceability and compliance with industrial standards. Then, according to the metrological specifications, the most suitable sensors will be selected and will guide the design of the electronic board of each measuring node. In the biomedical area, the emphasis is on the extraction of quality parameters from vocal signals in the time, frequency and quefrency domains, on which is based a substantial clinical analysis in patients with neurodegenerative diseases. This involves the design of wearable devices, based on air and contact microphones, sampling the voice signals to measure acoustic and biomechanical properties of the voice, defined alongside their respective measurement requirements. The identified measurement requirements in both the covered topics will guide the design of distributed wireless sensor network architectures, which will incorporate low-cost, low-power, scalable, and flexible nodes, which can be also supported by energy harvesting technologies to improve power

	autonomy. Both commercially available components and innovative solutions will be evaluated in order to meet technical and operational demands. Ensuring measurement traceability is a core aspect of this research, which will lead to the development of a metrological management framework encompassing calibration procedures for the measuring nodes. In this regard, the calibration procedures will be automated and remotely executed to enhance efficiency and maintain measurement accuracy over time. The resulting systems will bridge the gap between advanced sensing technologies and their practical applications in industrial and biomedical settings, supporting improved quality, safety, and patient care.

Skills and competencies for the development of the activity	Analog and digital electronics, sensors, signal processing, measurement, uncertainty evaluation, traceability and calibration.