DIPARTIMENTO DI INGEGNERIA
CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE -
PHD COURSE IN INDUSTRIAL AND INFORMATION ENGINEERING -
37TH CYCLE

Title of the research activity:	**Intelligent and IoT-Based Systems for Soil Monitoring in a Sustainable Economy** https://soilsensor.com/soil/applications/ https://www.nap.edu/read/2132/chapter/9#193 *Research Fields*: soil monitoring applications, IoT System, Sensors and Electronic Systems, Distributed sensing, sustainable economy *Collaboration*: *Dipartimento di Scienze Agrarie, Alimentari e Ambientali, Perugia*.
State of the Art:	In the framework of the Internet of Things (IoT), [1-6] communication technologies can improve the current methods of monitoring, supporting the response appropriately in real time for a wide range of applications in different fields of engineering. The pillars, or technologies, enabling the IoT scenario are clearly described in [7]: i) smart everyday objects ii) information-centric networks, and iii) automated real-time insights. In the environmental field, sensors are designed for collecting information (e.g., temperature, pressure, light, humidity, soil moisture, etc.) whereas network-capable microcontrollers are able to process, store, and interpret information, building intelligent wireless sensor networks (WSN). A clear advantage of wireless transmission is a significant reduction and simplification in wiring and harness, in the perspective of a sustainable economy. Recently, an experimental characterization of a commercial, low-cost "capacitive" soil moisture sensor that can be housed in distributed nodes for IoT applications has been developed at our Engineering Department. [8]. The chosen sensor is the cheapest and most easily available in the market. A preliminary validation of the sensor for the determination of the soil water content has been recently carried out on silica sandy soil samples.
Short description and objectives of the research activity:	In this scenario, the objectives of this work can be summarized as follows: • acquisition of awareness on Low Power Wide Area Networks (LPWAN) in different environmental fields, e.g. precision agriculture. • acquisition of basic physical parameters of plants (vegetation), soil and ambient/environment: soil water content, soil temperature, greenhouse relative humidity (RH), temperature and light; • availability of a modular system built with cheap off-the-shelf components aiming to compare the performance with commercially available expensive systems to select possible applications in the IoT scenario.

	• laboratory experimental investigation aimed at validating the applicability of the developed sensor to different soil types, in terms of mineralogical constituents, physical soil-state parameters, degree of saturation, etc… The design of a modular architecture subdivided into different layers will be investigated: i) wireless nodes (encompassing sensors, actuators, low-power embedded processor, battery), ii) internet gateway/concentrator, iii) user interface and iv) database applications placed in a virtual machine in the cloud. The proposed development relies on these key elements: - participation; - building a system by using a smart hardware and software platform available in the market and enabling Real Time Software Execution; - capability to store the acquired information for real time or post-processing elaboration; - getting acquainted with electronics operating also in harsh environment.
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