Politecnico di Torino

Honors Thesis

Master of Science in Sustainable Architecture

Abstract

PROMET&O PROJECT: OBJECTIVE/SUBJECTIVE BINOMIUM IN INDOOR ENVIRONMENTAL MONITORING. A FOCUS ON THE METROLOGICAL CHARACTERIZATION

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The topic of Indoor Environmental Quality (IEQ) monitoring, meant as the sum of the four environmental domains (thermal, visual, acoustic, and air quality), is becoming increasingly relevant, mainly in tertiary-use spaces. The reason is to be found both in a growing interest in personal well-being, comfort, and productivity and in the advent of inexpensive and easy-to-use tools, the low-cost sensors. However, it is not possible to trace the clinical picture of the indoor environment based on the numerical quantity expressed by the sensor. It is necessary to combine this objective data with the subjective data of the user's personal comfort (IEC). The PROMET&O (PROactive Monitoring for indoor EnvironmenTal quality & cOmfort) project, developed by a multidisciplinary team at the Polytechnic of Turin, composed of experts in building physics, electronic and computer engineering, fits into this perspective. One of the project goals is to produce an accurate, innovative , and low-cost continuous monitoring system in terms of both Indoor Environmental Quality (IEQ) and Comfort (IEC). For this purpose, a low-cost multi-sensor designed and built at the Polytechnic is used, for the acquisition of objective data (Air temperature, Relative Humidity, Sound pressure level, CO_2, CO, $PM_{2.5}$, PM_{10}, Formaldehyde, NO_2, TVOC, Illuminance), and an ad hoc questionnaire, for the collection of subjective user feedbacks, correlating them with the objective ones, and returning them graphically on the graphical interface, which can be consulted by the user. Thus, it is an innovation that can reconcile the objective/subjective pair in terms of the quality of the indoor environment.

The present thesis work is presented as a continuation of previous work, with a focus on the metrological characterization of the individual sensors that make up the internal organs of the multisensor. On their adequacy in the measurement ranges of interest, the accuracy of the entire multisensor in the simultaneous monitoring of all parameters and physical quantities depends.

After an outline of the fundamental concept of uncertainty, as well as how to calculate it, and that of calibration and calibration verification, the reference standards dictating the conditions for performing a metrological characterization, for each of the four domains, were investigated. Next, a literature review was conducted on the topic of low-cost sensor calibration that answered some basic questions, namely, what reference standards were used, what procedures were used, and whether the results were similar to those obtained for PROMET&O.

After that, the metrological characterization process performed by comparison with an accurate reference instrument was described generically. First, a calibration check was performed since manufacturers already provide the nominal accuracy value of the sensor in the data sheets. In case it meets the metrological requirements, imposed at the design stage following standards and guidelines, the actual accuracy value of the sensor will be verified by comparison with the reference instrument. If, on the contrary, the nominal accuracy of the sensor already exceeds the requirements at the beginning, a preliminary adjustment using Matlab software will be used, and only then a calibration check will be performed.

Finally, the settings, procedures, and results, in numerical and graphical form, for each test conducted are reported. So far the sensors tested have been those of Temperature, Relative Humidity, Illuminance, CO2, and Sound Pressure Level.

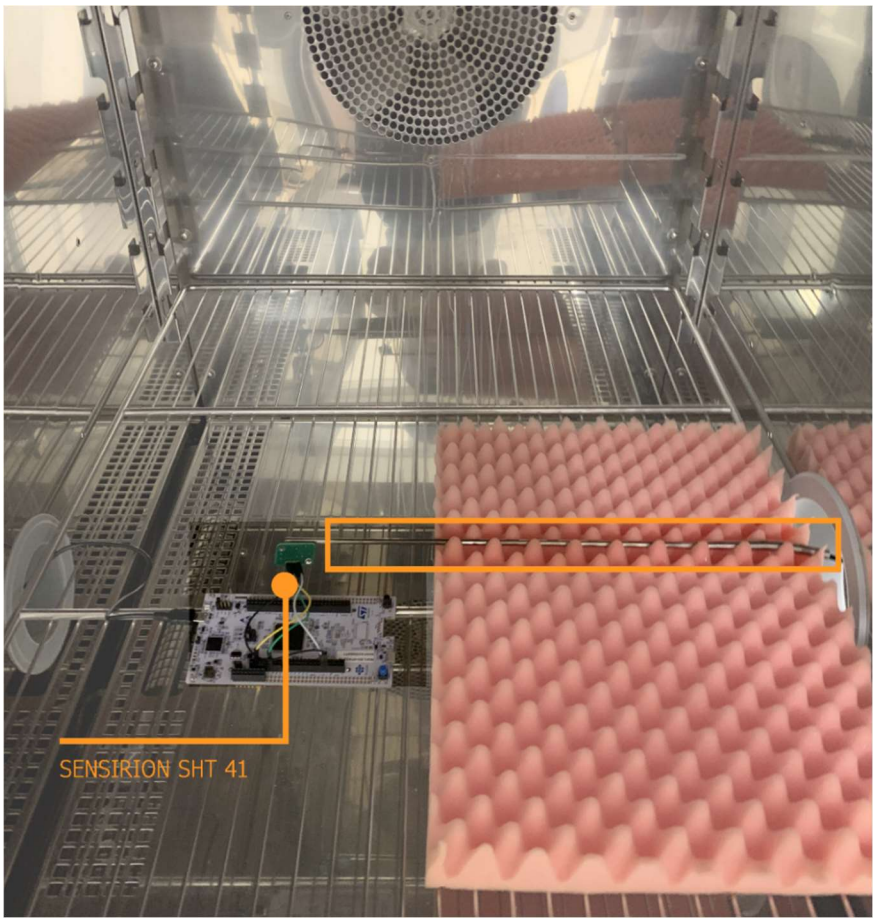

Figure 1 Disposition inside the climatic chamber of the sensor and Pt100

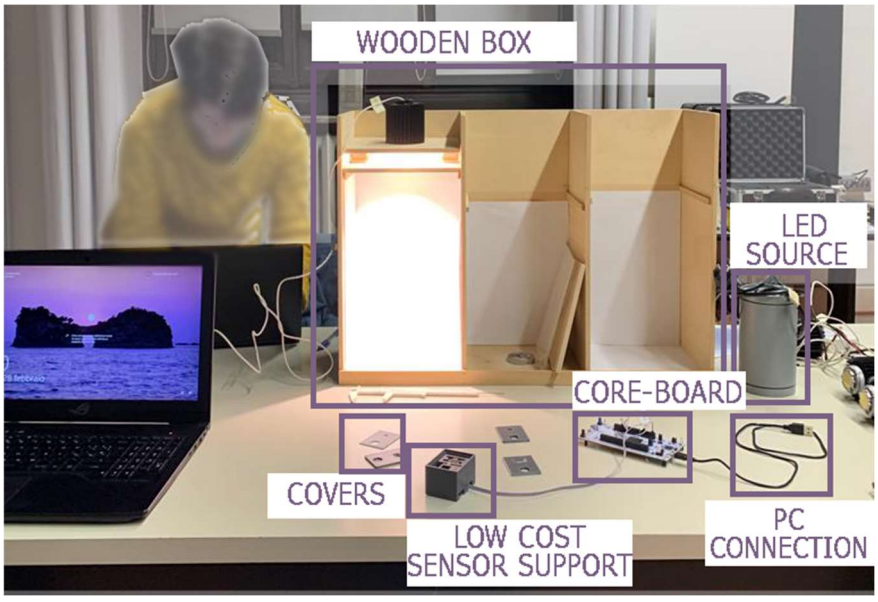

Figure 2 Instrumentation required for the illuminance test

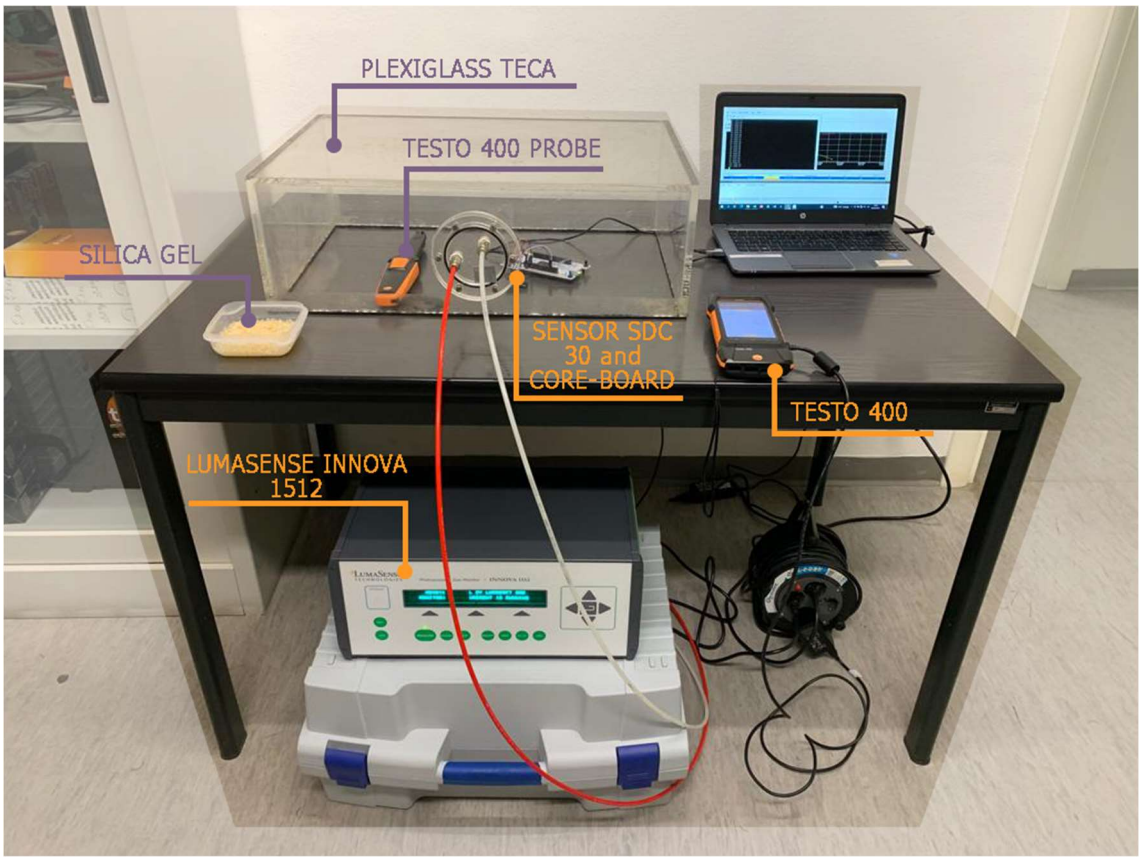

Figure 3 Instrumentation required for the CO_2 test

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