Achieving high accuracy air quality measurements with Bettair® static monitors

Air pollution is a major problem for public health. The main sources of these pollutants are **transport** and **energy** followed by **industry**. According to the World Health Organization (WHO), **ambient air pollution kills over 4 million people** every year[1], largely in cities. It is an invisible killer. Air pollution in urban scenarios is estimated to cost approximately 2% of the Gross Domestic Product in developed countries and 5% in developing countries[2].

The high prices of the pollutant analysers translate to high costs of setting up fixed-site monitoring stations with significant additional resources required for maintenance and calibration. Operation of such sites is also constrained by the need for significant infrastructure (secure enclosures, mains power and others). The consequence is that, while well proven in terms of precision and accuracy of air quality measurements, most existing networks are sparse as higher network densities would be impractical as well as prohibitively expensive. There is, therefore, an urgent need to complement existing air quality monitoring methodologies with flexible and affordable alternatives, to improve monitoring capabilities for both scientific and legislative purposes, to allow source attribution and to improve understanding of health impacts of urban air quality.

Bettair® is an Internet of Things (IoT) platform that permits, for the first time, to map air pollution in cities on a previously unimaginable scale based on a **large deployment of outstandingly accurate gas sensors** by using an **advanced post-processing algorithm** to consider both the **known and unknown factors** that affect the sensors. The platform includes Hardware (network of air quality monitors), cloud-based software (back/front end) for cities and an APP for citizens.

Our platform (that complements traditional air quality monitoring equipment) can perfectly assist cities to i) **identify unknown pollution sources**, ii) to **assess the impact and effects of different environmental actions** to identify the most effective ones, and iii) **recommend specific local actions**. This information can provide unique insights and will enable smarter and better decisions to mitigate air pollution in the short run. In the medium run, it is also a very powerful tool in order to **define effective and appropriate urban plans** to improve the air quality in urban scenarios considering all the information provided. Additionally, it will also permit to: identify and **categorize zones per air quality**, important for people with respiratory diseases, and runners; recommend the cleanest routes; study the **evolution of air pollution** with the seasons and years; **plan civil works**

[1] https://www.who.int/airpollution/en/
[2] United Nations Environment Programme – Urban Environmental Unit - Urban Air Pollution

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on the most appropriate date and timetables and, **compare and identify the best urban topologies** from this perspective. **The possibilities are almost endless.**

Bettair® static nodes – The experiments

Electrochemical sensors employ indirect methods to measure the amount of contaminant gases in a specific place at a given time, in this case generate a voltage that depends on the gas concentration where the sensor is. Afterwards, the gas concentration is inferred from the measures. During the Citi-Sense project, we noticed that the **laboratory inferred models** for this kind of sensors **do not perform well** when employed in real environments. Therefore, **field experiments are needed** to gather data and construct models, infer the different dependencies as well as to validate the performance of the sensors.

At bettair® we have carried out several experiments to compare the performance of our nodes with traditional air quality monitoring equipment. The experiments have been carried out since 2017 (with the same nodes) in several locations. The most relevant are the traffic and background stations located in Barcelona.

Bettair® static nodes with three electrochemical sensors (NO, NO_2, O_3) developed by Bettair were co-located with an air quality monitoring station of the *Generalitat de Catalunya* located in Barcelona (Gràcia - Sant Gervasi and Parc de Vall d'Hebron) to compare the response of the data models to infer the concentrations developed by bettair® using the raw data from electrochemical sensor measurements of NO_2, CO, NO with a calibrated reference instrument. The reference instruments were located at the top of the station with an inlet height of 1 m approximately 5 m horizontally from a busy urban road (Gràcia)- 1 m height and approximately 30 m horizontally from an urban road. (Pack de Vall d`Hebron.

The results of the experiments carried out during the year 2017 until 2019 show the high potential of the bettair® technology. Our proprietary platform can easily achieve high correlation with reference AQM stations as well as a repeatability of almost 100% between nodes.

The main goal of the long-term experiment was to demonstrate que adaptability of the post processing algorithm to diverse scenarios as the changing conditions through the year can have an impact on the accuracy of the data.

The high performance of the electronics combined with the complex proprietary post processing algorithm proves that our technology can provide highly accurate data in several scenarios. Additionally, our technology can provide not only highly accurate data but data with high spatial and temporal resolution.