Intelligent ventilation system

The Internet of things (IoT) concept refers to the interconnection between everyday electronic devices, usually via internet. Consequently, the data flow allows establishing "communications between the devices themselves" based on guidelines possibly programmed by the user. If we include nanoscale devices, we talk then about the Internet of Nano-Things (IoNT) [1]. This technology has high applicability in a multitude of areas, e.g. transport, environmental monitoring and health. Portability, on-site deployment capability and high sensitivity and selectivity, among others, make nanosensors a very promising detection technology [2]. This work proposes the design of an intelligent IoNT-compatible system destined to regulate the ventilation in closed places in an automated way.

Focusing on environments with unhealthy air quality due e.g. to urbanization and traffic, the installation of intelligent electronic systems that regulate and enhance air quality in spaces where people spend continuous long times (e.g. households and offices), can have a positive impact on the individuals themselves and many relevant aspects like quality of life, concentration, efficiency at work and physical and mental health. In this work the design of an electronic system to regulate ventilation in closed places is presented. The objective of this design is to enhance air quality by ventilating spaces and ensuring comfortable conditions of temperature and humidity. The system will regulate these parameters by automatically opening and closing windows, as well as automatically turning on and off air conditioning, air purification, and humidification/dehumidification systems.

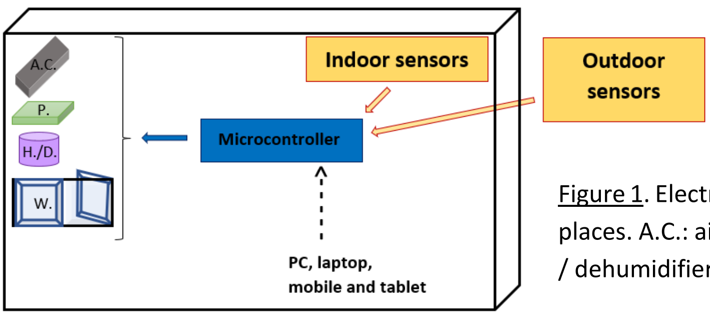

Figure 1. Electronic system to regulate ventilation in closed places. A.C.: air conditioning; P.: purifier; H./D.: humidifier / dehumidifier; W.: window.

The system has three fundamental components: a sensor network, a microcontroller and a set of actuators [Figure 1]. Each of these components is described below.

· **Sensors**

The parameters analyzed by the system are: concentration of polluting gases in the air (NO_2, SO_2, NH_3, CO_2, CO, CH_4) [3], temperature and humidity, both indoors and outdoors.

For the detection and measurement of polluting gases, the sensors are chemical-resistive [Figure 2], which means that the adsorption of gas molecules on the surface between two electrodes causes a variation in the resistance to the passage of current [4]. In this way it is possible to establish an adsorbed gas concentration / resistance variation relation. These sensors must have a very small size and a long service life, be robust, silent and economically efficient, in addition to showing high sensitivity and selectivity [3–6]. Among the materials used for the detection of gases are several semiconductor metal oxides (SMOs), 2D conductive materials and composites formed by SMOs or 2D conductive materials, with metals [4,6]. Selectivity can be improved by using filters (see e.g. the work by Van Den Broek et al. [6] for a wide variety of filters used to improve the selectivity of gas sensors, depending on the sensor material and the nature of the analyte to be measured).

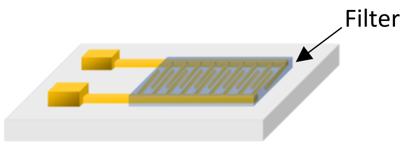

Figure 2. Chemical-resistive sensor with a filter.

For temperature measurement, the sensors are thermoelectric, which means that a temperature gradient causes a voltage difference between a metal and a metal alloy [7] (see e.g. the work by Rahman et al. [7], who manufactured flexible Cu/CuNi temperature sensors).

For humidity measurement, sensors resistive under humidity are used, i.e. a variation in the degree of humidity causes a variation in the resistance to the passage of current (see e.g. the work by Shukla et al. [8], who synthesized a nanocomposite of SnO2 and polyaniline valid for humidity detection based on electrical resistivity).

· **Microcontroller**

The microcontroller is the circuit that receives signals from the sensors and generates and sends orders to the actuators. The microcontroller is connected to a web server where the implemented algorithms carry out any required checks, and the subsequent orders [9] (see [Figure 3] for an example of a possible algorithm). Then, the user can configure the system by accessing the server through an web interface [9] from a PC, laptop, mobile or tablet [Figure 1].

· **Actuators**

The actuators are the devices that receive the electrical signal from the microcontroller and transform it into physical actions (i.e., opening or closing the windows, and turning on or off the devices for air conditioning).

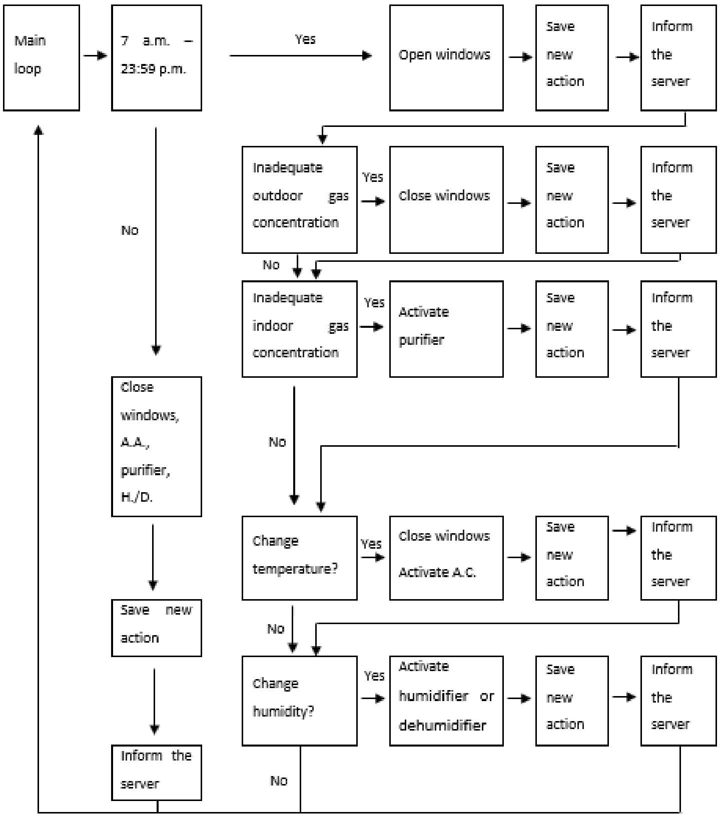

Figure 3. Possible flow chart [9] depicting the checks that the smart home system has to carry out and the subsequent actions.

In conclusion, the design of electronic systems that adapt to our needs can suppose a remarkable increase in quality of life. The implementation of nanosensors as fundamental elements in intelligent systems for home automation (or any other type of IoNT system), can have a very positive impact in terms of people's habits, as well as physical and mental conditions.

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