A SMART CITY SOLUTION FOR POLLUTION MONITORING IN HEAVY TRAFFIC STREETS

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Over the last decades, due to the advance of microelectronics, electronic devices are progressively getting smaller and achieve extremely low-power consumption enabling the design of energy autonomous systems (EAS), which are low-power systems that run without being connected to any power grid, and are powered by small batteries or even, nowadays, are batteryless with the advent of Energy Harvesting (EH).

EH can be defined as the process by which electric energy is collected from external energy sources from the environment around the low-power electronic system to be powered. There are several ways to harvest energy from the environment (light, mechanical vibration, thermal, RF); the decision depends on the application and on the environment around it.

On the other hand, the advance of communication technologies along with sensing and EH techniques, has enabled the development of EH-powered Wireless Sensor Network (WSN) composed of a set of Energy-Autonomous Wireless Sensor Node for monitoring environmental physical variables in large and hard-to-reach areas.

One important application area of EH-powered WSN is in urban pollution monitoring and ones of the most polluted areas of any city are its heavy traffic streets. This is a very important application since according to a survey released in 2016 by the World Bank Group and by the Institute for Health Metrics and Evaluation, deaths caused by air pollution have cost the world $225 billion in 2013, for lost work income, and caused 5.5 million deaths in that period.

Currently, several cities have immense pollution monitoring stations but, as they are very expensive, there are only a few installed and they are located in some specific points of the city. Considering the main pollutants those stations have been monitoring, the most unsettling one is concerning Particulate Matter (PM), which are particles suspended in air that can be very hazardous.

In this way, to develop a low-cost easy-to-deploy real-time EH-powered WSN that can be installed along the city's main streets for PM-level monitoring is welcome since it can be used to alert drivers to avoid a high polluted street and, as a consequence, the street may have its pollution level decreased if some number of drivers get the same action.

Considering that along the main streets of a city there are in general overhead power line along them, this project intends to develop a PM-sensing wireless sensor node powered by harvesting energy from the magnetic induction around the power line.

The easy-to-deploy goal will be achieved since the sensor node will have to be just clamped onto the power line since its design is small-size clamp shaped. The low-cost goal will be achieved since it will be used low-cost low-power off-the-shelf System-on-Chip (SoC) integrating processor, some peripherals and RF radio.

About harvesting energy from magnetic induction around the power line, the clamp body will be composed of a magnetic material toroidal core and a coil. After clamping it on the line, the electric current that passes through the power line generates a magnetic field around it that, for its turns, induces a voltage in the coil ends. An energy conditioning circuit gets this voltage and powers the sensor node. The chosen magnetic core material is a nanocrystalline alloy due to its extremely high magnetic permeability allowing the usage of very small core dimensions.

The sensor nodes will be truly energetically autonomous, easily installed along the city's arterial streets and will enable the city to enter into the concept of smart cities. The streets and avenues of the city will have the level of particulate matter monitored, so one of the main "invisible" problems that affect the population nowadays, the air pollution, can be early detected. Also, a great amount of pollution data in a high temporal and spatial resolution can be obtained for analysis and development of public policies to solve the problem before it causes greater harm to society and the environment.