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Design and modeling of an intelligent system based on piezoelectric materials for the dual control of the load and the gas emissions of a vehicle in motion

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The whole world is currently facing two major challenges related to energy security and climate change. The transition to a circular economy is one of the key projects of the ecological, energy and social transition targeted by Morocco. In order to meet this increased need, both in terms of energy and environment, our research work focuses on the exploitation of natural sources for the production of electrical energy and also the prevention of the environment. This goal can be achieved by designing energy harvesting systems that are optimized and useful to the industrial sector. One of the energy harvesting applications, proposed and studied by our research team, is dynamic vehicle weighing system (weighing-in-motion "WIM"). Indeed, an electromechanical transduction structure via piezoelectric materials has been optimized for an application in the road sector but also within the context of industry 4.0. The system consists of the implementation of an intelligent architecture in roadways. These devices will be used to control not only the vehicle load but also the gases emitted by the latter when it represents an overload. In addition to its functionality as a WIM system and electronic nose, the designed structure allows the recovery of energy on our roads and represents a good converter of mechanical vibrations into electricity. A numerical simulation taking into consideration the characteristics of the road but also those of the piezoelectric sensor and the vehicle gave a power of 154.6 kW under a road traffic of 60,000 vehicles/day.

Keywords: weighing-in-motion, energy harvesting, piezoelectric material, electronic nose, intelligent system