VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING TECHNOLOGY

of **Quentin Quevy**

The public defense will take place on **Tuesday 17th January 2023 at 17:00pm** in room **D.2.01** (Building D, Brussels Humanities, Sciences & Engineering Campus)

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ADVANCED SELF POWERING TRIBO-ELECTRIC SENSORS AND EMBEDDED SYSTEMS TOWARDS SUSTAINABLE SENSING

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Abstract of the PhD research

In recent years, there has been an increasing interest in sustainable sensing devices that are powered by ambient energy sources. Sustainable development brings together several global issues, such as pollution, depletion of minerals, and more. Technologies have played an essential role in creating the problems we face, but they will also play an essential role in solving them. Nevertheless, energy harvesting for embedded systems is not yet integrated much into everyone's life. One promising technology in this area are the nano-triboelectric energy harvesters, which can generate electricity from micro vibrations; kinetic energy. These energy harvesters are typically made from two different dielectric layers. When the two materials are brought into contact, they create an electrical charge that can be used to power a variety of electronic devices. This technology gained interest thanks to the modelization of the process in 2016. Since then, many new harvesters have been developed.

My research was about developing advanced embedded systems for sustainable applications. Two major aspects for creating sensing solutions that minimize the impact of batteries were studied to work toward a solution for harvesting energy from ambient sources. This has led to the investigation of nano triboelectric harvesters, which have proven to be potentially efficient. Secondly, we have investigated the difference between the realization of realworld applications.

First, a proof of principle has been designed and developed of a fully embedded battery-free priority vehicle detector that can extract acoustic energy from sirens and environmental noises. We have analyzed the system, dimensioned the generators, and implemented an accordingly tuned Helmholtz generator. As a proof of principle, we have built a battery-free priority vehicle detection system in a smart city context. This self-powered sensor is optimized to detect priority vehicles and adapt signalization accordingly. A more fundamental study has been done to improve the dielectric/electrode layer's performances. Therefore, different processes were tested to determine which offered the best results. The sample made by spin-coating TiO2 solution on a brass substrate showed the best homogeneity.

Secondly a non-trivial complex sustainable sensing application has been researched on its feasibility and implement ability. A sustainable robot for water quality monitoring that uses multiple sensors, advanced communication technologies, and advanced energy optimization techniques. Besides implementation, we have analyzed energy consumption, the need for energy harvesters, and the integration into a networked water monitoring system. The water-quality monitoring device recess water-quality parameters, such as pH, dissolved oxygen levels, electric conductivity, and more, to establish the state of the water body it is floating on. The goal was to end up with a device which is low-cost and delivers qualitative data. This work gathers different sustainable sensing methods, from the actual harvesting and sensing technique to the controlling mechanism, the involved mechanical design,
and the connectivity in low-power networks.