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Optoelectronic and Photonic Sensors, Frontiers in Sensors

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Optoelectronic and photonic (OE-P) sensors incessantly expand their roles in emerging sciences and technologies that evolve into new industries. Various OE-P sensors are being developed and implemented in autonomous vehicles to secure precise maneuvering. *In-situ* sensing of physical parameters between a vehicle and surrounding objects demands an unprecedented level of OE-P sensing technology. The broader expansion of internet-of-things technologies into industry and society is facing new hurdles to which OE-P sensors can provide solutions. Furthermore, recent green taxonomy regulations have opened a new avenue of detection, monitoring, and feedback of environmentally sensitive substances. OE-P sensors will generate an interdisciplinary technical platform capable of coping with these societal issues, in a bottom-up manner. This platform will encompass novel sensing materials, creative device structures, multi-functional components, and integrated system implementation. OE-P sensors will also include the innovative area of sensing based on quantum technologies that can extend the sensing scope into nanoscale dimensions.

Autonomous vehicles are being explored in various prototypes, and numerous supporting sensors are being developed (Ignatious et al., 2022). Yet, they share a fundamental challenge for sensor technology-how to measure distances between the moving vehicle and its surrounding objects in real-time. Lidar became one of the critical solutions to this task (Li and Ibanez-Guzman, 2020). It is a sensor unit that illuminates the surroundings by emitting lasers. Ranges are measured precisely by opto-electronically processing the reflected laser returns from surfaces. Lidar is an excellent example of an OE-P sensor that integrates the pathways of electrons and photons to sense physical quantities. Information on the physical range between two objects can be converted into meaningful information. We believe that Lidar can serve as a platform for OE-P sensor technologies that can be expanded to other areas such as structural safety monitoring, seismic sensing, as well as robot orthopedic operations.

In recent decades, IoT technologies have shown rapid growth, especially in manufacturing, to increase yields in mass production, and expand the scale of autonomous unmanned processes. These sensors and their networks are aimed at monotonous production growth based on scalable deployment of sensor units with existing functionalities. However, this seemingly everlasting expansion of IoT in manufacturing has met a serious hurdle. The Taxonomy Regulation was published in the Official Journal of the European Union on 22 June 2020 and entered into force on 12 July 2020. (Sustainable financial taxonomy, 2020)[1] According to this regulation, economic activity has to meet overarching conditions to qualify as environmentally sustainable, directly confronting global issues such as climate change, air and water pollution, and ecosystems. Meeting the demands of this regulatory environment will require new multi-functional platforms in which OE-P sensors will play a critical role.

Lastly, we are witnessing a new era in which quantum sciences are being implemented in various macroscopic applications, such as a long-distance transmission of entangled quantum information

[1]https://ec.europa.eu/info/law/sustainable-finance-taxonomyregulation-eu-2020-852_en

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(Jaeger, 2007), and quantum computing networks (O'brien, 2007). Currently, quantum sensing (Pirandola et al., 2018) is based on efforts using quantum resources to enhance sensing performances in radar-like detection of faint objects, precise readout of information from optical memories, and the optical resolution of extremely close point-like sources. For instance, quantum scale interferometers are being investigated to measure the temperature and displacements of neurons *in vivo*. The entirely new concept of OE-P sensing at the quantum level is rapidly becoming the focus of intense interest, and is being intensively investigated globally.

"Optoelectronic and Photonic Sensors, Frontiers in Sensors" will offer an open forum to publish top-quality research combining optoelectronics and photonics into integrated sensing platforms, allowing in-depth discussion on perspectives and opportunities.

AUTHOR CONTRIBUTIONS

KO has initiated this topic and written the manuscript.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.