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EDITED AND REVIEWED BY
Lorenzo Pavesi,
University of Trento, Italy

*CORRESPONDENCE
Kaijie Xu,
kjxu@xidian.edu.cn

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Editorial: Acquisition and application of multimodal sensing information

Xukun Yin[1], Changhui Jiang[2], Huadan Zheng[3], Angelo Sampaolo[4] and Kaijie Xu[5]*

[1]School of Optoelectronic Engineering, Xidian University, Xi'an, China, [2]Department of Photogrammetry and Remote Sensing, Finnish Geospatial Research Institute, Kirkkonummi, Finland, [3]Key Laboratory of Optoelectronic Information and Sensing Technologies of Guangdong Higher Education Institutes, Department of Optoelectronic Engineering, Jinan University, Guangzhou, China, [4]PolySense Lab, Dipartimento Interateneo di Fisica, University and Politecnico of Bari, Bari, Italy, [5]School of Electronic Engineering, Xidian University, Xi'an, China

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Editorial on the Research Topic
Acquisition and application of multimodal sensing information

With the development of advanced sensors in modern science and technology, sensors have already penetrated into such fields as industrial production, space development, ocean exploration, environmental protection, medical diagnosis, biological engineering, and even cultural relic protection [1–3]. Sensors are the basis of all data acquisition. Almost every modern project, from the exploration of the vast Universe and ocean, to the complex engineering systems, is inseparable from a variety of sensors. Sensors convert physical parameters (e.g., temperature, pressure, humidity, speed, etc.) into signals that can be measured electrically. A high-performance sensor with the advantages of high sensitivity, high resolutions, and real-time observation is desirable. In addition, the application of computers and advanced signal processing signal-processing methods makes sensor management possible ([4]; Najmeh et al. 2019). The use of sensing data from multiple sensors has been proven to be an efficient way to improve service experiences in different fields, e.g., intelligent transportation, remote sensing, smart city, and UAVs.

Recently, various optical sensors develop rapidly with the help of the advanced light source. For example, the laser spectroscopy-based trace gas sensor exhibits excellent sensitivity and selectivity compare compared with the electrochemistry gas sensor [5–7]. The laser radar or scanner are widely used in target detecting, tracking, aiming, and imaging recognition since the extremely high resolution in frequency domain, space domain and time domain. Therefore, it is meaningful to set up a Research Topic for the acquisition and application of multimodal sensing information. The Research Topic includes seven original research works, which are summarized below:

In the first article, Xiao et al. introduced an innovative approach to boost the Direction of Arrival (DOA) detection performance in the realm of array signal processing. Focusing on the optimization of the array's steering matrix, this method plays a pivotal role in accurately estimating the angles of incoming signals. The application of this enhanced steering matrix exhibits tremendous potential to

significantly elevate the accuracy and dependability of DOA detection, which bears paramount importance in various fields like radar systems, wireless communications, and sonar applications.

In the second study, Ruan et al. gained access to a valuable open-source resource that effectively extracts essential vegetation phenology information from satellite remote sensing data, through the innovative phenoC++ tool. The tool's sophisticated algorithms and cutting-edge techniques enable the processing of vast amounts of satellite data to derive meaningful insights into plant life cycle events, encompassing budding, flowering, leaf senescence, and more. This transformative tool empowers scientists to study ecological changes, understand climate impact on vegetation dynamics, and monitor ecosystem health across different regions and over extended periods.

In the third article, Guo et al. employed a rigorous quantitative assessment methodology, this study delves into the intricate relationship between human activities and nature within Chinese national parks, focusing intently on the renowned Three-River-Source National Park. The assessment encompasses multifaceted factors, including human impacts, ecological interactions, and conservation efforts, culminating in a comprehensive measure of the delicate balance and harmonious coexistence between human presence and natural ecosystems. By illuminating the level of harmony achieved, this research provides valuable guidance for policymakers, ecologists, and park management authorities, facilitating sustainable preservation and responsible utilization of natural resources.

In the fourth work in this Research Topic, Li et al. embarked on an empirical journey to analyze the performance of an innovative shipboard gravity gradient measurement system. Crucial in diverse fields of geophysics, navigation, and geodesy, the measurement of gravity gradients from a moving platform poses significant challenges. Leveraging the advances in instrumentation and data processing techniques, the paper meticulously details the design, implementation, and evaluation of the novel system, effectively demonstrating its prowess in delivering accurate and reliable gravity gradient measurements, thereby unlocking new possibilities for precise navigation and geophysical exploration on maritime ventures.

In the fifth contribution, Zhou et al. delved deep into the intricate web of factors influencing long-range single-site lightning location systems. By meticulously accounting for the propagation time delay of ground waves, the research undertakes a rigorous evaluation of existing algorithms, leading to their refinement and optimization. The revised lightning location methodology exhibits heightened precision in pinpointing lightning strikes, offering a substantial boost to lightning monitoring and early warning systems, thereby bolstering public safety and safeguarding critical infrastructure.

In the sixth contribution, Lv et al. presented a novel method that synergistically addresses the joint detection of both Direction of Departure (DOD) and Direction of Arrival (DOA) for radar targets. Leveraging signal subspace reconstruction and matching techniques, the proposed approach transcends the limitations of conventional radar systems, ensuring accurate detection and precise localization of targets. The integration of DOD and DOA detection engenders a paradigm shift in radar technology, bolstering applications such as target tracking, radar imaging, and airborne surveillance.

In the seventh contribution, Li et al. introduced an ingenious method for recognizing and combating discrete side-lobe clutter that plagues radar systems. Operating in the unforgiving environment of space, radar systems encounter a barrage of clutter signals that jeopardize accurate target detection. However, by ingeniously harnessing the power of sliding filter response loss, the proposed approach excels in discriminating and suppressing clutter, thereby elevating the radar's efficacy in space-based applications, such as satellite imaging and space object tracking.

In the eighth contribution, Zhang confronted the challenge of ensuring robust predictability in discrete event systems amid sensor attacks. Discrete event systems, governed by a sequence of events, confront disruptions when sensor data becomes compromised due to adversarial activities. In response, this research investigates resilient methods that uphold predictability and system stability, empowering industries ranging from manufacturing to transportation with fortified cyber defenses and resilient operational capacities.

In the ninth contribution, Zhang et al. introduced a dual pulse heterodyne system featuring a semiconductor optical amplifier (SOA)-based fiber ring laser. Capitalizing on the phenomenon of distributed acoustic sensing, this system continuously monitors and analyzes acoustic signals propagating along optical fibers, ushering in transformative capabilities in seismic monitoring, structural health assessment, and intrusion detection. The dual pulse heterodyne technique amplifies sensitivity, elevating the spatial resolution of acoustic measurements to unprecedented levels, thereby revolutionizing safety and security applications across diverse industries.

In the 10th contribution to this Research Topic, Li et al. reviewed unfolds the myriad applications and principles that define this cutting-edge discipline. Beyond traditional imaging techniques, polarization 3D imaging captures the spatial information alongside the intricate polarization state of light, unlocking new vistas in remote sensing, computer vision, and medical imaging domains. Unveiling its wide-ranging potential, the review serves as an authoritative guide to researchers and practitioners alike, underscoring the transformative impact of polarization 3D imaging across diverse scientific and technological frontiers.

Finally, in the 11th Original Research article, Fan et al. pioneered a novel approach that marries local neighborhood information granularity with the principles of rough set theory. In the realm of sensor networks, where the deluge of data poses computational challenges, the proposed method crafts an ingenious balance, retaining essential information while eliminating redundancy and noise. By virtue of its streamlined data representation, the approach bestows remarkable advantages in data transmission efficiency, storage optimization, and real-time processing in multifaceted applications like the Internet of Things (IoT) devices, environmental monitoring networks, and smart grids.

*In summary, this Research Topic of research papers represents a comprehensive exploration of the frontiers in various scientific fields, showcasing groundbreaking innovations and advancements. These papers contribute valuable insights and applications, propelling technology, environmental protection, and human wellbeing forward. Their publication will undoubtedly have a profound and lasting impact on academia and industry, inspiring further research endeavors in science and engineering.

Author contributions

XY: Writing–original draft. CJ: Writing–original draft. HZ: Writing–review and editing. AS: Writing–review and editing. KX: Writing–original draft, Writing–review and editing.

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.

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