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# Editorial: Industry-oriented interfaces: bridging the gap between humans and machines in the context of Industry 4.0 in the generative AI era

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Editorial on the Research Topic
Industry-oriented interfaces: bridging the gap between humans and machines in the context of Industry 4.0 in the generative AI era

Since the advent of the industrial revolution, professionals have continuously sought innovative ways to optimize manufacturing processes for greater efficiency, cost reduction, and superior product quality. In the current scenario of constantly evolving industrial advances, the intersection of Industry 4.0 and Human-Computer Interaction (HCI) is emerging as a pivotal element in reshaping industry and society alike. This Research Topic, "*Industry-oriented interfaces: bridging the human-machine gap in the context of Industry 4.0 and the age of generative AI*", brings together work at the nexus of a revolution that promises to reshape the very fabric of industrial operations, workforce dynamics and technology integration.

Historically, industrial operations adhered to a top-down leadership structure (Uhl-Bien et al., 2007), but today's information era is fundamentally data-driven (Bécue et al., 2021). Decision-making processes now hinge on timely data analysis, creating a competitive edge for companies that leverage this asset effectively. As a result, another paradigm shift has occurred: Industry 4.0. This movement integrates digital and physical systems, incorporating automated, intelligent technologies into nearly every industrial process (Lu, 2017). In this data-rich environment, the role of data has become as crucial to industrial success as physical machinery once was (Horlings, 2022).

Industry 4.0 represents a profound shift, characterized by the fusion of physical and digital technologies. This revolution harnesses the potential of cyber-physical systems, the Internet of Things (IoT), and data-driven decision-making to create smart factories and intelligent, self-optimizing manufacturing processes (Tyagi et al., 2024). Human-Computer Interaction emerges as a cornerstone of this transformation, enabling the design, creation, and optimization of technology with the human element at its core. By improving user interfaces and experiences, HCI offers industries unprecedented levels of productivity, innovation, and personalized solutions.

A critical challenge in this transformative era is the development of interfaces that not only facilitate human-machine interaction but also simplify it, ensuring workers can harness the full potential of advanced machinery without being overwhelmed by its complexity. This Research Topic addresses multiple dimensions of these industry-oriented interfaces, including ergonomic design, intuitive user experiences, advanced visualization tools, and augmented reality applications.

HCI plays a crucial role in bridging the gap between humans and machines in the context of Industry 4.0 (Brückner et al., 2023). By designing intuitive interfaces, optimizing user experiences, and facilitating collaborative decision-making, HCI empowers humans to harness the potential of advanced technologies while leveraging their own expertise. As Industry 4.0 continues to reshape industries, HCI will remain a critical enabler of seamless collaboration, productivity, and innovation, unlocking the full potential of the digital revolution which is already impacting Industry, empowered by the new possibilities brought by Generative AI techniques and algorithms.

This Research Topic explores the crucial role of HCI in fostering seamless human-machine collaboration within Industry 4.0, particularly in the context of generative AI advancements. Although automation and machine-to-machine communication are central to Industry 4.0, the human element remains irreplaceable. HCI ensures effective communication, collaboration, and decision-making between humans and machines, with intuitive interfaces that allow individuals to interact with complex systems, comprehend real-time data, and provide critical input for decision-making processes.

First, "*Facial emotion recognition through artificial intelligence*" (Ballesteros et al.) addresses the challenge of detecting human emotions through facial expressions using artificial intelligence. The authors develop software using computer vision algorithms, specifically convolutional neural networks (CNNs), to recognize facial emotions in real-time. Their methodology involves image processing pipelines that assess users' facial expressions. The results show that the system effectively identifies emotions but requires further training and additional algorithms to enhance precision in distinguishing similar emotional patterns.

Regarding "*Reliability on the Internet of Things with designing approach for exploratory analysis*" (Singh et al.), it explores reliability issues in the IoT, focusing on the challenges of failure rates, latency, and system robustness. The authors employ a layered model for IoT systems, analyzing each layer (perception, transport, support, application) to assess key reliability parameters such as mean time to failure (MTTF) and mean time between failures (MTBF). The study proposes reliability models to address these challenges and enhance system performance. Results indicate that IoT reliability remains an open issue, and further improvements are required, especially for systems operating in critical environments.

The work entitled "*Empowering engagement: unveiling motivational drivers for social media adoption: a Facebook case study*" (Allam et al.) examines the factors influencing social media adoption, using Facebook as a case study. The authors apply the Technology Acceptance Model (TAM) to analyze predictors such as perceived usefulness, ease of use, and hedonic motivations (enjoyment, curiosity, connectedness) on users' attitudes and intentions. The study uses structural equation modeling on a sample of 540 participants. Results reveal that both utilitarian and hedonic factors significantly affect Facebook usage, with social presence playing a key role in shaping user intentions. The study concludes that a mix of functionality and enjoyment drives social media engagement.

Finally, "*Usability assessment of a greenhouse context-aware alert system for small-scale farmers*" (Brenes et al.) addresses the need for user-friendly agricultural technology by assessing the usability of a context-aware alert system for small-scale farmers. The authors employ the NASA Task Load Index (NASA-TLX) and User Experience Questionnaire (UEQ) to measure perceived utility, mental workload, and user experience. Results from farmers indicate that the system is perceived as highly useful, with moderate mental workload, suggesting ease of use. Farmers prefer adaptable notification mechanisms (voice and text alerts) for effective information dissemination.

Furthermore, some of the papers included in this special edition correspond to articles that have been selected and have submitted extended versions that have been presented at the IX Iberoamerican Conference on Human-Computer Interaction.

## Author contributions

IF: Conceptualization, Writing – original draft, Writing – review & editing. CC: Conceptualization, Writing – original draft, Writing – review & editing. AG-H: Conceptualization, Writing – original draft, Writing – review & 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.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

## Publisher's note

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