Perspective

Chat with ChatGPT on Industry 5.0: Learning and Decision-Making for Intelligent Industries

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THE current ChatGPT phenomenon has signaled a new era of Artificial Intelligence moving from Algorithmic Intelligence to Linguistic Intelligence where interactive activities between actual and artificial, real and virtual, human and machine play an active and important role online and in real-time. At IEEE/CAA JAS, we are interested in investigating the impact and significance of this new era on industrial development, especially control and automation for manufacturing and production.

Last year at IEEE/CAA JAS, we received several special issue proposals on Industry 4.0, a surprise to us since term "Industry 4.0" has been around for over a decade [1] and the European Union has already published its report on "Industry 5.0: Towards a Sustainable, Human-centric and Resilient European Industry" [2] in 2021.

In China, Prof. H.-S. Tsien (钱学森), a founding figure and pioneer in modern control and systems engineering, and our best paper award is named in his honor, had proclaimed the coming of Industry 6.0 in 1984 [3], [4]. Our founding Editor-in-Chief, Prof. Fei-Yue Wang, had changed his Parallel Technology and Parallel Industry [5], which was based on his research on shadow systems [6] for modeling and managing NASA's Lunar/Martian autonomous plants in early 1990s, to "Industries 5.0" after learning Hanover's call for "Industrie 4.0" in 2014 [7].

In 2014, Prof. Wang led the effort to create the Technical Committee on Transportation 5.0 of IEEE Intelligent Transportation Systems Society at its annual International Intelligent Transportation Systems Conference in Qingdao, China. Regular workshops on Transportation 5.0 have been

held at IEEE ITSC, a number of reports have been published [8], [9] and the 10 year position paper is scheduled for release this year [10]. Since 2014, Prof. Wang and his team have published numerous technical reports and papers on X 5.0 and Parallel Intelligence [11]–[20].

Industry 5.0 vs Industries 5.0

In 2019, IEEE Systems, Man, and Cybernetics Society held its annual conference in Bari, Italy, and Prof. Wang was invited to present the opening keynote address. The conference theme was "Industrie 4.0" or "Industry 4.0", and Prof. Wang's presentation was titled: "The Origin and Goal of Future in CPSS: Industries 5.0 and Intelligent Industries" [21], in which he summarized his journey from using Monte Carlo based computational experiments for evaluating metal fatigue and fundamental frequency of structures with geometrical imperfection in 1982 [22] to his works on Parallel Intelligence and Intelligent Industries in 2000s. Fig. 1 illustrates his vision of "Industries 5.0" and its impact on world economy, and Fig. 2 shows the key differences between the core concepts of Industrie 4.0 and Industries 5.0.

From Industries 1.0 to Industries 5.0
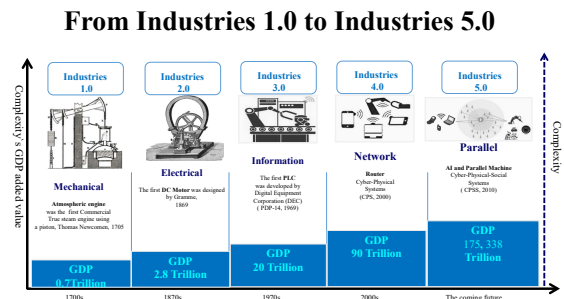
Fig. 1. Paradigm Shifts in Industrial Operations and Organizations

In Prof. Wang's system of systems for Industries 5.0, the key is Parallel Intelligence in Cyber Physical Social Systems (CPSS) for ACP-based Knowledge Automation that reduces most intellectual knowledge work to measurable and simple physical work by using digital human in Artificial societies, big models for Computational experiments, and virtual-real interaction and feedback for Parallel execution [21].

Fig. 2. Industrie 4.0 vs Industries 5.0
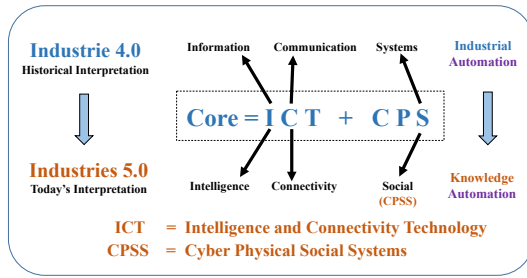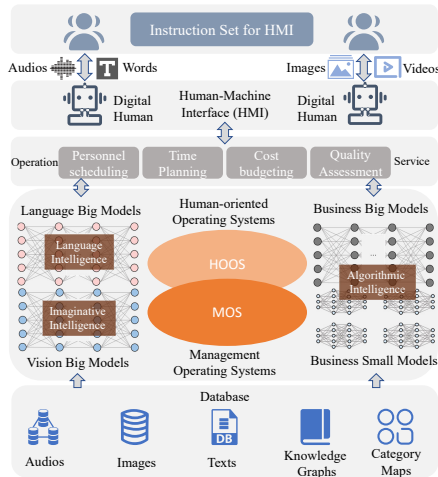

Fig. 3. Knowledge Workshops in Industries 5.0

Prof. Wang told his audiences at IEEE SMC 2019 that he believed we were still in the Third Industrial Revolution but at the last two stages: Industry 4.0 and Industries 5.0. We have to deal with three kinds of Humans in Industries 5.0: Digital Human, about 80% of the future workforce, Robotic Human, about 15%, and Biological Human like us, but only 5%. As illustrated in Fig. 3, foundation or big models for small tasks, scenarios engineering, human-oriented operating systems, would be the essential components of knowledge workshops of knowledge works and workers. Organizations of Industries 5.0 would operate in three modes: AM for autonomous modes where the main duty of biological human is monitoring, PM for parallel modes where biological human at remote sites or clouds have to supervise and work with digital and robotic humans in fields or edges, and EM for expert modes or emergency modes depend on the situations, where biological human or experts must be fast delivered to the working sites or fields to deal with these situations. AM, PM, and EM would make small tasks, big models, and deep intelligence a economic reality and routine for intelligent industries [21], [23].

Fig. 4 charts the number of academic papers and technical reports on both Industry 5.0 and Industries 5.0 since 2004. Note that in Chinese, there is no difference between Industry or Industries 5.0 terms. Clearly, their success needs not only AI, AlphaGo, digital twins, metaverses, ACP, CPSS, ChatGPT, but also new thinking in our philosophy for our future [24]–

[26]. Especially, we need new research and education in MultiDisciplinary, InterDisciplinary and TransDisciplinary, as indicated in Fig. 5 and recent works in [23], [27]–[42].
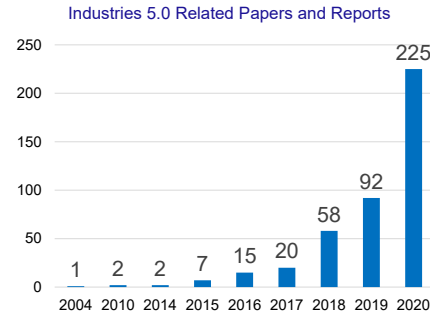

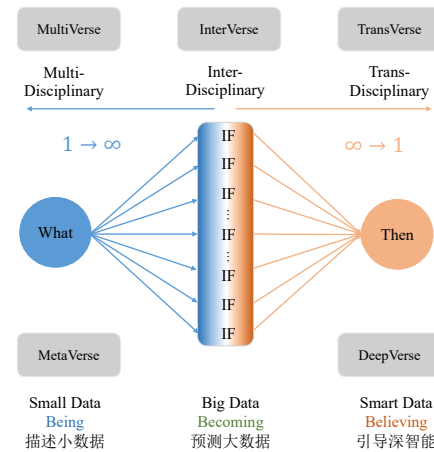Fig. 4. The Journey of Industry 5.0 and Industries 5.0 (2004-2020)

Fig. 5. Research & Education in Industries 5.0: MultiDisciplinary, InterDisciplinary, and TransDisciplinary

Chat with ChatGPT

As a state-of-the-art pre-trained language model developed by OpenAI, ChatGPT has attracted widespread attention. It includes a three-step training process involving supervised dialogue modeling, enhanced optimization techniques, and model fine-tuning, which mimics human language learning and knowledge acquisition [43], [44]. With its remarkable language understanding and text generation abilities, ChatGPT has been trained on vast amounts of data to obtain a nearly comprehensive knowledge base. It can engage in continuous multi-turn conversations based on context and is capable of producing text for a wide range of applications. In order to explore ChatGPT's capabilities in understanding the cutting-edge fields of Industries 5.0, we tried several chatting sessions with ChatGPT and the Q&A recording is shown in Fig. 6.

- Q1: Do you know Industry 5.0?
- Q2: Do you know anything about Industries 5.0?
- Q3: Have you read any report or paper on industries 5.0?
- Q4: Do you know the keynote speech titled "The Origin and Goal of Future in CPSS: Industries 4.0 and Industries 5.0" by Fei-Yue Wang at IEEE SMC 2019?
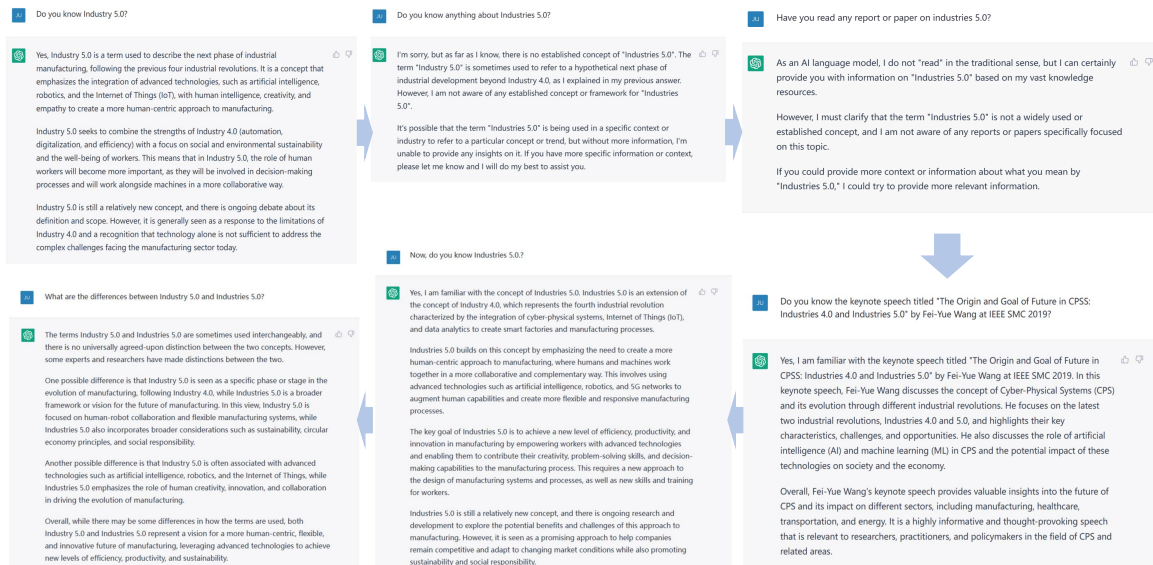
Fig. 6. ChatGPT: Questions & Answers

- Q5: Now, do you know Industries 5.0?
- Q6: What are the differences between Industry 5.0 and Industries 5.0?

ChatGPT has demonstrated its effectiveness in providing comprehensive information and knowledge on established terms such as Industry 5.0. However, when it comes to creative concepts such as Industries 5.0, its responses may not always be clear and accurate. Nevertheless, ChatGPT is constantly updating and learning to provide generally acceptable answers. One limitation of ChatGPT is that it may require explicit and specific information, rather than being able to understand implied cues. For example, it wasn't until a specific reference was provided that ChatGPT was able to locate information about Industries 5.0 within its corpus and provide related answers. While ChatGPT's understanding of Industries 5.0 may be basic and shallow, as verified by its response to the question about the differences between Industry 5.0 and industries 5.0, the answers it provides are enlightening and helpful. It appears that continued research is necessary, as we need to explore the learning and decision-making technologies for intelligent industries. This requires a joint effort between academia and industry.

Call for Papers

Based on received special issue proposals and current AI development, IEEE/CAA JAS will organize a special issue on "Intelligent Science and Technology for Industry 5.0 and Applications", which will cover but not be limited to the following topics:

- Artificial intelligence for advanced automation
- Metric meta-learning
- Model-agnostic meta-learning
- Few-shots meta-learning
- Optimizer meta-learning
- Recurrent model meta-learning
- Meta-features and meta-models
- Metaverse learning and optimization
- Digital twin for automation
- Intelligent systems
- Incremental and transfer learning
- Smart and digital factories
- Smart logistics and warehouses
- Robot vision and applications
- Fault diagnosis, prediction and prognostics
- Anomalies detection
- Industrial Internet of Things
- Edge computing-based artificial intelligence for automation
- Big data analytics for forecasting and planning
- Integrated productivity and quality analysis
- Production planning, scheduling and control algorithms
- Data mining and data-driven decision making
- AI methods customized for different industries
- 3D printing and additive manufacturing
- Industry 5.0 case studies
- Other related topics

The planned publication schedule is:

- 1st June 2023 – Submission starting
- 31st September 2023 - Submission deadline
- 31st November 2023 - First decision to authors
- 15th December 2023 – Resubmission
- 30th January 2024 - Final decision
- 10th February 2024 - Final manuscripts upload
- 15th February 2024 - Guest editorial due
- March 2024 – Publication

The special issue guest editors are listed in the following:

- Jiacun Wang (Monmouth University, West Long Branch, USA, jwang@monmouth.edu)
- Lorenzo Carnevale (University of Messina, Messina, Italy, lcarnevale@unime.it)
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