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DEPARTMENT: AI AND CYBER-PHYSICAL-SOCIAL SYSTEMS

Smart Decentralized Autonomous Organizations and Operations for Smart Societies: Human–Autonomous Organizations for Industry 5.0 and Society 5.0

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This article explores the concept of human–autonomous organizations (HAOs) based on decentralized autonomous organizations (DAOs) and operations as well as human, artificial, natural, and organizational intelligence and their roles in shaping smart societies in the context of Industry 5.0 and Society 5.0. It discusses the potential of AI-generated content and prompt engineering in specific goal-guided manufacture and governance. Additionally, the article introduces the concept of the HAO as a framework for integrating human intelligence to achieve fair, transparent, and accountable decision making within DAOs. The proposed HAO reduces the risk of instability and unreliability in "human-in-the-loop" copilot systems and human–machine hybrid systems, leading to more reliable, secure, and flexible systems. It provides insights into the future management of smart societies and the symbiotic relationship between human ingenuity and the suite of emerging new AI technologies.

Industry 5.0[1] builds upon Industry 4.0's Internet-based production by adding collaborative human–machine intelligence. It focuses on the development of artificial worlds to overcome resource disparity in the physical world, information disparity in the mental world, and intelligence disparity in the human–machine world.[1] Industry 5.0 seeks to augment both human and machine intelligence in a symbiotic relationship, where humans perform tasks that require creativity, social interaction, and critical thinking, and machines handle repetitive, computational, and other tedious tasks.

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INDUSTRY 5.0

Currently, with the rapid development of digital twins and metaverse technologies,[2] big data and computing resources can be utilized for creating and generating digital production, manufacturing, and logistics environments and processes. At the core of the artificial systems–computational experiments–parallel execution (ACP) approach[3] are digital environments that provide software-enabled computational experimental facilities to verify and validate management and control policies

before the systems are implemented into physical spaces. Risks of failure, high consumption, inefficiency, and ineffectiveness can be assessed and discovered in the digital environment rather than causing great and, potentially, unaffordable costs in the physical environment.

Industry 5.0 integrates cyberphysical–social factors into production, manufacturing, and logistics processes, emphasizing human–machine collaboration, knowledge–action consistency, digital–physical interaction, and progressive optimization. It connects the Internet of Things, the Internet of Devices, the Internet of Minds, and the Internet of People in a vision of future of industries where robot humans, digital humans, and biological humans collaborate together in cyberphysical–social-factor-integrated systems with their full strengths at play while enabling the productivity in cyberphysical–social systems (CPSSs) to be more efficient and effective, safer and more secure, and agile and flexible.

SOCIETY 5.0

The ubiquity of "big data," social networks, and knowledge graph technologies allows a systematic study of globalized, digitally enabled group dynamics. Online worlds compress social distances between people. One effect of this has been to enable people to cooperate on shared problems across geographical, demographic, and other social divides. A cost of this connectivity has been the routine violation by large organizations and criminals of user privacy and personal security, leading to problems such as big data discriminatory pricing, huge fines, and the violation of fundamental human rights to privacy and dignity.[4]

Digital twin technologies and the vision of a parallel, digitalized society have been getting increasing attention in recent years. Drawing data from sensors and other sources, digital twins construct a digital version of objects, processes, and human interactions, making them well suited to cyberphysical systems. However, their suitability for CPSSs is questionable. In CPSSs, the processes and interactions among objects are flexible and changeable; they cannot be mapped but can be computed and created in accordance with specific needs. Therefore, social computing and parallel systems[5] are proposed for CPSSs, where Merton's self-fulfilling prophecy laws dominate.[3]

ACP is a methodology for developing parallel systems[5] that integrates artificial systems ("A"), computational experiments ("C"), and parallel execution ("P"). Supported by blockchain and smart contracts, these kinds of parallel systems can combine identity authenticity, data permission, resource scheduling, task management, and contribution evaluation to guarantee the operation of fair, transparent, secure, and accountable decentralized autonomous organizations (DAOs).

The DAOs, in the form of cybermovement organizations (CMOs), human flesh searches (HFSs), crowdsourcing, and swarm intelligence, etc., bridge the physical space and cyber space to form a "digital–physical complex space." They generate various social signals to drive digital–physical interaction and calibration, while generative adversarial networks and parallel learning[6] overseen by human actors generate, learn, and train policies that will adapt to different scenarios. Thus, we step into the Society 5.0 era,[4,7] whose defining features are social-signals-driven knowledge automation, adaptivity, and active management and control for the sustainable development of societies with human dignity.

AI GENERATED CONTENT (AIGC) AND PROMPT ENGINEERING

Since the beginning of AI, a theme in modern culture is the belief that AI will surpass human intelligence. Irving John Good proposed the concept of "ultraintelligent" and the "intelligence explosion" in 1965, and, after the explosion, "the intelligence of man would be left far behind." Such an idea has stimulated dozens of science fiction novels and films, including Philip K. Dick's *Do Androids Dream of Electric Sheep?* (1968), Stanley Kubrick's *2001: A Space Odyssey* (1970), and Michael Crichton's *The Terminal Man* (1972), to name but a few. However, it has always been desirable and ideal in the past 58 years. Today, with the emergence of AIGC technologies and AIGC tools, such as ChatGPT, DALL-E, MusicAutoBot, VideoGPT, etc., springing up like mushrooms, is there any possibility that AI will surpass human intelligence in the near future?

From our perspective, this is not the key question. Instead, a more pressing questions is, "How should we use AIGC to promote the development of industry and society to ensure human being dignity rather than worrying about being replaced by AI and robots?"

This reorients the discourse to the idea of socially responsible automation (SRA)[8] as the crucial point. Industry 5.0[9] can be framed using a multilevel model for industry comprising four distinct levels, structured in a pyramid, according to the stakeholder values and business goals: 1) cost-focused automation, 2) performance-driven automation, 3) human-centered automation, and 4) SRA. The authors also point out the connection between SRA and ethical AI, which covers a broad set of values including human rights, fairness, bias, transparency, and privacy.

Social responsibility is embodied in new regulations, but these have struggled to keep pace with the ongoing march of new technologies. As an example, responsibility might be difficult to identify in industrial cyberphysical systems (ICPSs), as pointed out by Jonas and Lamnabhi-Lagarrigue,[10] due to the complex and interconnected nature of actual systems and the absence of a clear demarcation between products and services. Also, Jonas and Lamnabhi-Lagarrigue[10] point out that the establishment of a specific legal personality for autonomous systems and, by extension, for ICPSs was initially envisaged, but this idea has now been set aside, and European institutions (for example) are in favor of a specific liability regime. Legal issues are, indeed, of major importance if the technologies are to be socially accepted, legitimized, and widely adopted.[11,12]

Prior to AIGC, the development of content-generation technologies went through four stages: 1) professionally generated content (PGC), 2) user-generated content (UGC), (3) AI-assisted PGC, and 4) AI-assisted UGC. Now, with AIGC tools embedding human-in-the-loop reinforcement learning, generative adversarial networks, and prompt learning methods in large models, the statistical patterns of languages, music, and video can be learned and processed automatically. The only thing you need to do is give the right prompts. Therefore, machine learning and AI will transform from "parameter engineering" to "prompt engineering." Prompt engineering focuses on how to design effective prompts or instructions to guide AI systems to produce the desired outcomes. By giving specific prompts, researchers and developers can shape the behavior and output of AI models. These prompts act as guiding signals, enabling AI systems to generate content that aligns with specific goals or objectives.

DAOs AND HANOI

Distributed autonomous organizations and decentralized autonomous organizations (DAOs)[13] include entities that operate collectively but are decentralized through code based on smart contracts and blockchain technology. The members of a DAO hold voting rights to make decisions and execute actions, making it a democratic and transparent system. DAOs can democratize AI development by organizing the public to contribute to AI projects. Taking scientific research as an example, DAOs can help create a decentralized research system that allocates research funding based on merit and contribution rather than political or financial considerations.

In 2022, the concept and framework of human, artificial, natural, organizational intelligence (HANOI)[14] was proposed based on DAOs. This, in turn, was a basis for the organization and coordination of intelligence between the artificial world and the natural world, with particular emphasis on human agency. As ChatGPT shows, successful AI projects are built on human-in-the-loop AI systems with crowd intelligence (massive amounts of Internet data) and refined knowledge in continuous question-and-answer iterations through social interactions. Without a doubt, there will be more AIGC tools in the future, but what will be most prized will be the participation of capable, intelligent humans in a symbiotic relationship with the machine.

HUMAN–AUTONOMOUS ORGANIZATIONS (HAOs)

Large-scale studies of human values demonstrate the importance of existential sociobiological drivers in human culture and social behavior, including organizational interactions.[15,16] Human values, cultural meanings, and the needs that drive them are manifested in multimedia social networks and other online spaces. These inform both scientific and commercial social manufacturing and related research[1,7] as well as cyber-enabled social movement organizations, HFSs, and CMOs so that needs and meanings can be understood and used to drive new developments. DAOs, HANOI, and true DAOs (TAOs)[17] provide the foundation for discussing how to organize massive collective and collaborative projects while fairly and transparently guaranteeing to benefit people who contribute to the effort. HAOs are proposed for Society 5.0 as a way to engage with these diverse, deeply held needs and values (see Figure 1).

The organization forms of HAO include but are not limited to HFSs, CMOs, swarm intelligence and social communities, crowdsourcing, and crowdfunding. Every member of an HAO can choose to contribute his/her time, attention, trust, authority, or money to fulfill the social needs of others. Since the HAO operates transparently and fairly, everyone's residual value is counted on himself/herself.

HAOs operate in a decentralized and distributed way, organized autonomously and actively, and they reward participants via contribution-based and on-demand allocation. Blockchain, smart contracts, tokens, credits, and protocols support the infrastructure of the HAO. The social needs layer in Figure 1 draws upon Maslow's work to demonstrate how the model can incorporate sociobiological human motivations and shared cultural values. The layer can be adapted for other axiological models, such as the universal values system or Hofstede's cultural values model, as well.

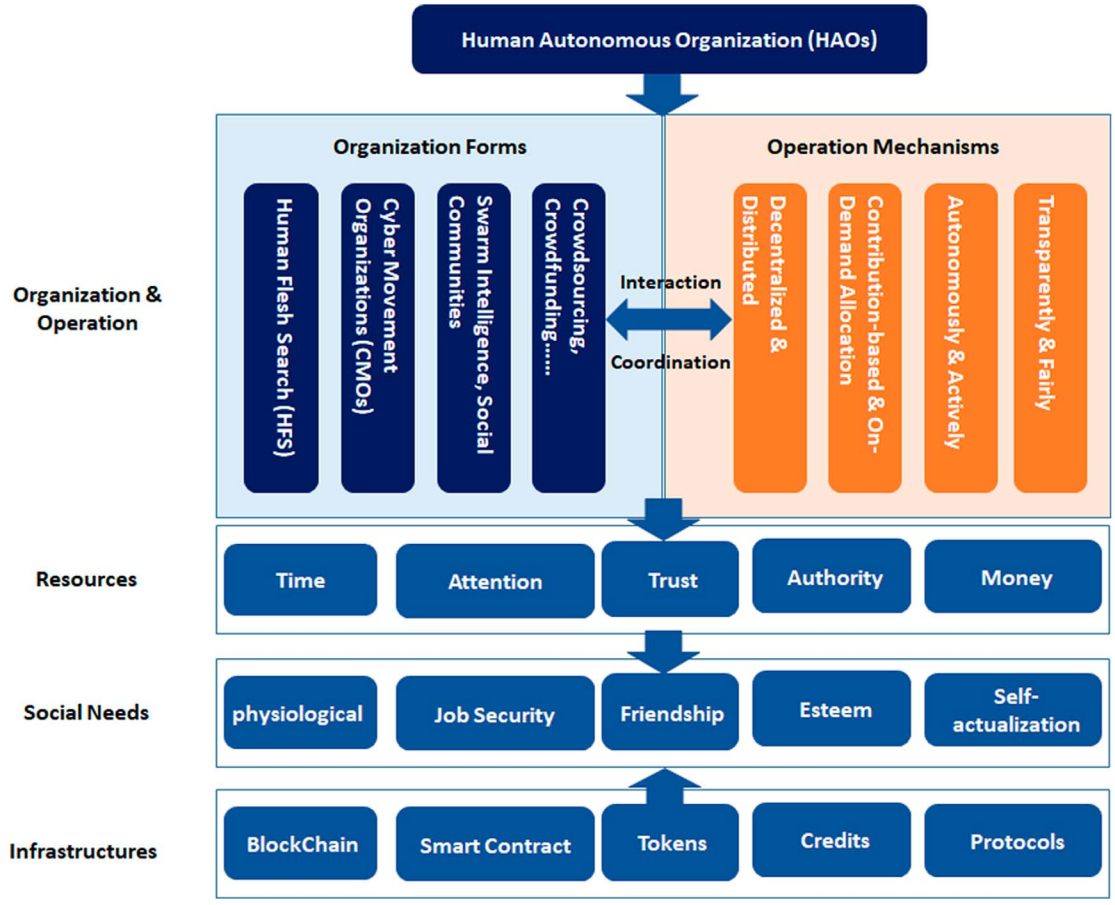

FIGURE 1. Framework of a human–autonomous organization based on a human values and needs model.

CONCLUSION

This article examines the concepts and developments of Industry 5.0 and Society 5.0, and it reflects upon recent developments and trends in AIGC and organizational and operational mechanisms shaping the future of smart societies. It discusses the potential of AIGC tools and applications, and prompt engineering technologies and other developments are introduced as a basis for goal-guided, socially responsible generative intelligence. HAOs are briefly reviewed based on recent research on DAOs, HANOI, and TAOs. These models highlight the role of humans in fulfilling the social needs of society as part of an emerging human–machine symbiosis. This approach actively promotes human values and dignity, contributing to a new AI–machine–human discourse in which smart societies and the technologies that enable them are co-evolved, nondeterministic, inclusive, ethical, and fully accountable.

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