

Collaborative Intelligence of Robotic Swarms in State and Situation Awareness and Human-Swarm Co-Work

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Abstract

The growing interest in swarm robotics stems from their potential to perform large-scale, real-time monitoring and decision-making tasks efficiently, from disaster management to logistics, using the combined distributed intelligence of multiple autonomous agents. The performance of swarm robotics is dependent on effective self-organisation using the digital twins (DTs) of state and situation awareness (SSA) in dynamic and unpredictable environments. Swarm robotics, instilled with bio-inspired artificial intelligence (AI), can revolutionise the field of autonomous systems, enabling collective intelligence and adaptive decision-making in complex environments by mapping the entire operational environment and collective state awareness through effective sensor fusion, seamless real-time communication and data sharing.

By leveraging distributed sensing, decentralised communication and control, swarm intelligence can significantly improve autonomous responses with collective decision-making in diverse applications. This research, aiming to address potential challenges, explores the role of collaborative intelligence in robotic swarms, emphasising their capability to enhance SSA through distributed sensing to achieve assigned individual tasks, paving the way to accomplishing the mission goal. This study, furthermore, discusses how to build a trusted and effective human-swarm collaboration using the DTs of SSA and immersive devices to achieve shared objectives.

Index Terms— Artificial Intelligence; robotics; joint cognition; human-robot teaming; human-in-the-loop (HITL); autonomy-in-the-loop (AITL); autonomous robotics agent swarms; collaborative decision-making, Human-Swarm co-work, digital twins, cybernetics, immersive devices, SSA

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