Abstract

This literature review aims to look answer the question – What are the applications of self-organization and what impact has it had in those applications? The goal is to analyze the different aspects and features self-organization has displayed within each piece of research.

Common themes in each paper

Main theme – Self organization process by which a decentralized control model can adapt and evolve to achieve a goal in mind with regards to its environment.

Robust:

<https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7753189>

Theme that self-organization provides for robust applications, where the system is able to react to its environment accordingly and adapt while still maintaining its original goal.

Emergent behaviour -- collective Intelligence – self organization to solve problems – and apply the concepts of it to something – systems using multi agent with self organization- adaptive-robust

Emergent behaviour of self organization:

The idea that self organization is based on a decentralized model whereby individuals perform small interactions between each other which at face value looks insignificant but when taken as a whole an emergent behvaiour can be seen. i.e. ants clinging onto another ant(small local interaction) -- forms a life raft (emergent behaviour) which can also be viewed as an artificial or collective intelligence

Take <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7049635> for example, this research looks at how self-organization can be applied to multiple robots which act as agents and exchange information between each other in regards to the continuously changing environment to work towards a goal. This paper aims to discuss how this concept of self-organization if developed enough can be used to use a team of robots to work in jobs which are dangerous to humans.

It bases the work off swarm intelligence and references to areas where communicative swarm technology has been used with robots in the real world; urban search and rescue robots and automated traffic cones. A strength that this paper prides itself on is uses reactive control, instead of deliberative control where agents base their next actions using the information taken from the environment with sensors basically prediction which is not good due to the fact the system may fail in the event of unforeseen factors. The agents in this system collaborate together by communicating to each other searching induvial areas but as a whole cover a wide net of undiscovered areas which represents the emergent behaviour. Emphasizing how one agent with limited capabilities and constraints can not do much, but put together with many other agents can achieve complex and difficult tasks highlighting the robustness of this application and concept to which one day can be used to in such applications such as cordoning off hazardous areas from humans.

Similarly <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5582159> makes use of self organization in a way that’s applied to creating an self-organizing algorithm that is used for creating various robust and adaptable networks. They’re similar in the sense that both want to make use of the concept to create an autonomous system that can be used in the future with practical applications. By using the trademarks of self organization , representing nodes in a wireless network as individual agents which then communicate information to each other and create a complex yet optimal network yielding robustness, scalability and adaptability (emergent behaviours of this application). A strength of this paper it discusses about using self-organization for this application is that it is able to handle and react to unforeseen factors while still maintaining its intended goal. Additionally results show that the proposed algorithm that makes use of self-organization improves energy consumption and longevity of the network.

A common similarity between these two papers is that through using self-organization in their respective applications the impacts both appear to be very alike. Showcasing benefits ranging from robustness, adaptiveness and efficiency, also highlighting how their systems are functional without any external input from outside the system itself.

Intelligence:

<https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5729600>

Concept that self-organization is seen as a form of intelligence where the system can automate itself and adapt to a scenario with a given purpose.

Emergent behaviours of self-organization in different applications:

Self-organization is a process by which a system has been constructed internally from itself without any external input —F. E. Yates et al. (1978), Self-Organizing Systems: The Emergence of Order. There have been many applications that have been built off this underlying concept of self-organization. Each piece of research showing that there are many emergent behaviours that arise from these implementations, these emergent traits are products of the system’s individual agents collaborating with each other which in the small scope of things seem insignificant, but when looked at as a whole is very useful and achieves the intended goal of the application with many benefits alongside.

Jolana Sebestyénová and Peter Kurdel’s research, [1] looks at how using self-organization with a swarm of robots can be used in applications that make robots perform jobs that are too dangerous to humans, such as search and rescue or searching for targets in a battle environment. By using each individual robot as agents of the system which communicate between one another, and perform actions based on the environment and other agent’s actions ultimately generates an emergent behaviour similar to collective intelligence, this emergent property that can be observed is the intended goal of the system.

This research takes a novel approach to using self-organization with robots, and uses reactive control opposed to the traditional deliberative control which is more restraining and consists of varying weaknesses, namely prone to failure if unforeseen factors occur. Reactive approach controls the robots by reacting to its environment not prediction. Making for a more robust and adaptive application. The impact of this research is significant as when compared to previous research in the same area, it showcases how their approach improves on what could already be done using the same parameters in fewer steps within the same simulation.

Similarly, a completely different application which uses self-organization that produces emergent behaviours is[2], this paper shows how through the use of self-organization you can create complex yet efficient wireless networks. By using the devices (nodes) as agents which communicate to each other, the common issue that arises when designing and constructing networks are energy consumption, robustness and adaptability. By implementing the concept of self-organization to this application, the system can autonomously generate an efficient yet flexible network (the emergent property) that is able to change depending on the scenario. The impact of this research is a significant contribution to its respective subject area as it has proven by using self-organization it is possible to improve energy efficiency when creating and maintaining a network further improving the standard or benchmark that can be achieved in creating wireless networks.

A common similarity between these two papers, is through using self-organization in their respective applications they both produce emergent behaviours that achieve their goal and contribute to their field of research. Producing benefits ranging from robustness, adaptiveness and efficiency. Highlighting how their systems are functional without any external input from outside the system itself.

References:

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