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Why would robots need to sleep?

A study published in the journal *BioNanoScience* reflects on the importance of “resting” for robots and proposes a “synthetic hippocampus” architecture, inspired by the human sleeping process. This would guarantee an online phase in which the system interacts with its environment, records episodes, and evaluates what is relevant, and an offline phase in which these experiences are replayed internally, combined and filtered.

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We usually imagine robots as machines that never stop, with no need for rest or sleep. But if we want them to learn and adapt like living beings, they may also need something similar to “sleep”. In our work we explore this question through a concrete case: how to endow future robotic systems with a flexible and efficient memory inspired by the brain’s hippocampus.

Today’s robots can excel at a single task if we train them with large amounts of data, yet they tend to be rigid: when conditions change, they struggle to adapt and often forget what they had previously learnt. Animals, by contrast, generalise from little data and use sleep to reorganise memories, remove noise, and strengthen what really matters. This alternation between an “online” state (acting) and an “offline” state (reorganising experience) is what we wanted to bring into artificial systems.

We therefore propose a "synthetic hippocampus" architecture implemented with spiking neural networks and neuromorphic hardware. On the one hand, there is an online phase in which the system interacts with its environment, records episodes, and evaluates what is relevant. On the other hand, there is an offline phase in which these experiences are replayed internally, combined and filtered, and synaptic connections are adjusted in a goal-directed way.

This mechanism relies on modified versions of well-known plasticity rules (such as STDP), adapted to operate across multiple temporal scales. This allows the system to integrate new information without erasing what it already knows and to do so in an energy-efficient manner when deployed on neuromorphic chips, which are closer to the behaviour of biological neurones than conventional digital processors.

In the article we discuss how this synthetic memory can be connected to decision-making and motivation modules, and how it could act as a bridge between real-time control and autonomous learning in future robots. Rather than presenting a specific robot, we outline a bioinspired framework that opens a pathway towards systems able to reuse their own experiences, generate internal scenarios, and adapt to changing contexts without constant external retraining.

In short, we argue that if we want truly adaptive robots, we must think not only about how they "think" but also about how they "rest". Giving them a form of sleep —through a synthetic hippocampus capable of reordering and imagining experiences— may be crucial for bringing robotic intelligence closer to the flexible behaviour of living systems.

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