Using fungal electrical activity for computing

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Materials have a variety of properties that can be used to solve computational problems, according to studies in substrate-based computing.BZ computers, slime mold computers, plant computers, and collision-based liquid marbles computers are just a few examples of prototypes produced for future and emergent computing devices. Modeling the computational processes that exist in such systems, however, is a difficult task in general, and determining which part of the embodied system is doing the computation is still somewhat ill-defined.

Claiming that fungi are the most intelligent living organisms in the world sounds like an exaggeration. However, a recent study by Mohammad Mahdi Dehshibi, a UOC researcher who is contributing to a growing body of knowledge on the use of fungal materials, concurs with this idea. Its implications are numerous and practical in both the medium and the long term. They include the possibility of using fungal tissues as actual computing devices. How could we use a fungus as if it were a computer?

Converting the fungal electrical signals into messages

Fungal mycelium like Pleurotus djamor, also known as the pink oyster mushroom, can resolve an incredible range of computational geometry problems, explained Mohammad Mahdi Dehshibi in a previously published article on fungal materials. "By changing the environmental conditions, we can reprogramme a geometry and a theoretical structure of the graphics of mycelium networks and then use the electrical activity of the fungi to create computing circuits," confirmed the researcher.

In a recent study, "Electrical activity of fungi: Spikes detection and complexity analysis," published by Mohammad Mahdi Dehshibi of the Scene Understanding and Artificial Intelligence Lab (SUNAI) group at the UOC Faculty of Computer Science, Multimedia and Telecommunications, in collaboration with Andrew Adamatzky of the Unconventional Computing Laboratory at the UWE Bristol, the researchers demonstrate that the pink oyster mushroom generates a series of spikes in electrical potential that are propagated by a growing mycelium.

The electrical activity property of the fungus corresponds to the extremely complex internal communication it uses, and this can be analyzed and utilized to operate and develop computing measures. In the research project, the authors propose a variety of measures to be able to "translate" these electrical signals into messages according to the classification of the spikes in potential that can be detected.

The electrical signals in the fungal tissue are so faint and complex that it is impossible to analyze them using the standard techniques of neuroscience, the discipline that traditionally measures them. The researchers' proposal consists of a method for detecting spike arrival time through an exhaustive algorithm that enables fairly efficient characterization of the electrical activity.

The key to the complex language of fungi

Fungi are among the largest, most widely distributed and oldest groups of living organisms in the world. The many advantages for which they are considered an interesting material include their tremendous availability at no cost, their resilience, their capacity for self-maintenance and their rapid growth. To all of this, as demonstrated in the study, we must add the communicative complexity shown by the electrical signals of the fungus.

To obtain a better idea, the researchers have proven that the complexity of this "language" is greater than that of many human languages in terms of communication. That reality opens up the possibility of using the signals as an efficient and practical means of information transmission and computing, giving fungi a very interesting potential as computers.

"At the moment, there are two major challenges to be confronted [in being able to use fungi as computers]", explained Dehshibi. "The first is to implement a computing purpose that makes sense. The second is to characterize the properties of the fungal substrates to discover their true computational potential." These two steps are essential for building functional computing units.

Designing environmental sensors

Will we really see, then, a laptop computer with a microprocessor made with fungi? For the author, the objective of fungal computers is not to replace silicon chips, as the actions in this type of computer are too slow for that. But the properties of fungi could be used as an "environmental sensor on a large scale." Fungal networks could monitor large quantities of data flows as part of their day-to-day activity. If we were able to connect to their networks and interpret the signals, they use to process information, we could learn more about what is happening in an ecosystem and act accordingly.

More information: Mohammad Mahdi Dehshibi et al, Electrical activity of fungi: Spikes detection and complexity analysis, *Biosystems* (2021). DOI: 10.1016/j.biosystems.2021.104373

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