Using slime mold to produce accessible biosensors

An EU-funded project is using slime mold to produce accessible sensing devices with a wide range of applications, including environmental monitoring and health – helping European industry become more competitive in the growing biosensor device market. The devices can also be used for citizen science applications.

Successful biosensors have to be versatile, small, easy to operate, and competitively priced for their commercial success. A significant upfront investment in research and development is also required.

These barriers have held back progress in developing successful biosensors in Europe, and commercialization has lagged behind advances in research, says Andrew Adamatzky, project coordinator of the EU-funded PHYSENSE project and a professor in unconventional computing at the University of the West of England, UK.

In response, PHYSENSE has developed a prototype biosensor using a single-celled organism – the slime mold *Physarum polycephalum* – and made the low-cost technology accessible to research centers, universities, schools and citizen scientists, who can use it and contribute to its development. The project team has also developed an online portal where participants can share their collected data.

'Citizen participation is being used to leapfrog years of traditional research, helping to catapult Europe into the driving seat of this exciting new scientific frontier of living technologies in sensing and computing,' says the project's co-investigator and lead developer Neil Phillips of the University of the West of England.

Living computers

An earlier EU-funded project, PHYCHIP, demonstrated that using slime mold as a living energy converter, called a transducer, in mechanical, optical and chemical sensors offers a practical and effective technology that can make contributions to many areas, including electronics and materials science.

Such devices, if accessible and cheap enough, could also be used to involve ordinary people in scientific research – a concept known as 'citizen science'.

Few, if any, current sensing devices incorporate living organisms because they are too dependent on a 'life-support' system; they need a constant supply of nutrients and a waste removal system.

'Therefore we decided to consider an autonomous living creature which does not require sophisticated support and can survive for a long period of time

without laboratory equipment,' Adamatzky say. 'A slime-based sensor will be the only marketable biosensor with a living substrate which does not require sophisticated maintenance and can be operated by anyone.'

Physarum polycephalum moves by means of oscillating muscular contractions in the tubular structures that form most of its body. The organism responds to stimuli like light, chemicals and vibrations. In so doing it is possible to determine what is in the environment, which is useful for detecting drugs or chemicals that are potentially harmful to humans.

The biosensors are made by encouraging the mold to grow across electrodes that are connected to electronic devices that amplify and measure its responses to these stimuli.

The slime can be used in chemical, tactile and color detecting sensors. The slime senses and responds to volatile aromatic substances. The frequency and amplitude of electrical oscillations in *Physarum polycephalum* increase when it is exposed to strong attractants.

Conversely, exposure to repellents can lead to a decrease in oscillation frequency and amplitude. To make a tactile sensor, the slime can be attached to a bristle hair which, when moved, causes a reaction in the slime. Exposure to light of different colours causes changes in the electrical activity of the slime.

Recent work by the group has already developed a working prototype, based on low cost electronics and bespoke software, which demonstrate the paradigm shift in accessibility the project offers.

Information sharing

In addition to making the technology accessible to both the general public and non-specialists, the project has established an online portal and database, which people can use to share millions of measurements. The intention is for people to share their findings with others to advance scientific research, for the greater good of society.

Biosensors can be used for applications such as drug discovery, biomedicine, food safety, defense, security, and environmental monitoring, for example.

'The biosensor industry is now worth billions' says Phillips. 'Biosensors are a ubiquitous technology of the future for health and the maintenance of wellbeing. With the addition of more environmental contaminants which may be a threat for humans and the overall ecosystem, the need for faster and more accurate biosensors is high.'

PhySense reached the semi-final of the Innovation Radar Prize 2018 in the Excellent Science category.

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