CONSORTIUM

ISTITUTO ITALIANO DI TECNOLOGIA

UWE Bristol | University of the West of England

Empa
Materials Science and Technology

PlasmaChem

CiaoTech | BY PNO GROUP

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COgITOR

A new COlloidal cybernetIc sysTem tOwaRds 2030

THE PROJECT

COgITOR represents a novel approach to cybernetics, proposing the study of Colloidal (liquid) Cybernetic Systems (CCS), a multifunctional liquid-based platform that we have designed to be capable of pressure sensing (i), computing and data storage (ii), energy harvesting (iii) and integrating fully custom electronics (iv). A CCS provides operation in extreme environments by definition, having distributed architecture (homogeneous liquid plus random network architecture), being fault-tolerant and featuring self-healing capabilities. Within COGITOR in 54 months the consortium will provide a platform where liquid electronics efforts can converge from all over the world, making European research the point of reference for this big step forward. COGITOR measurable and specific objectives are: i) creating an impedance liquid state pressure sensor with spatial and temporal resolution; ii) producing an holonomic reversible memory written/erased electrically and read by tomographic Microwave Impedance Spectroscopy; the electrical operation will be used to implement learning (both sequential and concurrent) and calculation, where the system acts as a many-input Boolean circuit; iii) harvesting energy from a thermal gradient artificially induced by IR radiation upon the prototype; iv) integration and testing of the final CCS prototype, testing self-healing and fault tolerance capabilities, as well as assessing interference, also under EE conditions varying T, p and B. The engineering applications that we plan to exploit will be part of the intellectual property of a spin-off company. The consortium is well-balanced with cutting edge Research Organizations across EU (IIT – Italy, UWE – UK, Empa – Suisse) and companies (PlasmaChem – Germany, PNO – Italy) that will closely collaborate to develop and really transfer knowledge and innovations into products and related services.

IMPACT

The project will create a liquid robot. It will “feel” the external environment like our skin, being sensible to pressure and temperature. It will be able to heal autonomously when wounded. A basic liquid memory and a rudimentary logic has already been demonstrated. It will produce a small amount of energy to “be alive”.

RESULTS

The first experiments have explored so far the capabilities of colloidal suspensions at liquid state to undergo learning and memorization. Several media have been characterized, including ZnO, polyaniline nanorods and ferrofluids, and setting of internal states is obtained by applying an external stimulus, such as a quasi-steady state potential, while resistance or microwave impedance are monitored. Pavlovian learning in colloids has been demonstrated for the first time, enabling an innovative programming protocol in liquids. We have used titanium nitride colloids to develop a strong thermal gradient by photothermal effect, that will be exploited in future experiments to scavenge energy for partial powering of the liquid robot. The synthesis of BiFeO3 has been validated for reproducibility. The material was made commercially available to the public through inclusion into the catalogue of nanomaterials by PlasmaChem. A novel concept of polymer bi-layer assembly with multi stimuli responsive properties has been demonstrated.

BENEFITS

The benefits of a base science research are for all the people. Inspiring new forms of art, of understanding, of conceiving a robot are among the expected benefits. The consortium will boost the European position in soft robotics and grant supremacy in liquid robotics.