



A new COLLOIDAL cybernetic system tOWaRDs 2030

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COgiTOR project reached M30, and several notable technical progresses were reached by the joint collaboration of technical partners, IIT, Empa, Plasmachem, UWE, and a new partner that joined the consortium, EPFL:

1. A measurement system to assess the capability of commercial colloids to respond as expected in terms of Radio Frequency (RF) to DC stimulation was developed: it allowed us collecting around 10 GB of raw measurements of different colloidal suspensions. These measurements led to the assessment of the capabilities of the materials to memorize information and computing. Based on the first results, we have designed a dedicated integrated circuit in a 180nm CMOS technology for measuring the colloids state changes and implement, in an aggressive

miniaturized and simplified fashion.

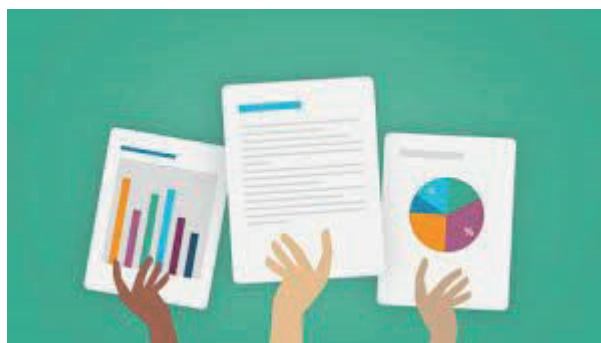
2. The chip, currently under the final testing phases, is capable of determining the status of the colloid by using a low-complexity and low-power measurement scheme. It was possible to demonstrate colloid status evolution and measurement using our integrated circuit.
3. We have developed a test set-up to assess the features of the colloid when considered alone a memristor device and we have demonstrated that is capable of running neuromorphic computing on it, thus enabling ease of scalability and required low electric fields, in contrast to solid state memristors. These results are very promising to justify the implementation of amorphous and liquid memristor devices. This result is complementary with respect to the main objective of the project where colloid is thought as a “holonomic” system, and it is a promising spin-off of the obtained results.
4. We obtained fundamental preliminary results on the implementation of reservoir computing in colloid systems, achieving very nice demonstration of in memory computing, of liquid analogue memory equivalent to 6 bits of liquid state artificial recurrent neural network. Such results represent a unique achievement in science.
5. Alternative energy supply in the soft cybernetic system were explored. We designed thermomagnetic and photothermal energy converter models by 3D printing and used those for the investigation of the heat transfer in ferrofluids.
6. The development of self-healing soft skins for protecting the functional colloids has advanced improving the mechanical and self-repairing properties as well as providing energy to the autonomous liquid robot.

In parallel the dissemination, communication and exploitation activities were carried out, reaching important milestones.

The Exploitation strategy

A Systematic Stakeholder Analysis was carried out by CTECH. Stakeholders participated in an online survey and their interest, attitude, influence, knowledge relevant for the project were collected and analysed. These gatherings were the basis for the preliminary definition of the exploitation scenarios.

The exploitation strategy continued as planned, reaching the identification of two key exploitable results (the liquid-in memory by IIT and the BiFeO₃ nanoparticles by PlasmaChem), which were characterized from a market point of view and related exploitation risks foreseen, as basis for the individual exploitation action of IIT and PlasmaChem.



PlasmaChem and the Synthesis of BiFeO₃ nanoparticles

PlasmaChem has repeated the synthesis of BiFeO₃ nanoparticles in a larger scale and conducted HRTEM characterization of the material. Upon successful validation at own facilities as well as at Empa, material was added into the company's materials catalogue and was made available for purchase worldwide.



IIT latest achievements

IIT has started exploring routes for the exploitation of the Microwave Impedance Spectroscopy hardware and software developed within COgITOR to assess the properties of alimentary liquids, in particular wines. This opportunity came through the collaboration with CREA-VE, the Italian Council for Agricultural Research and Agricultural Economics – Viticulture and Enology center based in Asti, who is operating in the science of wines since 1872. In parallel, another bilateral collaboration with CNAO, the National Center for Oncological Adrotherapy, will bring the liquid state in memory computing system under a proton and carbon ion beam to assess its radiation hardness.

“Advances in Unconventional Computing” workshop

During October 2023, the COgITOR project orchestrated a workshop titled "Advances in Unconventional Computing," hosted in-person in Bristol. This collaborative event served as a platform for presenting, discussing, and analyzing breakthroughs in colloid computing within the broader context of novel and emerging computing systems. The diverse spectrum of topics included thermal proteins, fungi, memristors, and enzymatic computers. Through this workshop, participants explored colloidal cybernetics, unveiling its remarkable potential across various scientific and technological domains. The workshop not only highlighted the accomplishments within colloid computing but also fostered an insightful comparison with other unconventional computing paradigms. The workshop's comprehensive examination of these innovative computing systems underscored their collective significance, paving the way for future advancements and interdisciplinary collaborations in the realm of unconventional computing. The workshop was accompanied by public talks, held in an Art Gallery (The Island, Bristol). The public talks were further enhanced by art exhibits depicting colloidal cybernetic systems, produced by IIT and Empa, as well as a demonstration of the prototype of liquid in-memory computing realized by IIT in collaboration with UWE, that visitors could see while computing.

COgITOR joined ECOMONDO 2023 with CiaoTech

ECOMONDO, The Green Technology EXPO event is a significant platform for showcasing and discussing advancements in industrial technologies and sustainable practices, taking place in Italy every year. The 26th edition marked a long-standing tradition of bringing together innovation and discussions in the field of circular economy, industrial technologies and environmental new processes.

In this framework, the COgITOR project was featured at the CiaoTech booth and attracted numerous stakeholders during visits interested in knowing more about the innovative cybernetic systems implemented by the project partners.



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