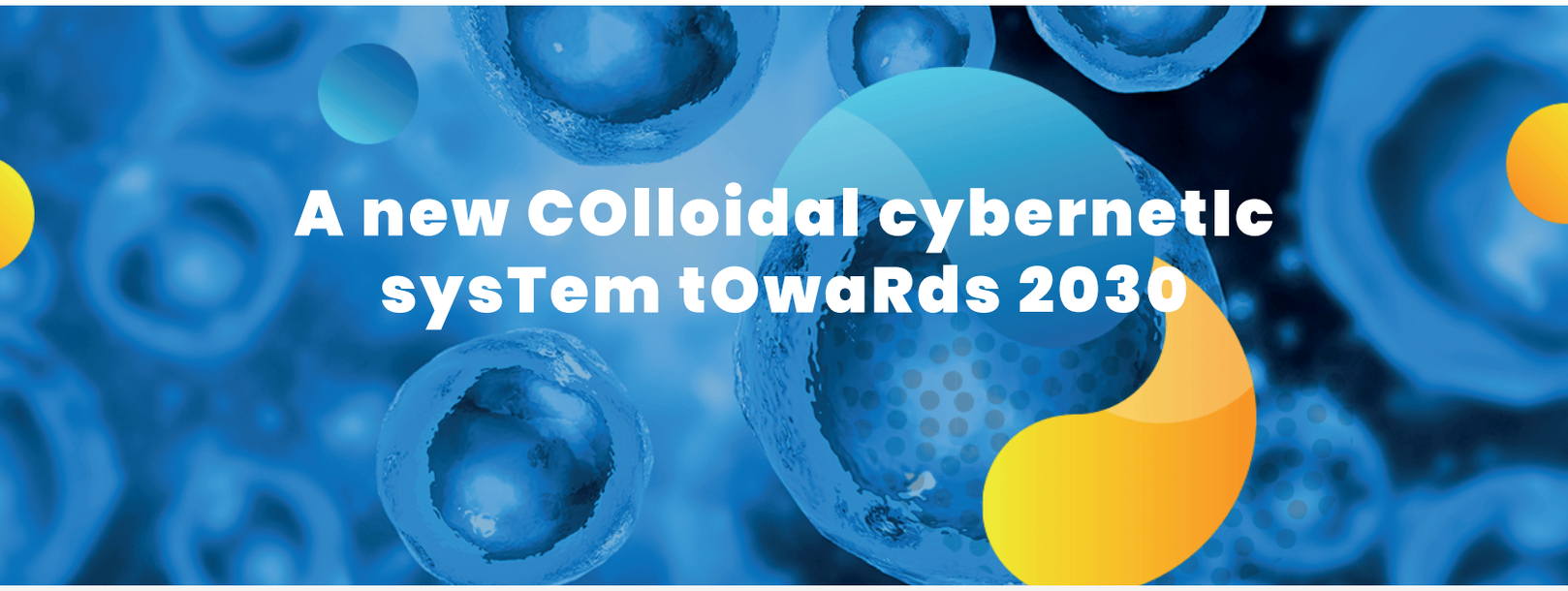
COgITOR



FIRST YEAR PROJECT RESULTS: LETS' FIND OUT MORE ABOUT COGITOR FIRST ACHIEVEMENTS!

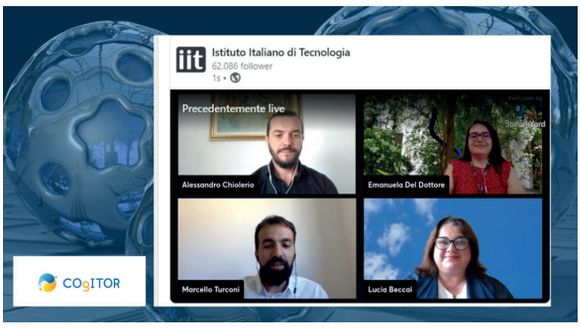
COgITOR is a project funded under the topic H2020-FETOPEN-2018-2020 / H2020-FETOPEN-2018-2019-2020-01 programme, aiming at developing a liquid state cybernetic system prototype. Holonomic memory and computing, pressure sensing, and energy harvesting from thermal gradients will be achieved using colloids. The prototype will be tested in extreme environments for potential space applications.

Despite the still difficult situation due to diffusion of the Coronavirus, the COgITOR consortium started to operate in a virtual mode, organizing the experiments in direction of setting the prototypal colloidal subsystems. A first group of early papers has been already submitted and will be made manifest to the scientific community. In July this year the consortium will be participating to the first integration workshop to be held in Bristol (UK), that will put together two EIC Pathfinder Open project and make scientist collide.

NEW PAPER RELEASED!

We are glad to announce that the COgITOR consortium has recently published a review paper on ChemRxiv at the following link: https://chemrxiv.org/engage/chemrxiv/article-details/62614a4b742e9f651f661fed, thanks to the work of Noushin Raeisi Kheirabadi, Alessandro Chiolerio, Konrad Szaciłowski and Andrew Adamatzky. It is a unique compendium of groundbreaking ideas on colloid brain-like devices.

Have a look at it!



COGITOR PROJECT COORDINATOR INTERVIEWED ON LINKEDIN!

Using a fresh format of online LinkedIn interviews, Istituto Italiano di Tecnologia is promoting European funded projects through their coordinator words.

An interesting overview of liquid and soft robotics, involving Alessandro Chiolerio in the presentation of COgITOR can be found here.

ISTITUTO ITALIANO DI TECNOLOGIA

COORDINATOR

PRELIMINARY RESEARCH

In the first year of the project we have developed a preliminary measurement system to assess the capability of commercial colloids to respond as expected in terms of Radio Frequency (RF) to DC stimulation. The system we have developed, based on commercial sub-systems and custom components, has been capable of automating measurements and collecting up to 8Gbytes of measurements in a very large time span. These measurements led to the assessment of the capabilities of the materials to memorize information and computing. The measurement system we have developed, operates thanks to a specific scripting language we have developed on purpose, to speed-up measurements and data analysis, that has been achieved using a dedicated set of scripts on the obtained measurements.

CMOS DESIGN RESEARCH

Based on the first results obtained using the measurement system, we have started developing a dedicated integrated circuit for measuring the colloids state changes and implement, in an aggressive miniaturized, and simplified fashion the techniques used in the set-up but with very few hardware components to favor integration in a final set-up. The chip is currently under design tages in a low-cost 180nm CMOS technology and it will implement RF/analog and mixed-signal techniques and circuit solutions to achieve the read-out of the material state, thus providing a tool for understanding the behavior of the colloids using a set-up with up to 8 electrodes, and frequency up to 6GHz.

UWE Bristol University of the West of England

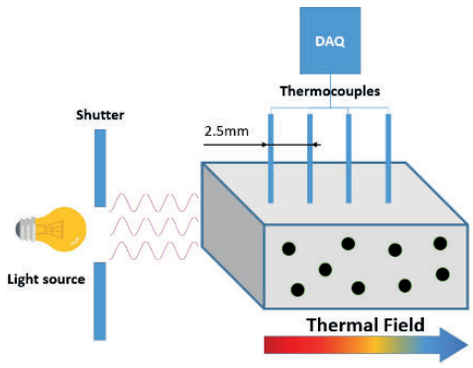
We discovered a protocol for implementation of learning in colloid systems via a programmable propagation of conductive pathways. Also, we obtained preliminary numerical modeling results on implementation of reservoir computing in colloid systems. We are hosting several integration and dissemination events Summer 2022:

1. 1st International Workshop on Colloid Cybernetic Systems, 4th July 2022, Bristol
2. Invited talk by Prof Alessandro Chiolerio and public discussion on principle of non-neural intelligence, 5th July 2022, Business School, Frenchay Campus, Bristol
3. International workshop on Post-Apocalyptic Computing, 6-7th July 2022, Bristol.

Empa

Materials Science and Technology

The first year has been dedicated to the study of alternative energy supply in the soft cybernetic system. With the Fe3O4 ferrofluid received from partner PlasmaChem, we tested that an electromotoric force could be generated in a cogitor ring converter. The materials were titanium nitride (TiN) and metal oxides. The idea was to prove the possibility of recovering waste heat in electricity by the heat induced in a nanofluid. First results on thermo-magnetic convection have shown interesting opportunities and pushed toward further investigation of the mechanisms of heat transfer. The idea is to induce the conversion of light into heat (photothermal effect) directly in the liquid phase, avoiding solid interface. This promise to allow a much better exploitation of the heat and possible further conversion in electrical energy by addition of a thermoelectric phase. We designed thermomagnetic and photothermal energy converter models by 3D printing (assistance Frank Clemens group at Empa) and used those for the investigation of the heat transfer in ferrofluids.



Specifically, the ferrofluid volume was probed with an array of thermocouples, while exposed o UV, vis and NIR radiation. With the large set of complex analytical data collected, it was possible to reconstrtuct uv vis absorption spectra of the nanoparticles, underlining the consistency of the experimental approach. Experiments performed by water-based TiN solution showed a uniform temperature increase in the fluid, see Fig. 1, which should be avoided to boost the thermoelectric performances. In fact, confining the heat in the first layer of fluids maximizes the temperature gradient experienced by the nanoparticle during their motion.

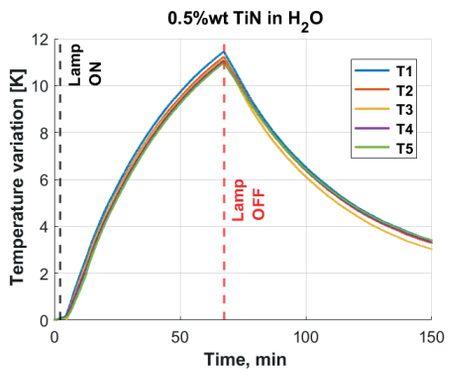


Figure 1: Water based TiN 0.5%wt temperature increase under Solar Radiation.

The studies on the heat transfer in nanofluids lead to address viscous materials to limit the heat convection. Oleic acid is selected for this reason as well as biocompatibility, cost and density suitable to disperse particle. It is also largely used as surfactants in literature, enhancing the stability of the nanofluid. Extremely fast heating is shown, as reported in Fig. 2. Temperature difference in the first 5mm of fluid is around 11K for 0.5%wt sample, and is hold stably in time. The switching behavior is also remarkable, driving the imagination toward liquid logic gates and liquid memories.

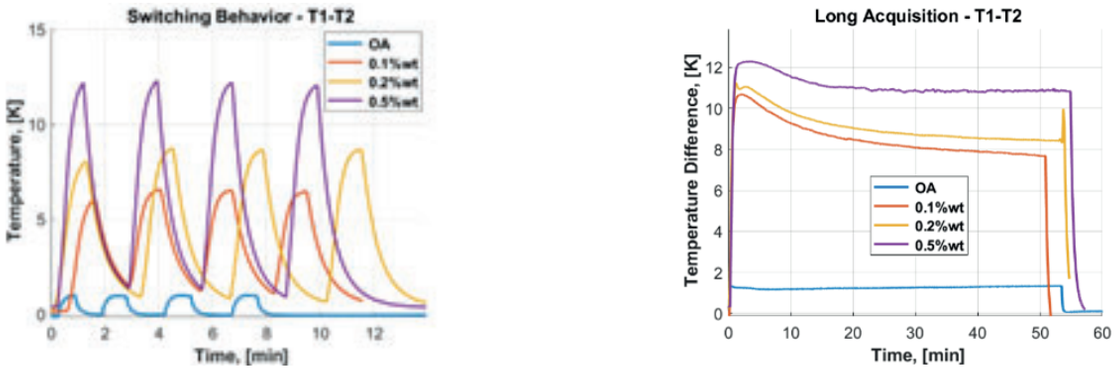


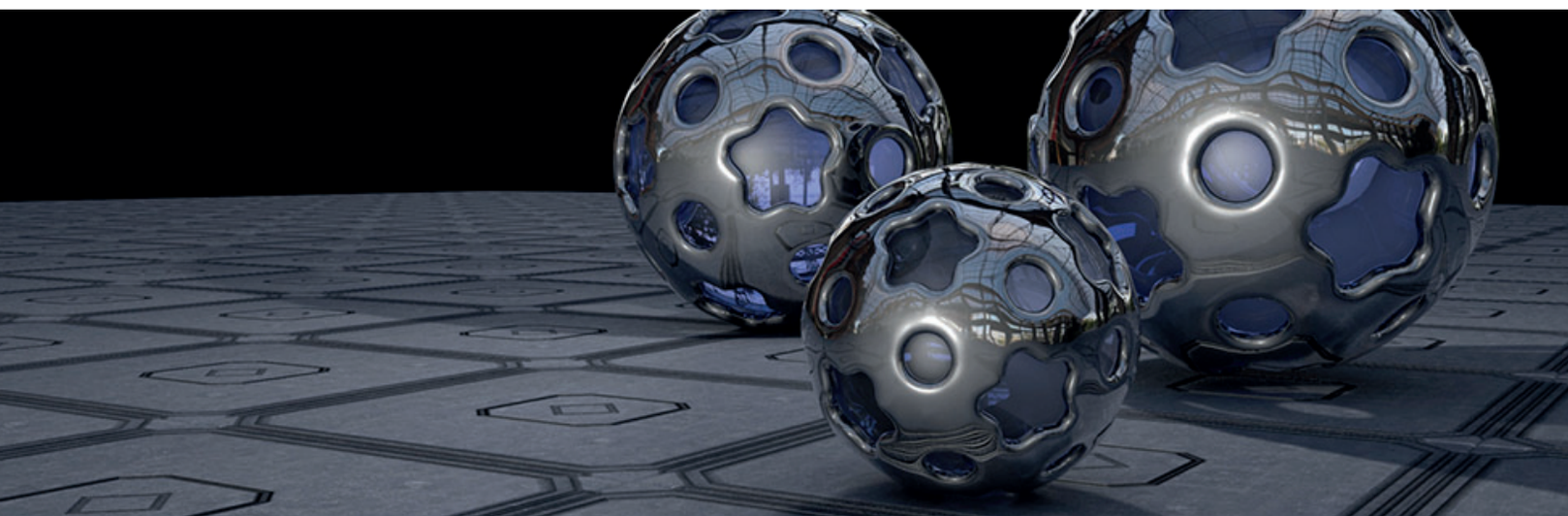
Figure 2: a) Switching behaviout of TiN oil-based nanofluid and b) long acquisition under solar illumination.

Cogitor postdoc Dr. Loghman Jamilpanah leftthe project, because he could aqcuire an Empa internal project on a different topic. To fill the vacancy he left, Empa hired Dr. Qing Chen from Hamburg / DESY, who will work on the self healing skin and energy conversion in Cogitor. Cogitor PhD student Matteo Bevione successfully passed his candidacy exam at EPFL Lausanne.

PlasmaChem

In the first year of the project PlasmaChem has developed and supplied several magnetic and infrared absorbing nanopmaterials on the base of Iron(II, III)oxides and Titanium Nitrides as well as Fe3O4 magnetic liquids with different susceptibility and pyromagnetic effects.

These materials and colloids have already been initially investigated for energy harvesting capabilities and electrically activated assembly in liquid state at EMPA. These technologies will lay the basement for computing subsystems used in later tasks. At the moment syntheses for diversification of magnetic liquids are getting done with new materials for further investigation by the other involved partners coming soon.



EXPLOITATION

In the first year of the COgITOR project, CiaoTech, leader of the Exploitation, started the stakeholder analysis with all partners actively participating. We defined together a set of keywords that characterize the COgITOR research activities during several brainstorming meetings and identified the preliminary sectors of applications. Based on them, CiaoTech analysed related papers, patents, funded projects and extracted a group of them, the most significant with respect to COgITOR.

In parallel a first version survey was prepared by CiaoTech, then improved and updated with all partners' suggestions. The survey was circulated among the identified group of stakeholders.

In November 2021 an internal webinar focused on the knowledge identification, management, exploitation actions and related dissemination was held by CiaoTech with the collaboration of all partners.

DISSEMINATION & COMMUNICATION

In the first year of COgITOR project, CiaoTech, leader of the Dissemination and Communication, planned a sound communication strategy to engage the general public towards the key messages vehiculated in the project, with the aim of:

1. raising awareness about the project, the Colloidal Cybernetic Systems, Holonomic Memory, Impedance Spectroscopy, and creating expectations among Stakeholders and potential end-users as early adopters, general public, other selected categories.

2. Sharing and aligning the knowledge developed in the initiative with different stakeholders, especially industrial stakeholders, including industrial associations (i.e. EUnited Robotics), as well as scientific community, European Networks and Associated Partners and other (EU-) funded projects in the fields of soft robotics/electronics, colloidal Science and Technology, nanotechnology, analytic tools, nanomedicine, bio-nanotechnology).

All the actions implemented by the partners in the D&C plans were coordinated and supervised to deploy what was previously defined, including setting up a project identity through branded newsletters, rollups, flyers, posters and brochures.

The project website has been updated with interesting events and news in line with the project scope; the COgITOR social media channels are managed to provide information and updates about the project activities and the main D&C outputs were made public also during online events and initiatives virtually attended by the partners.

INTERNATIONAL EVENTS

The project was showcased at the CiaoTech booth, arranged as a 'Projects Hub' during the 'ECOMONDO Green Technology Expo' event, which took place from 26 to 29 October 2021 in Rimini (Italy). ECOMONDO represents the leading show in the Mediterranean basin and a benchmark event in Europe for technological and industrial innovation. It is an international event with an innovative format that brings together all sectors of the circular economy on a single platform: from the recovery of materials and energy to sustainable development.

The coordinator was invited to give a lecture at the 13th International Conference on Physics of Advanced Materials (ICPAM-13) and the 4th Autumn School on Physics of Advanced Materials (PAMS-4), jointly organized in September 2021, in Croatia. As invited speaker, (list here https://icpam.ro/invited-speakers/) the coordinator prof. Alessandro Chiolerio, presented its talk "Towards liquid state cybernetic systems" during the online session" at the event where 150 participants from academia gathered.

The COgITOR coordinator was invited to give a lecture at the Università degli Studi di Salerno, in May 2022, in the frame of the "Ecological Health: l'uomo, le piante, l'ambiente" event.

Phenomenological universalities, sequentiality, causality will be introduced and discussed. The main electronic and computer implementations will be briefly discussed, with a brief reference to holonomic machines such as COgITOR, by means of which it is expected to restore a link that closes this apparent dichotomy between artificial and biological intelligence.

PRESS RELEASES

Main information, results and finding were spread thanks to press releases published by IIT (the project coordinator) and other partners to celebrate the project launch, at national and international level, reaching out more than 9 millions people.

RESEARCH GATE

COgITOR project was included in ResearchGate at the following link https://www.researchgate.net/project/COgITOR-A-new-COlloidal-cybernetIc-sysTem-tOwaRds-2030

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