LagLivLab spring 2021, proposed projects

Biohybrid robots[1,2]

Muscle cells from mouse or rats (ethically approved cells will be bought) can be attached to solid structures. The muscle cells can be made to contract by electrical impulses. In this way you can build millimeter sized robots. Training of robot motion can be done using machine learning. Together with collaborators at the Centre of Excellence "Ritmo" we will arrange

- a dance contest. This is cool and fun and makes good youtube videos.
- mapping of motion while standing still. This is a research project that Ritmo has performed on human beings. Comparing this to the motion of robots without stimuli can be a research paper.

Standalone cell culture system[3,4]

The rage of the 2020s are organs-on-a-chip[3]. These are systems that have to be specifically engineered for each type of organ. Growing and maintaining cell cultures, however is a more generic activity of cell biology. They are kept in expensive incubators and several times a week they have to be looked after and the growth media replaced. When there are too many cells, most of them are killed and some are re-applied in a new flask/petri dish. All this can be done inside a lab on a chip[4]. In addition, the incubator functions of controlling temperature, CO_2 and O_2 pressure can be reduced to small modules in a standalone cell culture system that is small enough to be moved from lab to lab and between research microscopes at different imaging facilities. Adding electrodes to the system will allow electrochemical or bioimpedance monitoring of the cell coverage, a feature that will be publishable in a scientific journal.

The system is perhaps not the most exciting project to start with, but it contains all the basic technology needed for more advanced organ-on-a-chip systems: temperature, gas and fluid control, hydrogel membranes, monitoring of cell state, etc. It will be a platform that LagLivLab students can build on and modify for years.

Acoustic/electrical rotation of cells

Acoustical and electrical waves are used on a daily basis in biological labs in order to alter cells' membranes (sonoporation[5] or electroporation). In a more gentle way, ultrasound imaging is commonly used in hospitals in order to diagnose tumoral tissues for instance. As these kind of tissue have different mechanical properties than healthy tissues their responses to the mechanical waves that are ultrasounds can be detected using these techniques.

In the lab, the use of ultrasonic or electric field can input mechanical energy into biological materials: single cells or tissues for instance, allowing to trap them[6], to rotate them or to chain them[7]. All these behavior can be used to measure rheological properties of biological materials, for instance by measuring the mechanical response of cells driven by such stimuli. In a medical context, such properties are interesting in order to allow differential treatments between different categories of cells (cell types, healthy or not healthy for instance). The proposed project would be to try to induce a rotational motion of single cells using acoustical waves, electrical waves or a combination of the two. By measuring the cell deformation, for different applied torques for instance, one can recover informations on the mechanical properties of the probed object.

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