

07/8102 BIO-CONTROLLER BASED ON MICRO-ORGANISMS' BEHAVIOURS

Type of activity: Short Study (2 months, 15 KEUR)

Background and Motivation

In order to perform complex tasks as for example the exploration of harsh, dynamic and uncertain environments, autonomous systems such as satellites or planetary rovers need to be controlled by highly adaptable, robust, failure tolerant and ideally self-aware and self-healing systems. State-of-the-art controllers are far from showing these qualities and efforts in engineering them have had so far limited success. On the other hand, extremely simple biological organisms have evolved such extraordinary capabilities in order to survive in adverse and hostile conditions [1]. Micro-organisms as, among others, prokaryotic bacteria and archaea, simple eukaryotes, or different fungi populations demonstrate complex, non-linear but stable behavioural patterns in response to environmental stimuli and disturbances.

The goal of this study is to investigate whether we are already able to import their behavioural capabilities (in terms of decision-taking and control, not the sensor aspects) in the core of a machine controller by using what nature has developed in a billion of year's evolution, and if yes, how this could be achieved. Some work has already been performed [2] where biological cells are used in a controller to import the plasticity and adaptability of a living organism into a device of hybrid bio-electronic architecture. More inspiration on the topic can be found in [3, 4] and the references therein.

Research and Study Objective

The objective of this study is the identification of those particular behaviours and strategies of micro-organisms that can possibly be employed as a core for adaptive, self-learning and robust system controllers to be possibly used in space systems. The study shall not include an overview of micro-organisms found on spacecraft and spacecraft assembly halls, already covered in [5]-[14] but rather:

- Provide a characterization of the most relevant behavioural patterns that are/could be suitable for control purposes in terms of:
 - the required external stimuli
 - the resulting measurable outputs related to those stimuli
 - the compensating reactions towards unexpected (internal and/or external) disturbances.
- For promising (and yet technologically feasible) behavioural patterns for system control, propose a hybrid control architecture.
- Identify technological state-of-the-art analogies and compare them with their biological pendants in terms of adaptability, failure tolerance, robustness, and the compensational effort of external disturbances.

It is emphasized that for this study space knowledge is not required (will be provided by the ACT) and the community of micro-/molecular-biology and cybernetics is strongly encouraged to tender.

References

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