Slime Extralligence: Developing a Wearable Sensorial and Computing Network with *Physarum polycephalum*

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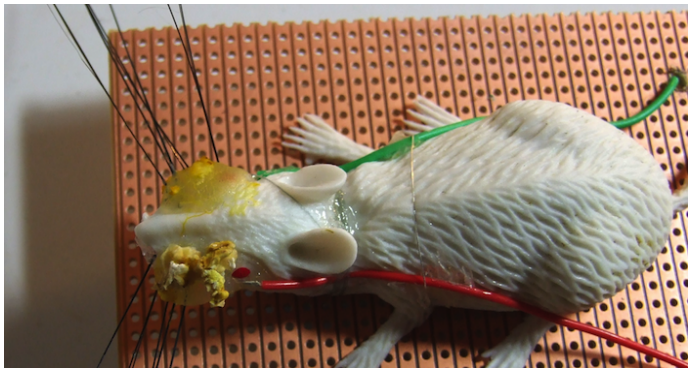
Research in unconventional, or nature-inspired, computing aims to uncover novel principles of efficient information processing and computation in physical, chemical and biological systems, to develop novel non-standard algorithms and computing architectures, and also to implement conventional algorithms in non-silicon, or wet, substrates. Lion part of the unconventional computing research deals with theoretical constructs or oversimplified laboratory representations of basic logic gates. We propose to move away from abstract theory of unconventional computing and develop working prototypes of non-standard sensing and computing devices capable for functions in realms of every day's life.

We have chosen an acellular slime mould Physarum polycephalum as an amorphous living substrate because Physarum is a living, dynamical reaction-diffusion pattern formation mechanism; Physarum may be considered as equivalent to a membrane bound sub excitable system (excitation stimuli provided by chemo-attractants and chemo-repellents); Physarum may be regarded as a highly efficient and living micro-manipulation and micro-fluidic transport device; Physarum is sensitive to illumination and AC electric fields and therefore allows for parallel and non-destructive input of information; Physarum represents results of computation by configuration of its body. In experimental laboratory studies we show that when inoculated on bare plastic surface Physarum successfully develops an optimal network of protoplasmic tubes spanning sources of attractants while avoiding domains with over threshold concentration of repellents.

We proposed, and partly implement in laboratory conditions, an intelligent adaptive living network wearable by humans and robots. When grown on 3D bodies (living or inanimate) the living Physarum network provide a highly-distributed sensorial structure (light-, electro-magnetic, chemical and tactile sensitivity) with embedded dynamic architecture of massive-parallel computing processors based on geometry of proximity graphs (Fig. 1).

We provide blueprints and descriptions of prototypes of slime mould based colour sensors, tactile sensors and chemical sensors. We analyse networks of conductive self-growing and self-repairable pathways and wires made of intact slime mould and Physarum loaded with functional nano-particles. Principles of distributed computation and decision making in wearable Physarum networks are outlined and illustrated with working examples of Physarum computers. Finally, we speculate how interfacing between Physarum computing networks and hardware actuating devices will be implemented.

(a)



(b)

(c)

Fig. 1. Prototypes of Slime Extralligence:
(a) Intelligent network grown on a mannequin.
(b) Slimy whiskers grown on a rubber mouse.
(c) Directed growth of living sensorial network on plastic model.