Amoeba-Like Mobility by a Group of Units

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Abstract

Amoeba-like mobility as emergent functionality was realized by a multi-agent robot system in computer simulations. For the coordination between units' movements for the amoeba-like mobility, the restrictions to GU are organized into a "Dissipative Structure" to be used as useful information to do the cooperative task. One restriction, for example, is an obstacle on the way of GU to a goal. Then GU should recognize and avoid the obstacle. Use of the structured information leads to a mechanism that does not load units with heavy computational burden due to GU's self-organizing feature. Since, the GU's free dissipative structure itself is an intelligent processor. The medium of information for agents is "Vibrating Potential Field (VPF)." The GU showed flexible changes in the shape of its own body--to move around, avoid physical obstacles, and wrap a food--by not giving algorithms to GU but only to individual unit. This model can show highly-coordinated primitive intelligent behavior by lower level units without high ability.

Amoeba-like mobility is shown by the cell and slime mold as emergent property (Stossel 1994) (Raper 1984). Cell or slime mold is the creature that has no particular organ to control the whole as a unit, but consists of many subunits that act on their own: for example, proteins in the cell; and cells in the cellular slime mold. Here, the main claim is that how cells or proteins achieve the highly coordinated--spatially and temporary--behavior of the organized group of subunits. In the study on *Physarum*, Ueda proposed the hypothesis of chemical self-organization, "Cell movements are caused by rearranging cytoskeleton according to self-organizing chemical pattern," to explain the whole of cell activities (Ueda 1993).

Model

Schema-Based Motor Unit. It is an algorithmic robot with input and output: For example, input is local perception in VPF, and output is emitting information to VPF and exerting force. Now we are assuming simple self-mobility of the unit, but ideally the ability is not necessary for GU's amoeba-like mobility in future work.

Food. It is a goal in navigational application of GU. The food is single unit that behaves differently from GU's unit. It emits pulse information to VPF.

Environment with VPF. In two-dimensional plane environment, there are physical barriers, and extracellular matrix that is medium of information as wave or diffusion, i.e., VPF. The detailed description about VPF is available in (Yokoi et al. 1996). VPF is mainly used by GU to search for a food unit.

Structured Information. Here, we used a pattern of concentration of units: to recognize and avoid physical obstacles on the way to a goal; and to "find out whether it is a food or not" (see Figure 1). GU changes the degree of bonding between units. The generation of a pattern is spontaneous and independent from the calculation of units, so the coordination of GU is not the burden of each unit.

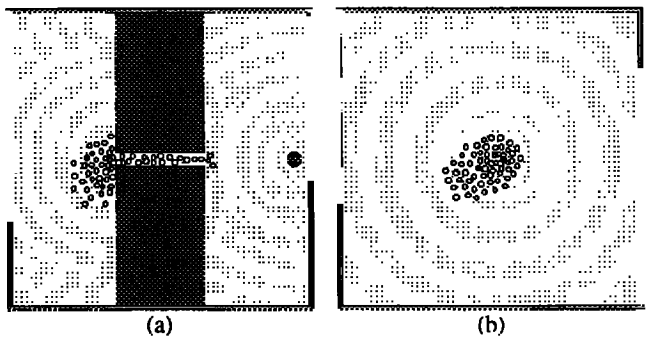

Figure 1: **Results.** The white circle is GU's unit; The black circle is food unit; The ripple shows VPF that is info about food's position. (a) GU has searched and approached to food, avoiding tunnel by changing the shape of its own body. (b) GU wrapped food when food's size is smaller than a threshold. When the size is larger than the threshold, the food would be pushed out.

References

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