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A NEW SELF-ORGANIZING MODEL SEPARATING POSITION AND DIRECTION INFORMATION FROM VISUAL INPUTS FOR ROBOTS

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Our visual system effortlessly and instantaneously identifies our position and direction from what we see in the environment familiar to us. We learn the scenes from experience, and some kind of map is supposed to be organized in the brain. This is the desirable ability for robots to share.

The visual input to a robot in a room is a function of two factors, the position and direction of the robot. Here, we concentrate on the problem of separating two factors of information in the observed images. This is an example of so-called two-factor problems.

For this purpose, we have developed a computational model based on two learning algorithms, the Kohonen’s self-organizing map (SOM) and the neural gas (GAS). The SOM, which was proposed first as a model of cerebral self-organization, is usually a two-dimensional array of learning units. The GAS, a collection of similar units without predetermined topology, is more flexible and can fit for wider variety of topology of the signal space. Our model, a product of these two models, is SOM-like in one dimension of the unit array and GAS-like in the other dimension. The GAS, however, has no efficient dimension nor topology. Our model, therefore, can cope with unknown shape of a room. Periodic boundary condition is assumed in the SOM dimension to fit for the circular topology of the direction information. By putting these algorithms together with some new learning rules, we demonstrate, by computer simulation, that position and direction are extracted separately in different dimensions of the unit array.