Multi-object Segregation: Ant-like Brood Sorting Using Minimalism Robots

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Abstract

This study shows that a task as complicated as multi-object 'ant-like brood sorting' can be accomplished with a 'minimalist' solution employing a simple adaptive mechanism and minimal hardware. The success of the mechanism, which employs a combined leaky integrator, is demonstrated both in simulation and using real robots. Results obtained by using the mechanism are then compared with the brood sorts of *Leptothorax unifaciatus* ants. This solution is an extension of the object clustering research of Beckers *et al.* (1994) and the object segregation research of Melhuish *et al.* (1998). Beckers *et al.* (1994) used a very simple mechanism and achieved puck clustering in an arena with simple robots. Melhuish *et al.* (1998) extended this technique to sort two objects, again using simple robots and a simple mechanism. Using less hardware, the mechanism described in this paper offers an alternative multi-object sorting mechanism to the one described in Melhuish *et al.* (2001). A comparison between the results of this novel sorting mechanism and the behaviour of actual ants should inspire further biological and robotic research.

1. Introduction

The inspiration for this study is taken from the brood sorting behaviour of *Leptothorax unifaciatus* ants; a species that have evolved to live between the cracks in rocks. Due to their two-dimensional environment it is possible to recreate fairly natural conditions for these ants between two glass slides, which provides the opportunity for detailed observations (Franks and Sendova-Franks, 1992). The ants sort their brood so that "*different brood stages are arranged in concentric rings in a single cluster around the eggs and micro-lavae*". Franks and Sendova-Franks (1992) speculate that these patterns are produced to influence the priority in the tending of different brood items. In general the older and larger brood items, that need more tending, are placed in bands further from the centre of the structure. This is clearly visible in Figure 1 below; shaded shapes have been superimposed onto a Dirichlet tessellation (colony D after rebuilding (Franks and Sendova-Franks, 1992)) in order to make clear the positions of the different brood items. The annularity of the ant structure is slightly distorted due to the rectangular shape of the nest and the position of the nest entrance. Our mechanism is capable of recreating an 'ant-like brood sort' within a group of objects of differing types. It has been tested both on real robots and in simulation.

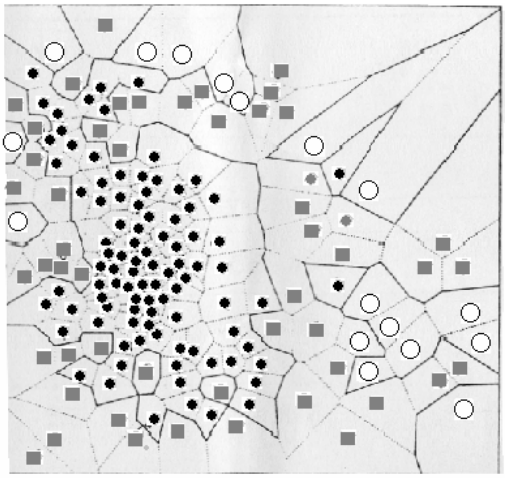

Figure 1: A Dirichlet tessellation taken from (Franks and Sendova-Franks, 1992) with shaded shapes superimposed.