Multi-object Clustering: Patch Sorting with Simulated Minimalist Robots

Chris Melhuish[1], Matt Wilson[1], Ana Sendova-Franks[2]

[1]Intelligent Autonomous Systems (Engineering) Laboratory, Faculty of Engineering,
[2] Intelligent Computer Systems Centre, Faculty of Computer Studies and Mathematics
University of the West of England, Coldharbour Lane, Frenchay, Bristol BS16 1QY

Chris.Melhuish@uwe.ac.uk Matthew.Wilson@uwe.ac.uk Ana.Sendova-Franks@uwe.ac.uk

Abstract. This study shows that a task as complicated as patch sorting can be accomplished with a minimalist solution of four simple rules. The solution is an extension of the object clustering research of Beckers *et al.* [1994] and the object sorting research of Melhuish *et al.* [1998a]. Beckers *et al.* [1994] used a very simple mechanism and achieved puck clustering in an arena with simple robots. Melhuish *et al.* [1998a] extended this technique to sort two objects, again using a simple mechanism. This paper reports on a new mechanism, which explores the sorting of any number of different objects into separate clusters. The method works by comparing the object with which the robot has collided with the object it is carrying using a special antenna. The results in this paper are a demonstration of the success of the n-colour mechanism in simulation.

1. Introduction

Deneubourg *et al.* [1991] began the research into the idea of sorting objects using minimal rules. In their paper, *"The dynamics of collective sorting: ant-like robots and robot-like ants",* they present a simulation which demonstrates a simple mechanism that is sufficient to generate separate clusters of two different objects. The mechanism modulates the probability of dropping objects, as a function of the local density of objects near the robot. Although it was not discussed in the paper, the possibility exists to scale this method to sort any different number of objects into separate clusters. The mechanism used, while successful in simulation has a major drawback in that the agents need to be able to sense the local densities of the different types of objects. While this information is easily made available to simulated robots, it is difficult to transfer to real robots operating with minimum sensing capability.

A simpler mechanism was used by Beckers *et al.* [1994] and was successfully implemented on a group of real robots. This mechanism was later modified and tested by Melhuish *et al.* [1998a]. It involves robots moving in straight lines in an arena. They reverse and turn though a random angle whenever their scoop is depressed. While moving in the arena the robots are able to push objects (frisbees) with which they collided in the direction of their motion. If another frisbee is collided with, and the robot is currently pushing a frisbee, the frisbee currently being pushed is deposited and the robot reverses and turns through a random angle.

After testing the above mechanism on their robots, Melhuish *et al.* [1998a] extended the mechanism by the addition of an extra rule allowing two-object segregation. The physical implementation used red and yellow frisbees and an infrared sensor able to detect which of these two colours the robots are carrying. The extra rule differentiates the action to take place when the robot is carrying a frisbee and it collides with another frisbee: red frisbees are dropped, while yellow frisbees are first pulled back a distance before being dropped. This pullback mechanism allows the yellow frisbees to be pulled away from any potential red cluster.

This paper describes research into a further extension to the mechanism above to enable the sorting of any number of different types of objects. An antenna has been added to each of the robots, which is used to sense the colour of a frisbee. If a robot is 'carrying' a frisbee and a collision takes place with another frisbee, the antenna moves and senses the colour of the frisbee in front. A comparison is then made with the frisbee being carried so that one of two possible actions can result: if the sensor comparison judges the two frisbees to be of a similar colour, then the frisbee being carried is dropped otherwise the frisbee is taken away so that it can possible be deposited elsewhere.