Collective Energy Distribution: Maintaining the Energy Balance in Distributed Autonomous Robots

Chris MELHUISH[1] and Masao KUBO[2]

1. IAS lab., CEMS Faculty, University of the West of England, Chris.Melhuish@uwe.ac.uk
2. National Defense Academy, and IAS lab., CEMS Faculty, University of the West of England, masaok@nda.ac.jp

1. Introduction

Truly autonomous systems will be required to generate and manage their own energy budget [4, Holland]. This is true of single robots as well as a group of distributed autonomous robots. Research has shown how a group of 'food foraging' robots can benefit when employing a strategy which involves them replenishing their energy from the collective repository (nest) created by the individual foragers [Krieger and Billeter]. In contrast to this form of 'central sharing' it is observed that in the world social insects, such as ants, the phenomenon of food sharing – trophallaxis - is also employed to distribute the collective energy resource owned by the group members [1]. It is reasonable to ask if such a mechanism might be beneficial to a collective of autonomous robots.

Already some researchers are exploring the prospect of creating robots which will be able to generate their own energy from the environment employing, for example, sugar [3] as well as natural substrates [2, Kelly ET AL, Ieropolous et al].

These robots have rechargeable energy storages. Each rechargeable energy storage will have its own characteristics. Most Lithium ion batteries have high energy density but requires a 'long' time to charge. Fuel cells are very 'clean' but have low energy density but are improving, for example, Direct Methanol Fuel Cells (DMFC) are more portable. The storage capacity for super capacitor and polymer battery cell are also continuously improving. Roughly speaking, energy devices are becoming more portable, quicker to charge, and with higher energy densities. The improvements might be able to be employed in a manner which allows robots to transfer energy between them. How then will these characteristics influence the choice of design and behaviour of a robot collective? Such considerations will be important to future designers employing collective robot solutions. It appears that, currently there are examples of few practical multiple robots systems. We think that the one of the reasons is that there is no methodology for the maintenance and management of energy for multi robots. A single Trilobite™ carpet cleaner is said to work for an hour with fully charged Ni-H batteries and takes 2 hours to recharge. How would such a system scale up when cleaning a larger environment?