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Autostruosis: Construction without Explicit Planning in MicroRobots - A Social Insect Approach

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Abstract

With the advent of new micro-machining technologies including micro-sensing, micro-actuation as well as micro-electronics and micro-computation it is reasonable to assume that very small mobile robots will be built in the future. It is reasonable to speculate therefore how such machines can be controlled and how their activities can be co-ordinated. At the micro-scale robots will experience considerable limitations. Against this background, and inspired by natural collective systems, particularly the social insects, the paper explores collective minimalist mechanisms for key aspects of acting on the environment. The paper attempts to draw together the vocabulary of emergence, employed by researchers in different disciplines, into a pragmatic definition which can be used by engineers. Examples of these mechanisms employed by a group of real robots in the construction of clusters, linear structures and sorting are presented.

1 Introduction

Consider the problem of controlling and coordinating the behaviour of very small robots. For the purposes of discussion let us focus on robots with a volume less than 1mm^3 ; for this paper robots less than this volume will extend down from micro to nano-scale in range. All we can expect to be able to build in this domain over the next few years are really quite dumb and simple robots, with rudimentary sensing, communication, locomotion and computation abilities. As with all autonomous systems not only will power provision will be problematic but the capacity of a single tiny robot to achieve anything or even to survive for any length of time will be in doubt; an individual is limited and