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The Development and Energetics of SlugBot, a Robot Predator.

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Two key aspects of most living things is their ability to exploit natural sources of energy within their environment and their ability to carry out appropriate behaviour in a range of different conditions. This paper describes the progress of a current project that is attempting to develop a robot with an equivalent capability – a robot capable of autonomous action on agricultural land. The robot will sustain its self by hunting and catching slugs. Consequently the biomass will be fermentated to produce biogas, which will be converted to electricity by a fuel cell to provide the robot's energy.

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1. Introduction

Living systems display the remarkable ability of being autonomous for much, or all of their lives. They are able to survive and operate successfully in an unstructured environment without requiring any assistance whatsoever. Autonomy, whether biological or artificial, can be considered as consisting of two major aspects: computational autonomy, and energetic autonomy. Computational autonomy is demonstrated in the ability to determine and carry out actions independently; some of these actions may be related to the acquisition of energy, most will be concerned with other aspects of system operation. In the context of a biological system, some of the other aspects of computational autonomy are associated with survival and reproduction, such as avoiding predators, finding shelter, grooming, finding mates, and so on. A living system is also required to independently maintain its internal availability of energy above some lethal minimum, throughout its life. This ability does not merely involve making correct decisions in order to secure the raw energy; it also includes the conversion of the raw energy source into a usable form.

To date much of the investigations of so-called 'autonomous agents' in the field of artificial life involve simulated agents attempting to survive and reproduce in a simplified world containing spatially localised elements corresponding to 'food', 'predators' and so on. Although these abstract studies have been genuinely useful in exploring the dynamics of such situations, all fall very far short of the complexities faced by an actual animal in the real world.

There are now many examples of robots or automated mobile systems (such as missiles, smart torpedoes, and some spacecraft) which achieve an apparently high degree of energetic and computational autonomy. The study of such systems, in particular their design and control, has formed a major area of academic and industrial research over the last twenty years.

Although such systems are impressively sophisticated they are not truly autonomous. These systems usually carry sufficient fuel for their mission and can control themselves 'intelligently' without human intervention. Some automated cleaning and materials handling AGVs use 'opportunity' battery charging to achieve a degree of apparent autonomy. Several academic research groups have constructed robot environments which feature a 'powered floor', giving the possibility of indefinitely extended operation. However, most of these 'autonomous' robots still require some explicit or implicit intervention from humans in order to carry out their tasks. Forms of human intervention include supplying information and energy, physically assisting the robot, and modifying the environment to suit the robot. The issue of autonomy has been finessed, rather than having been confronted and overcome.

The study described here represents a serious attempt to design and construct a robot system with energetic and computational autonomy comparable to an animal system - albeit less sophisticated than its biological counterpart. We have sought to guarantee the comparability by constraining a robotic system to obtain its energy in the same way as most animals - by finding and 'digesting' organic material in an unstructured environment.

The decision to follow this approach forces us to confront a number of difficult issues. For example,