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1 New tasks for robots

The possibilities of robots working amongst animals are little explored. Unlike the objects of typical robot applications, animals are autonomous agents and will exhibit behaviour. Interesting constraints are placed on robot design regarding real-time action, robustness, flexibility and safety. We believe that such Animal-Interactive Robotic (AIR) systems are a new and interesting area for research.

Conventional engineering methods require detailed knowledge of system dynamics, but this is very hard to obtain with animal behaviour. We suggest a methodology for designing Animal-Interactive Robots based on our experience with an example task.

2 The Robot Sheepdog Project

The Robot Sheepdog Project has demonstrated a robot system that will enter an arena, gather a flock of ducks and manoeuvre them safely to a predetermined goal position. Ducks flock similarly to sheep, but their small size and low speed simplify engineering requirements; the problem remains essentially the same.

The goals of the project were 1) to better understand anti-predator flocking behaviour; 2) to devise a method to control that behaviour; 3) to construct an appropriate robot system to work and interact in the animal's environment; 4) to develop a methodology for future work in Animal-Interactive Robotics.

Project Hypotheses:

(1) Flock control can be achieved by exploiting the threat-avoidance behaviour

(2) The appropriate interaction is to position the robot behind the flock with respect to the goal while maintaining an appropriate robot-flock distance

(3) A simulated flock could be used to design and test a controller that achieves (2)

3 Generalised methodology

(1) Identify **reliable behaviours**

(2) Design an **appropriate interaction**

(3) Use minimal behavioural simulations to enable off-line trials

A **reliable behaviour** is one which can be incorporated into a further system which relies upon it for success.
An **appropriate interaction** is a behaviour which exploits an existing reliable behaviour to achieve a useful task.

It is suggested that reliable behaviours are

- isolatable
- comparatively simple
- amenable to simulation modelling
- scalable: an appropriate interaction on top of a reliable behaviour produces another reliable behaviour.

4 Conclusions

Lessons learned:

- successful first AIR project
- conventional control engineering impossible
- though control *concepts* may apply
- simplicity is key to satisfying constraints

Questions raised:

- are the reliable behaviour assertions valid?
- will this method generalise?
  (or were we just lucky?)
- are there any real applications?