Robot Sheepdog Project Achieves Automatic Flock Control

Richard Vaughan[1,2], Andy Frost[2], Stephen Cameron[1]
[1]Oxford University Computing Laboratory
[2]BioEngineering Division, Silsoe Research Institute
vaughan@comlab.ox.ac.uk

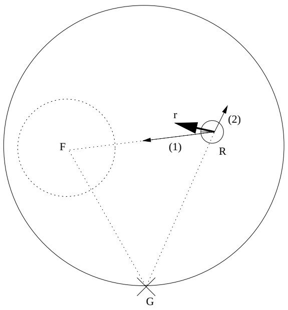
1 The Robot Sheepdog Project

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.

Unlike the objects of typical robot applications, animals are autonomous agents and will exhibit behaviour. We believe that such Animal-Interactive Robotic (AIR) systems are a new and interesting area for research.

2 Flock-control Algorithm

Flocks of animats can easily be created using potential field techniques of attraction and repulsion between individuals. We have shown that the same ideas can be used to produce a flock control algorithm. In our experiment a simulated robot has its trajectory guided by the resultant of two simultaneous forces, shown in the diagram (right):
(1) Attraction to ducks by an amount proportional to the ducks' distance to the goal;
(2) Repulsion from the goal position by a constant amount.
A seperate mechanism acts to prevent the robot steering into the arena walls.

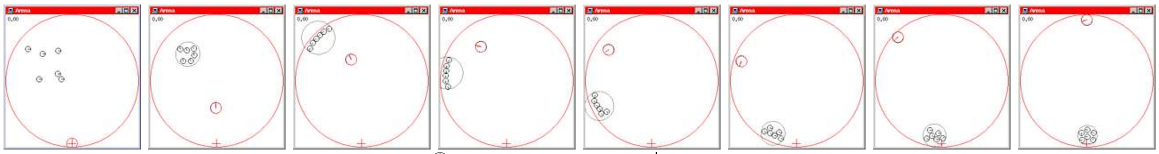


$$\vec{r} = \underbrace{(K_1|\vec{GF}|)\widehat{RF}}_{(1)} - \underbrace{K_2\widehat{RG}}_{(2)}$$

Key: gain parameters $K_{1,2}$; flock centre F; Robot position R; Goal position G; algorithm terms (1, 2) and resultant $\vec{r}$ (where $\widehat{a}$ is the unit vector of $\vec{a}$)

3 Simulation results

These screenshots (reading left to right) show this controller running on a simulated robot interacting with a simulated flock. The robot successfully gathers and manoevres the flock to the goal position, and is robust with respect to large variations in flock parameters.



Key: = robot, = ducklets, + = flock goal

4 Real-world results

The controller was then transfered unchanged to a purpose-built robot vehicle and tested on a real flock of ducks. This sequence of images from the overhead camera during an experiment shows successful behaviour very similar to that of the simulation. (The goal position is at the bottom of the picture).