Hunting a robot controlled by an artificial brain

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Abstract

In this demonstration an Raspberry Pi robot, controlled by an artificial brain which simulates the 302 neurons of the worm Caenorhabditis Elegans, is hunted by a flying robot: an AR.Drone quadrotor. The position of both robots are tracked by a motion tracking system, which guarantees that the flying robot can follow all movements displayed by the robot on the ground.

1   Introduction

To create Artificial Intelligence one can build systems that act like humans or think like humans. An example of this approach is the Blue Brain project [1], which builds a system that simulates the neurons of a human brain. A more pragmatic approach is the OpenWorm project [2], which simulates the neural system of the worm Caenorhabditis Elegans. The neural system of this species is well studied, including the mechanisms to control the body [3]. In our first years final project we aimed to let the unpredictability of our worm control another, flying robot, which lead us to the hunter-prey relation, a fitting theme for our Search, Navigate and Actuate class. In the future, simply following a robot would be a part of the hunting process. We imagine that AI developers could program a landing or catching procedure.

2   The worm

The nervous system of the 1 mm long C. Elegans holds 302 neurons and is sensitive to touch, chemical, odor, pain, osmotic, oxygen changes, temperature and mechanical changes. Its muscles are controlled by using excitatory and inhibitory connections which stimulate contraction resp. relaxation, resulting in an undulating movement of the worm.
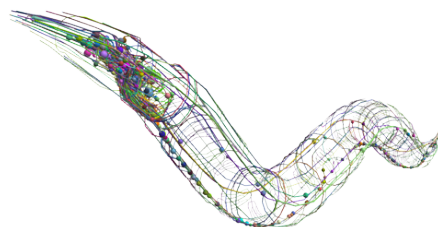

Figure 1: A 3D model of the neuron connections in the worm C. Elegans (Courtesy Christian Grove)

Not all this complexity could be embodied into a robot; the sensory part is represented by a sonar sensor and the undulating movement by activating the left and right wheel, comparable with the aggregation demonstrated by Suzuki *et al* [3].

There exist two artificial embodiments for this worm; one based on a Lego Mindstorm robot and one on the GoPiGo robot board[1]. The demonstration is based on the later robot, which consists of a Raspberry Pi board extended with accessories. Both of these embodiments are made by Timothy Busbice.
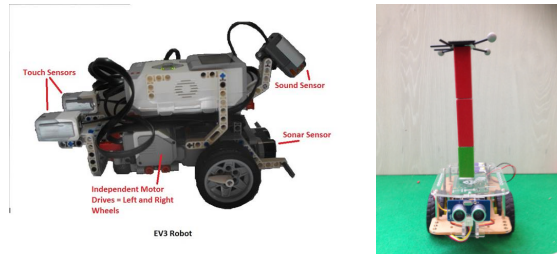

Figure 2: The two embodiments of the C. Elegans worm (Courtesy Tim Busbice and Dexter Industries)

3 The drone & the motion tracking system

The predator-role is fulfilled by an AR.Drone 2.0, controlled by a package based on Javascript library Node.js. The flying robot is very fast relative to the ground robot, so special care had to be taken not to overshoot the target.

The robots are followed with an Optitrack motion tracking system, consisting of six Flex13 cameras mounted on the ceiling. The system can track an area of 6x6x2m with an accuracy of 0.5mm. The position of the markers could be broadcasted with UDP binary messages according to the propriety NatNet definition. Based on the example given in the NatNet SDK, a Python depacketization library[2] was made by Sergey Astanin, which was ported by us to Javascript for the interface with the AR.Drone. The system requirements can be found here(see footnote)[3]

4 The demonstration

For the demonstration we have the following requirements: a space of 4x4x3 meter is needed. The motion tracking system is mounted on poles around this area. For safety, we can guard the surroundings with curtains mounted on the poles, although the AR.Drone has its own safety mechanism. The ground robot will be enclosed by a low wall. The demonstration can in theory continue as long as we want, although in practice it is limited to the battery life of the drones (approx. 10 minutes). The overall principle could be demonstrated by a few maneuvers of the ground and flying robot, which can be finished in 2-3 minutes.

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