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Abstract

We present an Action Selection Mechanism inspired by ethology and theories of emotion. We consider how emotions - using fear as an example - affect the behaviour of artificial animals, in this case deer and sheep, as paradigmatic flocking mammals. We show how olfaction can be used to communicate emotion amongst conspecifics, through pheromones modelled as particles in a free expansion gas. The action selection mechanism is demonstrated on virtual animals in an immersive virtual environment and results have shown that believable behaviour is achieved.

Ethology

The model for Action Selection is hierarchical like that proposed by Tinbergen [6].

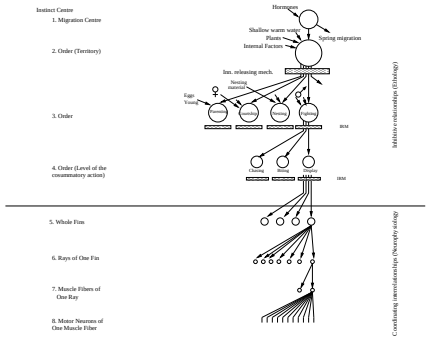

Figure 1: Hierarchical centres of the major reproductive instinct of the stickle back male. After Lorenz 1981 [5]

Emotion

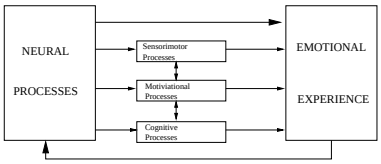

Figure 2: A multisystem model for emotion activation. After Izard 1993 [3]

Artificial Nose

The artificial nose is based on biology and electronic noses [2]. The clues that olfaction provides enable the animal to find food, escape from predators, find mates and communicate amongst conspecifics.

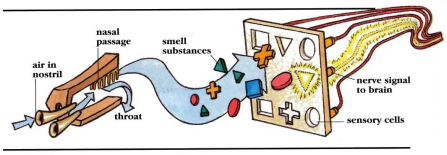

Figure 3: Olfaction. From Kelly 1994 [4]

Sheep flight zone

Figure 4: Flight zone in sheep

Overall architecture

Figure 5 shows a detailed diagram of the designed architecture, and the next sections describe its components.

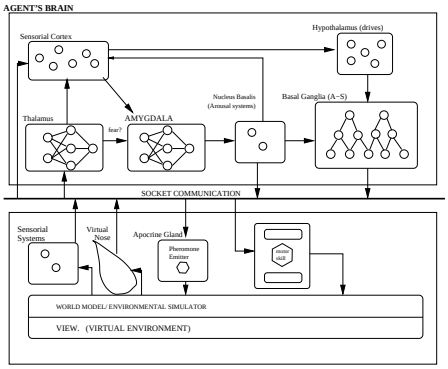

Figure 5: Detailed architecture

The emotional model is described in [1] and emotion theory is based on Izard's Four systems for emotion activation [3].

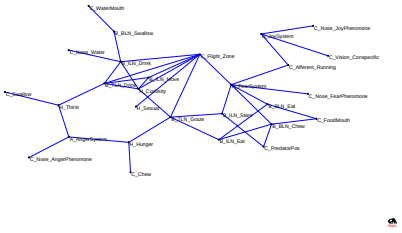

Figure 6: Net representing connections in the virtual animal's brain

Implemented flight zone

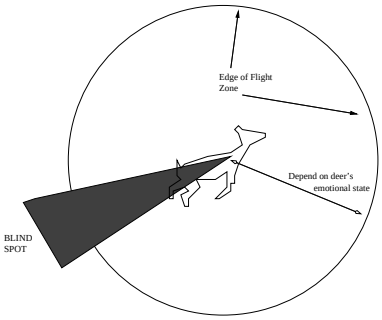

Figure 7: Mammal flght zone

Implementing emotion signalling

The diagram 8 represent a mammals signalling through pheromones. The diagrams represent four animals that communicate an emotion for example fear through pheromones exhudes through glands [7]. The different shaded colours represent the animals' position at three different times, with the darkest the oldest t_1 and the white the last timestep of the simulation. Pheromones are represented through the concentric circumferences, taken at 9 different time steps.

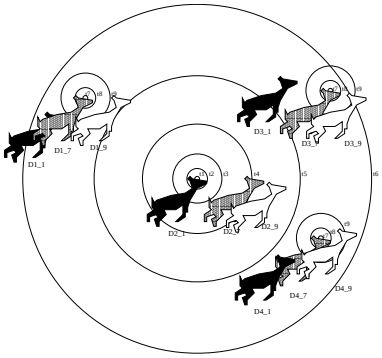

Figure 8: Emotional signalling through pheromones

Emotion Signalling in a Virtual Environment

As seen in figure 9 an abstraction of the body was developed to perform the bodily functions of perception and activation of glands in one place.

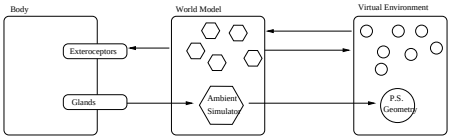

Figure 9: Overview of the animals signalling in a Virtual Environment

Deer in the CAVE

Figure 10: Users observing virtual deer in the Cave

Extensions

For example, musk-oxen throughout Canada are known to form defensive circles against predators. In this case, the circle is formed of older-oxen on with the animals' horns protruding outward, thereby protecting their young.

Figure 11: Real musk-oxen performing a horns-outward behaviour

Acknowledgments

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References

[1] Carlos Delgado-Mata, Jesus Ibanez, and Ruth Aylett. Let's run for it: Conspecifi c emotional flocking triggered via virtual pheromones. In Andreas Butz, Antonio Krüger, and Patrick Oliver, editors, *LNCS Smart Graphics 2003*, pages 131–140, Heidelberg, Germany, 2003. Springer-Verlag.

[2] Julian W Gardner and Philip N Bartlett. *Electronic Noses:Principles and Practice*. Oxford University Press, Oxford, United Kingdom, 1999.

[3] Carol E Izard. Four systems for emotion activation: Cognitive and noncognitive processes. *Psychological Review*, 100(1):68–90, 1993.

[4] John Kelly, Philip Whitfi eld, and Obin. *The Robot Zoo*. Turner Publishing, Inc, Atlanta, USA, 1994.

[5] Konrad Lorenz. *The Foundations of Ethology*. Springer-Verlag, Heidelberg, 1981.

[6] Nikolaas Tinbergen. *The study of instinct*. Oxford University Press, United Kingdom, 1969.

[7] Tristam D Wyatt. *Pheromones and Animal Behaviour*. Cambridge University Press, Cambrigde, U.K., 2003.

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