Do insects use visual recognition for navigation?

Two possible strategies:

Dead-reckoning
(keeping a running tally of directions and distances)

Scene-based navigation
(attaching vectors to observed scenes)

What is the benefit of one strategy over the other?

Evidence for dead-reckoning

Pieron (1904):

In a featureless Environment…

Evidence for scene-based navigation


Evidence for scene-based navigation (contd.)

(Collett and Baron, 1995)

Evidence for object-based navigation

(Collett and Baron, 1994)

Evidence for object-based navigation
Evidence for use of landmarks to pinpoint places

Tinbergen (1932)

Evidence for use of landmarks to pinpoint places

Wehner et al. (1996)

Can insects organize landmarks into ‘cognitive maps’?

Basic ‘snapshot’ model:
Landmark A: move NNE
Landmark B: move NW
Landmark C: move S
...

Cognitive map model:

Can insects organize landmarks into ‘cognitive maps’?

(Gould, 1986)

Can insects organize landmarks into ‘cognitive maps’?

Yes!

How do insects represent and match patterns?

It seems that they use retinotopic matching.

(Cartwright and Collett, 1983)
How do insects represent and match patterns?

Retinotopic matching in the desert ant
(Wehner et al, 1996)

Retinotopic matching in the waterstrider
(Junger, 1991)

My name is Gerris

Retinotopic matching in the waterstrider

Retinotopic matching in Drosophila
(Dill et al, Nature, 1993)
Retinotopic matching in Drosophila

Inference: Images are stored retinotopically
But,
What about an image is stored?
Is it an exact copy of the image?

No. Bees can learn to recognize shapes defined by any of a number of cues [Zhang et al., 1995]

What about an image is stored?

Is it just the local features in the image?

No. Bees can perform pattern discrimination on the basis of local or global characteristics. (Gould, 1985)
Local and global analysis by bees (Zhang et al., 1992)

Mobile robots based on insect navigation strategies
Max-Planck Institute for Psychological Research, Munich

Behavior that the robot seeks to replicate

Image processing in the Sahabot
Basic snapshot algorithm of the Sahabot

Showtime for Sahabot

Pattern recognition by Octopuses

A simulation of the snapshot algorithm

A sample Sahabot run
Is an octopus a CAT Scanner in reverse?

Can we use a tomographic representation for Real-world image-classification tasks?