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A mobile robot employing insect strategies for navigation

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Abstract

The ability to navigate in a complex environment is crucial for both animals and robots. Many animals use a combination of different strategies to return to significant locations in their environment. For example, the desert ant *Cataglyphis* is able to explore its desert habitat for hundreds of meters while foraging and return back to its nest precisely and on a straight line. The three main strategies that *Cataglyphis* is using to accomplish this task are *path integration*, *visual piloting* and *systematic search*. In this study, we use a synthetic methodology to gain additional insights into the navigation behavior of *Cataglyphis*. Inspired by the insect's navigation system we have developed mechanisms for path integration and visual piloting that were successfully employed on the mobile robot *Sahabot 2*. On the one hand, the results obtained from these experiments provide support for the underlying biological models. On the other hand, by taking the parsimonious navigation strategies of insects as a guideline, computationally cheap navigation methods for mobile robots are derived from the insights gained in the

experiments.



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Keywords

Insect navigation; Robot navigation; Polarization vision; Path integration; Visual landmark navigation

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Dimitrios Lambrinos received a B.S. and M.S. in Mathematics from the University of Ioannina, Greece, and an M.S. degree in Computer Science from the University of Sheffield. He received his Ph.D. with distinction in Natural Sciences at the AI Lab of the University of Zurich where he is also a Research Associate. His research interests include

University of Zurich where he is also a Research Associate. His research interests include robot navigation, visually guided behavior and learning. He is currently studying biological models for insect navigation by using robots.



Ralf MÃ¶ller studied Electrical Engineering and Computer Science and gained his Ph.D. in Engineering from the Technical University of Ilmenau, Germany, in 1996. He is currently a Postdoctoral Researcher at the AI Lab, Department of Computer Science, and at the Department of Zoology, University of Zurich. His research interests include visual robot navigation, biomimetic robots, neuromorphic systems, neuroinformatics, and parallel computation.



Thomas Labhart is a Lecturer at the Institute of Zoology of the University of Zurich. He has gained his Ph.D. in the Natural Sciences from the University of Zurich with a behavioral study on bee vision. During his two postdoctoral years at different universities in the USA, including CalTech and Yale he studied the electrophysiology of arthropod visual systems. Working on the electrophysiological, histological and synthetic level his present research focuses on the neural mechanisms underlying the polarized-light compass of insects.





Rolf Pfeifer received his degree in Physics and Mathematics from the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. After a number of years in the computer industry as a systems engineer, he worked at the Psychology Department of the University of Zurich in the area of simulation of cognitive processes. After his Ph.D. in Computer Science (ETH) he spent three years in the USA as a postdoc at Carnegie-Mellon University and Yale University in the areas of artificial intelligence and cognitive science. Since 1987 he has been a Professor of Computer Science at the University of Zurich. In 1990/91 he held the SWIFT AI Chair at the Free University of Brussels. He is Head of the Artificial Intelligence Laboratory at the Computer Science Department of the University of Zurich which has a strong focus on interdisciplinary research projects.



Rüdiger Wehner is Professor of Neurobiology and Behavior and Head of the Institute of Zoology of the University of Zurich, Switzerland. He obtained his Ph.D. at the University of Frankfurt, Germany, and did his postdoctoral research at both the University of Zurich and Yale University. He was A.D. White Professor at Cornell University, A. Forbes Professor at MBL, Woods Hole, Massachusetts, and received several named lectureships in the United States and Great Britain. He is permanent fellow of the Institute for Advanced Study in Berlin and foreign member of the American Philosophical Society. His research focuses on the neurobiology of insect navigation, especially on navigation in Saharan desert ants, *Cataglyphis*.

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