Scent of Science

Model Creation for Odour Following Control of Robotic Vehicles

Executive Summary

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Date: July 27, 2012

ACT research category: Artificial Intelligence / Planetary Science / Biomimetics

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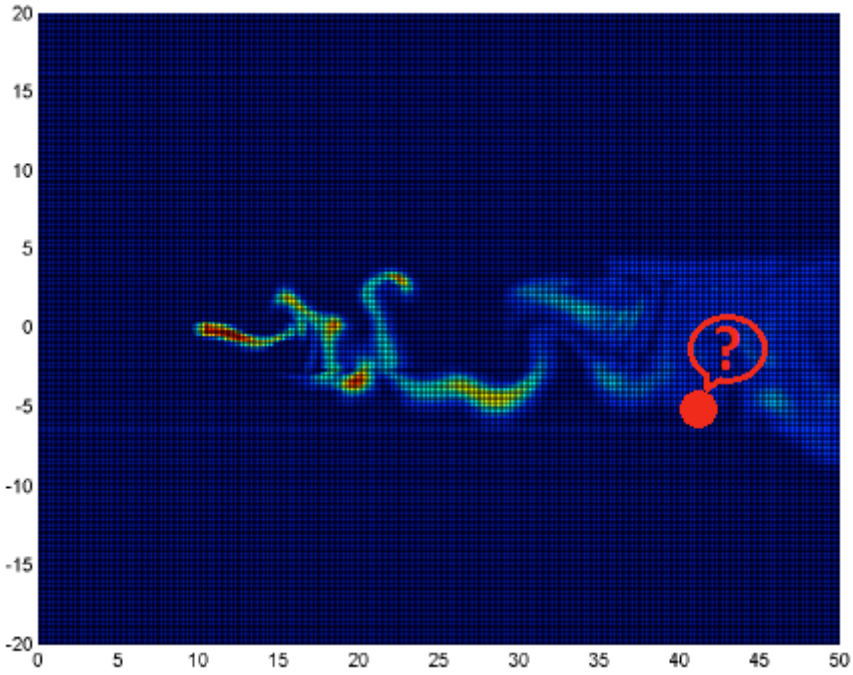
Ariadna ID: 11-6301
Ariadna study type: Standard
Contract Number: 4000104575/11/NL/KML



Motivation:
The motivation of this study was to increase the scientific return on planetary exploration missions by automating the localization of areas of high scientific interest. In particular, the autonomous search strategies are inspired by those of small animals when following odour plumes.

Methodology:
The project started with the investigation of two relevant scenarios: (1) a lander that has to localize the origin of Enceladus' icy jets, and (2) a robot that has to find methane sources on Mars. For both scenarios, a physical model was designed and implemented.

Enceladus' icy jets:
A 3D model of the laminar plume caused by Enceladus` icy jets was created. The icy jet model was compared to previous models, which were less detailed than the model created for this project. It was found that on the short time scale at which a possible lander operates, the icy jets are almost static, allowing for rather straightforward control techniques. Therefore, the remainder of the project focused on the Mars methane scenario.

Mars methane:
Turbulent odour plumes are representative of the environments in which methane would likely be found on Mars. Turbulent plumes can be defined as odor pulses separated by gaps of lower concentration or 'clean air', where the odor gradient does not necessarily point towards the source of the odor. A model representative of a turbulent environment was created and compared with experimental measurements of a turbulent odor plume found in the literature. After completion of the model, three control schemes were analysed

for conceptual design: neural control, Kalman filtering, and source likelihood mapping.

Results:

- A 3D model of Enceladus' icy jets and plume region was created and analysed
- A 2D odour plume model representative of the plumes expected on Mars was created and analysed
- Various control methods for a Martian rover seeking methane sources were explored for conceptual design, including neural networks, Kalman filters, and source likelihood maps.

Related publications:

- "A Martian Methane Plume Modeling Scheme for Developing Robotic Search Algorithms", Christopher Nicol, Brian Lynch, Guido de Croon; Alex Ellery; Ed Cloutis (under review)
- "Evolutionary robotics approach to Odor Source Localization", by G.C.H.E. de Croon, L.M. O'Connor, C. Nicol, D. Izzo, *Neurocomputing*, Volume 121, December 2013, Pages 481–497.