Hamiltonian Clsutering of Lidar Readings

PI: Alessandro Astolfi, Imperial College

Researchers: M. Sassano

Status Quo

The problem under investigation is the detection of aerosol clouds from Lidar (Light Detection And Ranging) readings. These include information on azimuth, elevation, wind direction and speed, pressure, temperature together with fluorescence and backscattering values.

The project aims at developing a real-time algorithm to detect, track and predict the evolution of aerosol clouds.

Desired features include obtaining a visual representation of the cluster, i.e. boundary detection, and a quantitative description of the cloud. The latter allows to define the meaning of time-evolution of the cloud in terms of spatial displacement and shape modification, differently from existing algorithms.

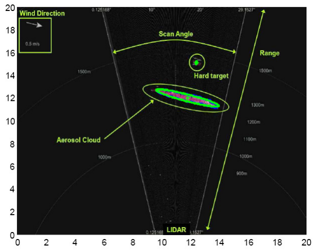
Technical Work

The algorithm is based on the notions of level function, level set and Hamiltonian system.
The key aspect consists in associating to each cloud a Gaussian function which describes its spatial distribution; the boundaries of the clusters are obtained as solutions to Hamiltonian dynamical systems derived from the corresponding Gaussian function. Geometric moments of arbitrary order are computed simultaneously. These allow to obtain a set of parameters that univocally describe the shape and extension of the cloud.

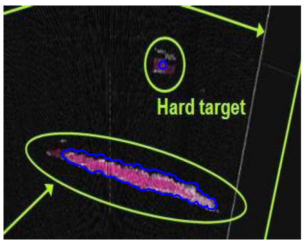
In its present form the Hamiltonian-based algorithm is implemented off-line on previously collected data. The data may consist of images, videos or .bin files.

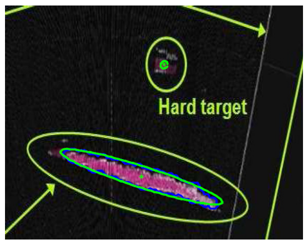
Quantitative Impact

Example of Lidar readings (image);



The boundary of the cluster (blue line) is obtained by integration of a Hamiltonian system.





The green line represents the minimal enclosing ellispoid univocally determined from geometric moments of order zero, one and two. The information reduction process allows to store data associated with each single detected cloud.

Exploitation & military relevance

- Real-time detection, qualitative/quantitative description and tracking of aerosol or potentially toxic clouds.
- Prediction of future-time evolution of toxic clouds in terms of spatial displacement and change in shape (increase/decrease of the area, .

MINISTRY OF DEFENCE

EPSRC
Engineering and Physical Sciences
Research Council

This work was supported by the Engineering and Physical Sciences Research Council (EPSRC) and the MOD University Defence Research Centre on Signal Processing (UDRC).