Mapping Using a mobile Sensor Network through Kriging

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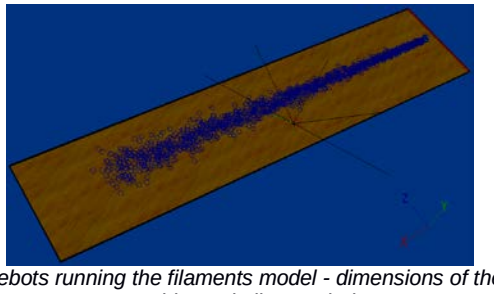
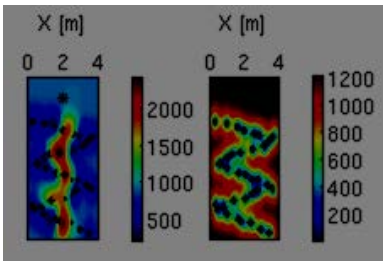
To address the problem of mapping a stationary plume of a compound within a fluid in a two dimensional field, Ordinary Kriging was used after sampling plumes generated in three degrees of reality: first a modelized plume generated from advective-diffusive equations solved at steady state; second a more realistic model called filaments implemented in Webots; third a plume made of ethanol in air generated in wind speeds from 0.1m/s to 1m/s in a wind tunnel.



Webots running the filaments model - dimensions of the world are similar to wind

The impact of plume's shape was also tested in the wind tunnel by placing the source at two different locations on top of varying the wind speed.

A single mobile sensor was used to perform all samples, using Khepera III model in Webots' simulations and Khepera IV robot in wind tunnel's experimentations. Two main strategies were tested, namely uniform and zigzag sampling. It was found that sampling uniformly yields in highly redundant increments providing a poor variogram model while sampling in zigzag allows a better efficiency in terms of spatial structure recognition and sample needs. It was also shown that a special care has to be taken when sampling by filtering through measurements repetition over a long enough period of time to counter variability encountered in noisy environments.



Kriging results obtained on samples taken in wind tunnel - absolute concentrations (right) and confidence interval (left)