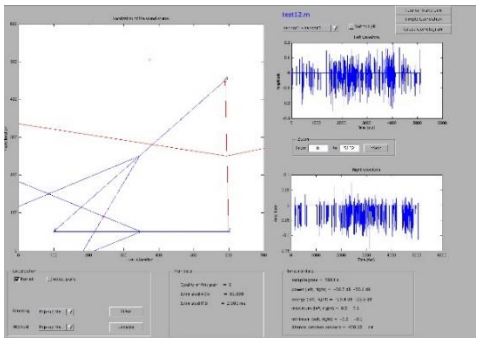
Developing a Probalistic Graphical Model for Fine Particle Estimation using OpenSense and Land-Use Data

Francesco Giardina, Camille Fallous

Professor : Alcherio Martinoli
Assistant(s) : Ali Marjovi

The problem of sound localization has been extensively studied from the beginning of the 20th century and different models have been formulated based on the results yielded by psycho-acoustical experiments. These processes have usually been implemented using hard-wired arrays of microphones but rarely using mobile devices. However, the recent advances in pervasive computing reduced drastically the size of mobile computing devices, and we emphasize the use of sensor nodes. These tiny computers endowed with sensing capabilities are intended to be deployed over large geographical areas and last for months without any external supervision. For this purpose I designed a framework for implementing a sound localization algorithm relying on the data gathered from the sensor network and then locates the sound source using a Matlab package running on a computer physically connected to the network.



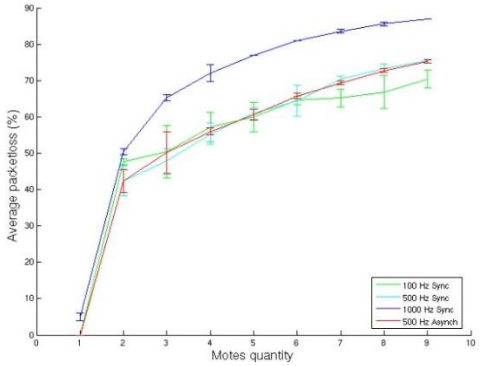
Main interface of the Matlab package we created

Unfortunately these tiny embedded devices have very severe constraints in order to minimize the power constraints and thus maximizing their lifespan and autonomy. Therefore a lightweight but efficient operating system is needed to control these devices, and thus sensor nodes performance is much lower than traditional computers and PDAs. I briefly reviewed the most common methods for localization and discussed their implementation on such devices. Finally, the simplest one was chosen in order to fit the severe constraints imposed by the sensor network framework and achieve efficient power consumption.

The quality of the location estimates are heavily influenced by many factors such as environmental conditions, and the maximal accuracy we can ensure is directly proportional to sampling frequency. I showed that available sensor nodes are not yet efficient enough in order to perform robust sound localization. The two topmost severe limitations of SN are

1°) Communication channel throughput

2°) Low sampling frequency



Packet loss (%) in function of sensor quantity

I proposed hardware and software improvements that can lead to design a dedicated sensor board able to perform accurate localization and I also describe which parameters have to be taken into account for design of an energy-aware controller software. I propose enhancements at different hierarchical levels, and how these issue, when carefully used can improve the system lifetime in a significant manner.

Nonetheless, the sound localization toolbox I developed is a very modular tool and new features can be easily added, as for example signal filtering, more precise azimuth estimation methods and better graphical visualization tools.