SAHAR ASADI received her BSc and MSc degrees in Computer Science from University of Tehran, Iran, in 2006 and 2008, respectively. During 2009 to 2012, she was enrolled as a PhD student at the Centre for Applied Autonomous Sensor Systems (AASS) in Örebro University, Sweden. After the PhD studies, Sahar has been working as a research scientist and data scientist. Her research interests include machine learning, mobile robot olfaction, temporal and spatial sampling, and pollution monitoring.

This thesis addresses the problem of gas distribution modelling for gas monitoring and gas detection. The presented research is particularly focused on the methods that are suitable for uncontrolled environments where environmental conditions may be unknown or only sparse noisy local measurements are available. Example applications include air pollution monitoring, leakage detection, and search and rescue operations.

This thesis addresses how to efficiently obtain and compute predictive models that accurately represent spatio-temporal gas distribution. Most statistical gas distribution modelling methods assume that gas dispersion can be modelled as a time-constant random process. While this assumption may hold in some situations, it is necessary to model variations over time in order to enable applications of gas distribution modelling for a wider range of realistic scenarios. This thesis proposes two time-dependent gas distribution modelling methods by introducing: (1) a temporal sub-sampling strategy and (2) a recency weight that relates measurements to the prediction time.

For mobile robot olfaction, we are interested in sampling strategies that provide accurate gas distribution models given a small number of samples in a limited time span. This thesis proposes a novel adaptive sensor planning method. This method is based on a modified artificial potential field, which selects the next sampling location based on the currently predicted gas distribution and the spatial distribution of previously collected samples. In particular, three objectives are used that direct the sampling towards areas of (1) high predictive mean and (2) high predictive variance, while (3) maximising the coverage area. The relative weight of these objectives corresponds to a trade-off between exploration and exploitation in the sampling strategy.

This thesis discusses the potential of using gas distribution modelling and sensor planning in large-scale outdoor real-world applications.

Doctoral Dissertation

Towards Dense Air Quality Monitoring: Time-Dependent Statistical Gas Distribution Modelling and Sensor Planning

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Computer Science