Gas Source Location Classification in Built Environment with a Sensor Network

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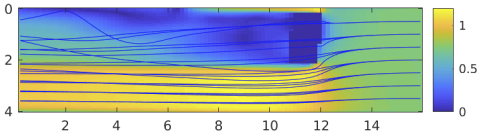
Gas Source Localization (GSL) refers to the process of determining the origin of a gas release within a given environment. It is a concept that plays a crucial role in ensuring environmental safety, industrial security, and effective emergency response strategies. As industries continue to expand, the potential for gas releases, whether accidental or intentional, demands accurate methods for swiftly identifying and locating their sources.

However, sometimes the hazardous nature of certain gas leaks poses significant risks to human safety, making it impractical for individuals to directly engage in locating these leaks. In such scenarios, the application of autonomous techniques, such as localization through stationary sensor networks or mobile robots, offers the advantage of exploring hazardous environments without endangering human lives.

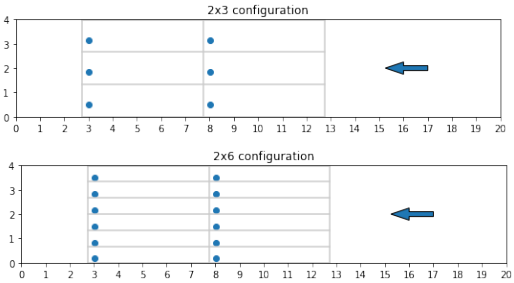


Example wind flow in built environment

In this project, GSL is approached as a classification challenge, with the goal of identifying the region of the gas source using stationary sensors.

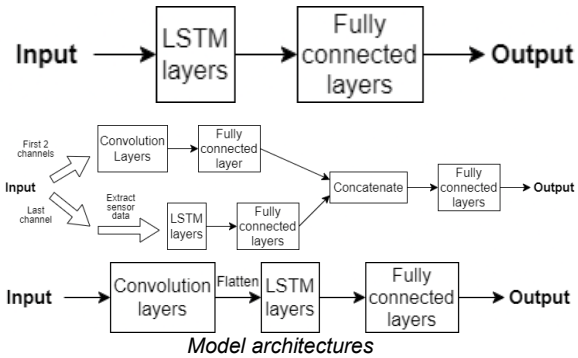
The challenge involves accurately classifying the source position into specific regions using sensor measurements and environmental information, with consideration for top-k accuracy. Factors like sensor quantity, distribution, region count, spatial division method, and k value are crucial variables affecting problem complexity. The experimental setup utilizes a virtual wind tunnel environment to simulate airflow patterns and controlled gas emissions, enabling sensor data collection through dispersion modeling.

What distinguishes the project's approach is its exploration of the fusion of Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) models. This combination leverages the spatial and temporal characteristics of the problem with the aim of accurately locating gas sources in various environments.



Sensor and region configuration used

The experimental journey involved the implementation of two hybrid architectures, combining Convolutional Neural Networks (CNN) and LSTM, evaluated against a standalone LSTM network.



Model architectures

While the outcomes may not have been groundbreaking, they establish a valuable foundation. We've developed infrastructure and software that can serve as a robust starting point for future experiments and enhancements. The intricacies of GSL should inspire further exploration and technique refinement as we strive for more effective and reliable solutions in the quest for safer and more secure environments.