Brain-inspired spiking neural network for gas-based navigation

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Introduction

Recent studies show that the structure of odour stimuli contains information about the olfactory scene [2, 3]. The circular and spiral-like movements caused by turbulence results in the formation of eddies. This causes the rise and fall of odour signals, where the increases are refered to as "bouts". We investigated how a filter bank of bout detectors can infer information about odour proximity and guide gas-based navigation in robotics.

Event-based Coding
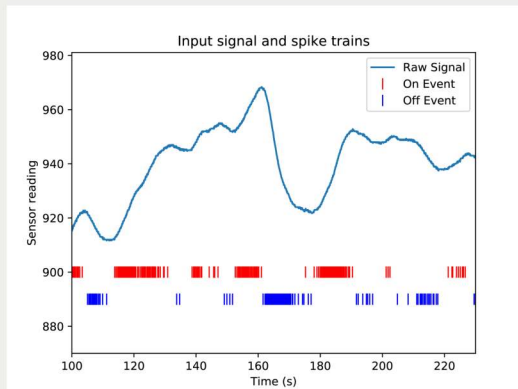
- ► The raw signal was recorded in a wind tunnel filled with evenly spaced gas sensors [4].
- ► We extracted the ON and OFF spikes from the signal during periods where it is constantly rising (ON) or falling (OFF).
- ► We define a set of adaptive amplitude thresholds for asynchronous population coding.
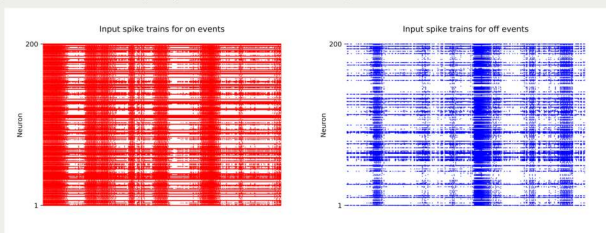

Figure: The raster plots show the input trains for 200 neurons when applying slightly different thresholds to the input signal. Left: the spike trains for ON events showing an overall increase in activity when the signal rises. Right: the OFF events showing an overall increase in activity when the signal falls.

Enose

- ► The enose prototype has four metal oxide gas (MOX) sensors
- ► They are mounted on an arduino where signals are read from the analog pins.
- ► The MOX sensors change resistance when binding with specific gases.
- ► This resistance change impacts the voltage read on the analog pins.
- ► The arduino then converts this analog signal into spikes and outputs events.
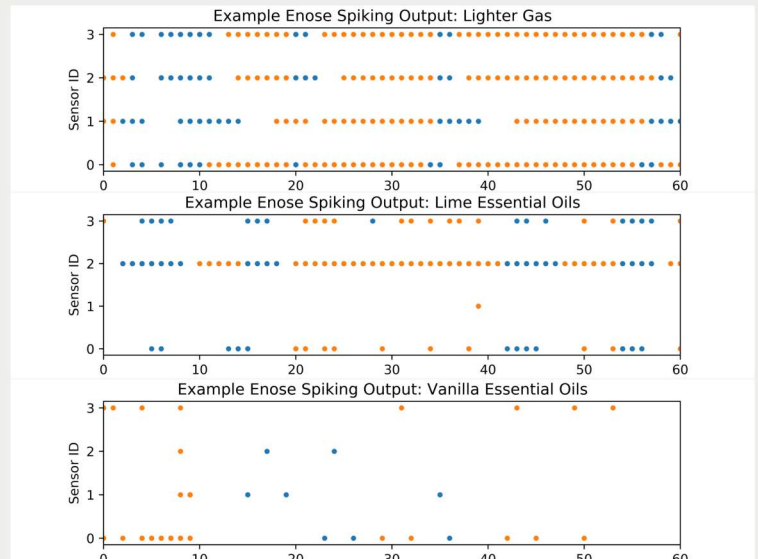
Enose Data

Figure: Examples of enose output using three different sources. The blue data points show ON events and the orange data points show OFF events. Upper panel: shows lighter gas causing the most activity for all four sensors. Center panel: shows the results from lime enssential oils, with little reaction from gas sensor 1. Bottom panel: shows the results from vanilla essential oils, demonstrating the least activity from all four sensors.

Conclusion

- ► The results demonstrate that the enose has the ability to diffentiate between different odours.
- ► The enose enables us to determine bouts of odours when using the same methods demonstrated in the event-based coding.
- ► With the ability to detect bouts, we can calculate bout intervals and therefore infer distance to the odour source [3].

Acknowledgements

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