Reinforcement Learning-based Active Odor Sensing System

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Odor mixture Quantification is challenging due to the instability of gas sensor arrays. Active sensing offers a promising solution by relying on the relative response difference instead of absolute response values. It iteratively adjusts the recipe of generated gas mixture to approximate the target response using feedback controller. Previous active sensing studies employed linear quadratic regulator (LQR), which struggles to handle the complex nonlinear transient responses of gas sensors. To address this issue, we propose a novel framework that integrates a pre-trained long short-term memory (LSTM) based neural network to construct a high-fidelity virtual environment and trains a soft actor-critic (SAC) network to learn the nonlinear control policy. Experimental results demonstrate that LSTM accurately models the transient responses of quartz crystal microbalance (QCM) gas sensors to time-varying gas mixtures. The trained SAC agent significantly outperforms LQR in both convergence speed and control accuracy in the simulation of binary gas mixture quantification.

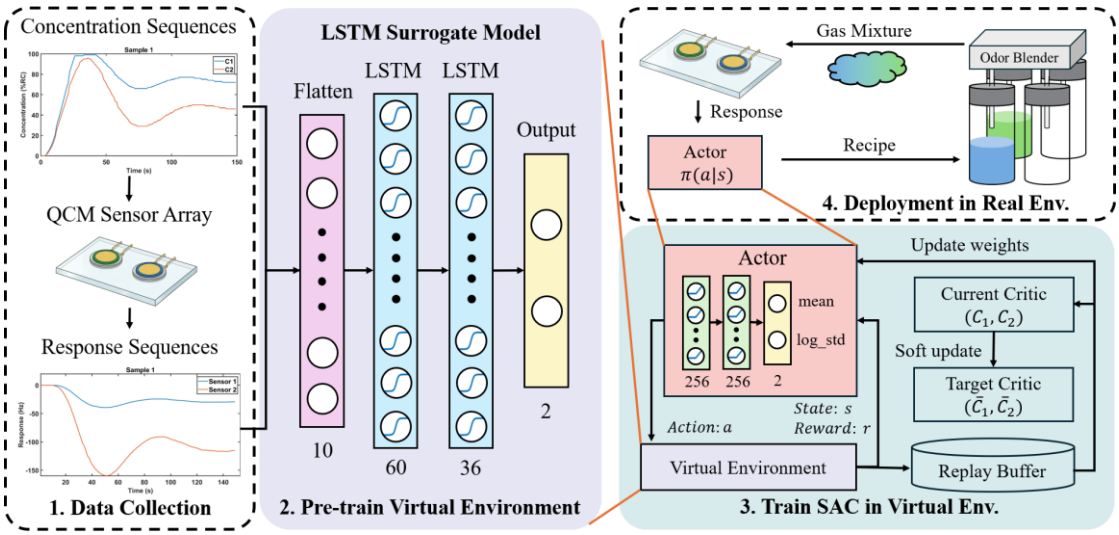

Figure 1. Two-Stage Pipeline Overview.

References

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