

# Inkjet Olfactory Display: From Psychophysical Validation to Portable FPGA Architecture

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Olfactory displays present controlled odour stimuli for multisensory human-computer interaction, yet achieving stable, precise fragrance ejection across a wide blending ratio remains challenging. We studied olfactory display pairing a piezoelectric inkjet head with an electroosmotic (EO) pump (miniaturised liquid pump) for voltage-controlled backpressure regulation. Droplet volume measurements confirmed frequency-independent ejection ( $\sim 200$  pL/drop) across 5–1000 Hz, yielding  $\sim 200$ -fold blending ratio dynamic range. A 3-AFC psychophysical evaluation using five odorants ( $\beta$ -pinene, limonene, cis-3-hexen-1-ol, menthone,  $\beta$ -ionone,  $n = 8$ ) established that inkjet-based ejection with EO backpressure control produces statistically distinguishable concentration differences. That capability will contribute to a simulator with scents.

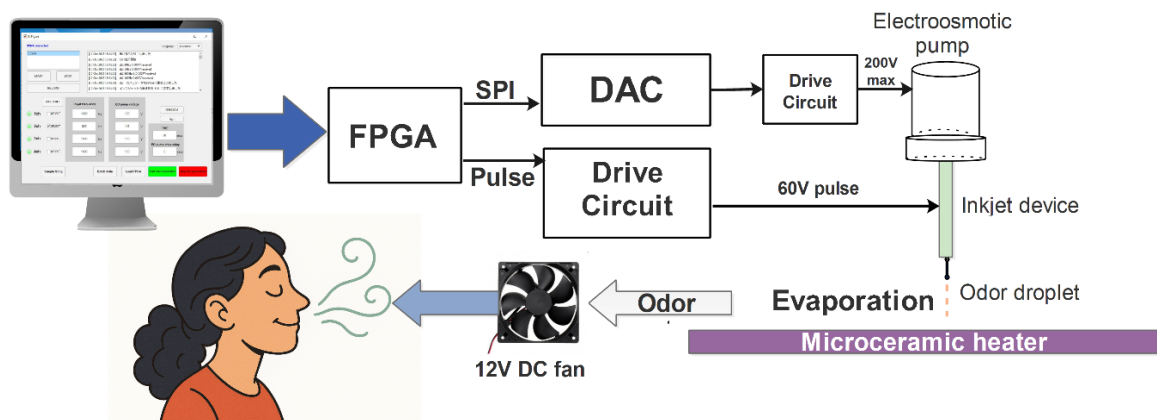


Fig. 1. System Architecture: Portable Inkjet Olfactory Display

Building on this validated platform, a portable two-channel wearable redesign in Fig. 1 is underway. A PC-based MATLAB GUI communicates with an FPGA via USB, which generates two independent control signals: an SPI stream to a DAC for EO pump voltage control (up to 200 V via a high-voltage drive circuit) and rectangular pulse outputs to a separate drive circuit producing 60 V pulses for the inkjet device. Odour droplets ejected by the inkjet head are vaporised on a micro-ceramic heater and delivered to the user via a 12 V DC fan.

## References

- [1] Debabhuti, N., Prasetyawan, D., Nakamoto, T.: Airflow Optimization for Olfactory Display Using Inkjet Device. In: 2024 IEEE SENSORS. pp. 1–4. IEEE (2024).
- [2] Debabhuti, N., Prasetyawan, D., Nakamoto, T.: Droplet Formation Analysis for Multi-Component Olfactory Display Using Inkjet Devices. In: 2024 IEEE International Symposium on Olfaction and Electronic Nose (ISOEN). pp. 1–3. IEEE (2024).