

INTISARI

PENGEMBANGAN SISTEM *ELECTRONIC NOSE* BERBASIS *ARTIFICIAL NEURAL NETWORK* UNTUK KLASIFIKASI KOPI ASLI DAN KOPI INSTAN

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Kekeliruan dalam membedakan aroma kopi Arabika asli dan Arabika instan masih kerap terjadi, terutama saat penilaian bergantung pada persepsi manusia. Penelitian ini menjawab pertanyaan bagaimana merancang sistem *electronic nose* berbasis *Artificial Neural Network* yang mampu membedakan kedua aroma secara objektif, akurat, dan efisien secara komputasi guna menekan potensi salah identifikasi.

Metode yang diusulkan memanfaatkan larik sensor gas dengan pola akuisisi *inhale-exhale*. Sinyal diproses berurutan dengan *low-pass* Butterworth orde-2 dengan $f_c = 1$ Hz, normalisasi per kanal pada domain waktu, lalu ekstraksi lima fitur statistik, yaitu minimum, maximum, *mean*, skewness, dan kurtosis. Fitur kemudian distandardisasi dan data dipisah secara stratifikasi 70% latih dan 30% uji. Tujuh variasi masukan dibandingkan, diikuti uji seleksi sensor pada tiga kandidat teratas. Model final menggunakan input *all-5* tanpa seleksi sensor, dengan MLP dua *hidden layer* (64, 16) dan koefisien regularisasi $L2 = 1e-3$.

Hasil menunjukkan $F1 = 86,0\%$, akurasi = $84,3\%$, presisi = $78,1\%$, dan *recall* = $96,1\%$ pada set uji. Latensi inferensi $< 0,1$ ms/sampel, ekstraksi fitur $\pm 1,4-1,6$ ms per siklus, dan model *size* $< 0,12$ MB, menegaskan kelayakan *deployment* sistem di *edge device*. Penelitian ini juga menunjukkan bahwa kualitas representasi masukan lebih menentukan dibanding menambah kompleksitas arsitektur dan seleksi sensor agresif tidak konsisten memberi keuntungan pada data ini.

Kata Kunci: *Electronic Nose, ANN, Pra-pemrosesan Sinyal, Ekstraksi Fitur, Klasifikasi Kopi*

ABSTRACT

**DEVELOPMENT OF AN ARTIFICIAL NEURAL NETWORK-BASED
ELECTRONIC NOSE SYSTEM FOR CLASSIFICATION OF
REAL AND INSTANT COFFEE**

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Human perception often misidentifies the aromas of real Arabica and instant Arabica coffee. This study explains how to design an electronic nose with an Artificial Neural Network that discriminates the two aromas objectively, accurately, and with low computational cost to reduce misclassification in practice.

This study employs a gas-sensor array with an inhale-exhale protocol. The signal pipeline started with second-order Butterworth low-pass 1Hz, per-channel time-domain normalization, and five statistical features, which are minimum, maximum, mean, skewness, and kurtosis. Features are standardized and data are split 70% train and 30% test with stratification. Seven input variants are compared, followed by sensor-selection tests on the top 3 candidates. The final model uses all-5 without sensor-selection with an MLP of two hidden layers (64, 16) and L2 regularization = $1e-3$.

On the test set, the model achieves $F1 = 86,0\%$, accuracy = $84,3\%$, precision = $78,1\%$, and recall = $96,1\%$. Inference latency is < 0.1 ms per sample, feature extraction takes $\approx 1.4-1.6$ ms per cycle, and the model size is < 0.12 MB, indicating edge-device feasibility. This study also shows that input representation quality matters more than increasing architectural complexity and aggressive sensor selection does not consistently help on this dataset.

Keywords: *Electronic Nose, ANN, Signal Preprocessing, Feature Extraction, Coffee Classification*