INTISARI

PENERAPAN FEATURE EXTRACTION BERBASIS WINDOW DAN SIMULATED ANNEALING UNTUK MENINGKATKAN KINERJA ELECTRONIC NOSE DALAM MENGKLASIFIKASI JENIS MADU

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Madu merupakan cairan manis alami yang diproduksi oleh lebah madu dari sari bunga tanaman. Autentikasi sumber nektar pada madu merupakan hal penting baik bagi industri maupun konsumen untuk menghindari kasus kesalahan pelabelan jenis madu. Pada penelitian ini, *electronic nose* (*e-nose*) yang terdiri dari 10 sensor *metal oxide semiconductor* (MOS) dan satu sensor suhu-kelembaban digunakan untuk mengelompokkan madu monoflora (kopi, kelengkeng, kapuk randu). Sinyal *e-nose* kemudian dianalisis dengan melakukan *feature extraction* (FE) berbasis *window* (1 hingga 4 *window*). Kemampuan *e-nose* dalam membedakan jenis madu ditentukan dengan menerapkan beberapa teknik pengenalan pola seperti *principal component analysis* (PCA), *linear discriminant analysis* (LDA), dan *support vector machine* (SVM). Nilai variansi kumulatif PCA untuk masing-masing *window* adalah 83,42%, 80,36%, 78,89%, dan 78,83%. Untuk model LDA dan SVM, data hasil FE dipilih secara acak sebanyak 80% untuk *training*, dan sisanya 20% untuk *testing* atau validasi eksternal. Selanjutnya, *simulated annealing* (SA) dan *K-fold cross validation* diterapkan untuk memilih kombinasi *feature* terbaik dan menghindari masalah *over-fitting* pada proses *training.* Hasil terbaik diperoleh pada model 4W-SA-SVM, yang mampu mengklasifikasi dengan benar data *training* sebesar 92,79% (akurasi rata-rata) dan data *testing* sebesar 99,83% (akurasi rata-rata). Hasil yang memuaskan ini menunjukkan bahwa *e-nose* yang disertai dengan teknik pengenalan pola yang tepat dapat digunakan sebagai instrumen yang berbiaya rendah, tidak merusak, dan mudah digunakan untuk mengklasifikasi jenis madu berdasarkan sumber nektarnya.

Kata kunci : *electronic nose*, madu monoflora, *feature extraction, support vector machine, simulated annealing*

ABSTRACT

IMPLEMENTATION OF WINDOW-BASED FEATURE EXTRACTION AND SIMULATED ANNEALING FOR ENHANCING ELECTRONIC NOSE PERFORMANCE IN CLASSIFICATION OF HONEY

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Honey is the natural sweet substance, produced by honeybees from the nectar of plants. Authentication of honey has essential significance for both businesses and customers in combating common honey fakes within the shape of mislabeling of nectar root. In this research, an electronic nose (e-nose) comprising ten metal oxide semiconductor (MOS) gas sensors and a moisture-temperature sensor, was used to classify the monofloral honey (coffee, longan, and kapok randu). The e-nose signals were pre-processed using window-based feature extraction (one to four windows). The capability for discriminating the type of monofloral honey was checked by applying several pattern recognition techniques, such as principal component analysis (PCA), linear discriminant analysis (LDA), and support vector machine (SVM). The cumulative variances of PCA for each window are 83.42%, 80.36%, 78.89%, and 78.83%. For LDA and SVM model, 80% of the data were randomly selected as training dataset and the rest 20% as testing or external-validation dataset. Furthermore, simulated annealing (SA) and K-fold cross-validation were implemented during the model training procedure to select the best combination features and to avoid over-fitting issues. The best performance was obtained from the 4W-SA-SVM model, which allowed 92.79% of correct classifications (overall accuracy) for the training dataset and 99.83 % of correct classifications (overall accuracy) for the external-validation dataset. The satisfactory results indicate that gas sensor device accompanied by appropriate pattern recognition techniques could be used as a promising low-cost, non-destructive, and easy-to-use for classifying honey according to their botanical origin.

Keywords: *electronic nose, monofloral honey, feature extraction, support vector machine, simulated annealing*