

INTISARI

TEKNIK KLASIFIKASI *SUPERVISED LEARNING* IKAN NILA MERAH (*Oreochromis niloticus*) BERFORMALIN BERBASIS INFORMASI WARNA DAN TEKSTUR CITRA

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Permasalahan terkait mutu dan keamanan pangan pada produk perikanan memiliki cakupan dan kompleksitas yang luas. Salah satu permasalahan aspek keamanan pangan tersebut adalah penggunaan *food additive* yang bersifat ilegal. Dari sejumlah penggunaan bahan aditif makanan yang sifatnya ilegal tersebut, formalin dilaporkan sebagai ancaman terhadap mutu ikan dan kesehatan konsumen. Deteksi keberadaan formalin pada ikan memerlukan keahlian khusus dan instrumen uji berbiaya tinggi. Penelitian ini bertujuan mengembangkan teknik non destruktif berbasis informasi warna dan tekstur citra dalam mengklasifikasikan ikan nila berformalin multikelas melalui penerapan teknik *supervised learning* untuk mengurangi subjektivitas penilaian.

Sebagai tahap awal klasifikasi ikan berformalin *supervised learning*, ikan nila (*Oreochromis niloticus*) mendapat perlakuan perendaman selama 1 jam dalam larutan formalin 3 tingkat konsentrasi yaitu 0.5% (v/v), 1%, dan 2%(v/v) dan perlakuan tanpa formalin sebagai kontrol dengan ulangan masing-masing perlakuan sebanyak 20 ikan. Perlakuan konsentrasi formalin dikodekan sebagai F00, F05, F11, dan F22, masing-masing untuk perlakuan 0%, 0,5%, 1%, dan 2%. Pada teknik klasifikasi *Supervised Learning* diperlukan serangkaian data latih untuk melatih data latih yang ada, selanjutnya akurasi pengklasifikasi dilatih menggunakan data uji. Set pelatihan mencakup ikan nila berlabel sesuai perlakuan formalin selama penyimpanan untuk melatih pengklasifikasi agar dapat membedakan kelas sejumlah sampel uji. Proses akuisisi citra ikan dilakukan menggunakan kotak pencahayaan berbasis *webcam*. Akuisisi citra dilanjutkan dengan tahap ekstraksi fitur dimulai dengan pelabelan citra keseluruhan tubuh ikan berdasarkan 7 wilayah *Region of Interest* (ROI) meliputi Mata, Insang, Sisik Atas, dan Sisik Bawah. Pada tahap ekstraksi fitur dihasilkan fitur warna yang diukur pada 3 ruang warna R, G, dan B masing-masing berjumlah 9 fitur yaitu 5 fitur warna (*min, max, sum, mean, standar deviasi*) dan fitur tekstur berjumlah 4 terdiri dari *angular second moment, contrast, correlation*, dan *homogeneity*. Total

data hasil ekstraksi fitur sebanyak 189 fitur. Untuk meningkatkan kecepatan proses klasifikasi dilakukan teknik pengurangan jumlah fitur pada data mentah dengan seleksi fitur dan reduksi dimensi. Seleksi fitur dilakukan berdasarkan metode *wrapper* dan filter, sementara reduksi dimensi berdasarkan analisis diskriminan linier. Untuk menguji validasi dan akurasi sistem klasifikasi, data dibagi menjadi 70% data latih dan 30% data uji. Data mentah (189 fitur), data hasil reduksi dimensi (42 fitur dan 26 fitur), dan data hasil seleksi fitur berbasis LDA (3 fitur) digunakan pada proses klasifikasi menggunakan pengklasifikasi *Quadratic Discriminant Analysis* (QDA), *Support Vector Machine* (SVM), *Multi Layer Perceptron* (MLP), *k-Nearest Neighbour* (k-NN).

Perbandingan kinerja 4 pengklasifikasi menggunakan data uji 189 fitur, 42 fitur, 26 fitur, dan 3 fitur menunjukkan perbedaan capaian akurasi dan waktu komputasi dalam proses klasifikasi. Pada data uji 3 fitur dan pengklasifikasi SVM kernel polinomial dicapai akurasi 78,65% dengan waktu komputasi uji model 7,62 detik. Untuk pengklasifikasi kNN dicapai akurasi 80,21% dengan waktu komputasi uji model 5,46 detik pada data hasil reduksi fitur dengan LDA. Untuk pengklasifikasi MLP dengan data uji 189 fitur dicapai akurasi 81,77% dengan waktu komputasi uji model selama 525,06 detik. Sementara untuk pengklasifikasi QDA mencapai akurasi 83,85% pada data uji 42 fitur dengan waktu komputasi uji model selama 1,81 detik. Hasil uji kuantitatif menunjukkan setelah 8 hari penyimpanan kadar formalin terdeteksi pada F00, F05, F11, dan F22 masing-masing sebesar 3,13 mg/kg, 7,19 mg/kg, 16,47 mg/kg, dan 36,09 mg/kg.

Kata kunci: Analisis Citra; Formalin; Nila Merah; Klasifikasi; *Supervised Learning*

ABSTRACT

SUPERVISED LEARNING CLASSIFICATION TECHNIQUE OF FORMALIN TREATED RED TILAPIA (*Oreochromis niloticus*) BASED ON INFORMATION OF IMAGE COLOR AND TEXTURE

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Food quality and safety on fisheries product require concern related to its vast coverage and complexity problems. Formalin application illegally has become major issues for many years. Formalin has been investigated and reported as a threat to the fish quality and consumer health. Some formalin detection methods developed have its limitations like a high-cost testing instrument, destructed samples, longer preparation time, and require a skilled and trained operator to operate such an instrument. In this research was developed a nondestructive and noncontact technique based on image texture and color attributes to classify multi-class red tilapia exposed by formalin combined with *Supervised Learning* technique application to minimize error caused by subjectivity in the manual evaluation.

Sample preparation procedure started with red tilapia dipped in 4 level concentration of formalin solutions stated in % v/v, arranged in ascending order, 0,5%; 1%, 2% for the 1-hour duration. As control treatment was used iced water with temperature range $4\pm 1^{\circ}\text{C}$. Each treatment used 20 red tilapias as repetitions of the sample. Formalin concentration treatment coded as F00, F05, F11, F22, each code indicated concentration level 0%, 0,5%, 1%, and 2%, respectively. *Supervised Learning* relies on training data to train classification model that followed by testing classification model that uses some test dataset that separated from training data. Training dataset in this research consists of red tilapia that labeled based on formalin concentrations to train and test classification model so it could categorize sample based on its class. Image acquisition process was executed in the lighting chamber installed with a *webcam* that followed by feature extraction on 7 Regions of Interest (ROI) include eye, gill, dorsal scale, and ventral scale. Features extraction conducted in RGB color space produced five intensity features (*min, max, sum, mean, standard deviation*) and four texture features (*angular second moment, contrast, correlation, and homogeneity*), with total features generated as many as 189. The speed of computation time of the

classification process was optimized by using some technique to reduce the number of original features based on feature selection and reduction method. Features selection chosen in this research based on Wrapper and Filter method, while Linear Discriminant Analysis was applied to reduce the original feature numbers. Validation and accuracy of the classification system were tested by supplied the model with randomized-split data divided into 70% training data and 30% testing data. Dataset consists of 189 features (raw data), 42 features (data produced from the Wrapper method), 26 features (data produced from Filtered method), and 3 features (Data from LDA transformation) were used in classification model generation by applying classifiers *Quadratic Discriminant Analysis* (QDA), *Support Vector Machine* (SVM), *Multi-Layer Perceptron* (MLP), *k-Nearest Neighbour* (k-NN).

Comparison of four classifiers used a test data consist of 189 features, 42 features, 26 features, and 3 features performed differences in term of accuracy value and computation time during the classification process. In a dataset with 3 features combined with SVM classifier kernel polynomial could reach an accuracy rate of 78,65% with computation time required for the testing model was 7,62 second. For k-NN classifier, using 3 features dataset could achieve accuracy 80,21% with computation time required was 5,46 second. MLP classifier applied to 189 features dataset could reach value for accuracy and computational time, 81,77% and 525,06, respectively. QDA classifier achieved the best result for 42 features dataset which reach accuracy as high as 83,85% with the computational time needed was 1,81 second. Spectrophotometer based quantitative test to detect formalin content after eight days of icy storage revealed that red tilapia treated with 0%, 0,5%, 1%, and 2% formalin achieved value 3,13 mg/kg, 7,19 mg/kg, 16,47 mg/kg, and 36,09 mg/kg, respectively.

Keywords: Image Analysis; Formalin; Red Tilapia; Classification; Supervised Learning