AI-DRIVEN PREDICTION OF WATER QUALITY TRENDS IN BIOFLOC AQUACULTURE SYSTEMS FOR SUSTAINABLE NILA (OREOCHROMIS SPP.) CULTIVATIONS

By

Cindy Hapsari, NIM 2215101032

Informatics Engineering Department

Computer Science Study Program

ABSTRACT

Water quality is a crucial factor in the success of biofloc-based tilapia cultivation, as fluctuations in parameters such as temperature, pH, and Total Dissolved Solids (TDS) can affect fish growth and survival rates. This study aims to develop a Long Short-Term Memory (LSTM)-based water quality prediction model by utilizing IoT sensor data collected over 90 days (4320 data points) and generating predictions for the next 3 days (144 time steps). Two modeling approaches were developed, namely the Alpha Model with a multivariate LSTM approach and the Beta Model with a univariate LSTM approach. The research process follows the CRISP-DM framework which includes business understanding, data preparation, modeling, and evaluation. Model evaluation was carried out using the Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and coefficient of determination (R^2) metrics. The test results show that the Beta Model has a more stable performance than the Alpha Model on the test data, especially in short-term multi-step predictions. The Water Quality Index (WQI) in this study is defined as the classification of water quality suitability based on optimal standards for tilapia life, namely pH 7.0–8.0, temperature 25–30°C, and TDS 310–440 ppm. The resulting predicted values are then categorized into Suitable, Alert, or Unsuitable conditions to support preventive decision making. Overall, this study shows that the LSTM approach can be used as a decision support system in monitoring the water quality of biofloc ponds, with the univariate model showing better performance stability in this research data configuration.

Keywords: Long Short-Term Memory (LSTM), Water Quality Prediction, Internet of Things (IoT), Time Series Forecasting

AI-DRIVEN PREDICTION OF WATER QUALITY TRENDS IN BIOFLOC AQUACULTURE SYSTEMS FOR SUSTAINABLE NILA (OREOCHROMIS SPP.) CULTIVATIONS

Oleh

Cindy Hapsari, NIM 2215101032

Jurusan Teknik Informatika

Program Studi Ilmu Komputer

ABSTRAK

Kualitas air merupakan faktor penting dalam keberhasilan budidaya nila berbasis biofloc, karena fluktuasi parameter seperti suhu, pH, dan Total Dissolved Solids (TDS) dapat memengaruhi pertumbuhan dan tingkat kelangsungan hidup ikan. Studi ini bertujuan untuk mengembangkan model prediksi kualitas air berbasis Long Short-Term Memory (LSTM) dengan memanfaatkan data sensor IoT yang dikumpulkan selama 90 hari (4320 titik data) dan menghasilkan prediksi untuk 3 hari berikutnya (144 langkah waktu). Dua pendekatan pemodelan dikembangkan, yaitu Model Alpha dengan pendekatan LSTM multivariat dan Model Beta dengan pendekatan LSTM univariat. Proses penelitian mengikuti kerangka kerja CRISP-DM yang meliputi pemahaman bisnis, persiapan data, pemodelan, dan evaluasi. Evaluasi model dilakukan menggunakan metrik Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), dan koefisien determinasi (R^2). Hasil pengujian menunjukkan bahwa Model Beta memiliki kinerja yang lebih stabil daripada Model Alpha pada data uji, terutama dalam prediksi multi-langkah jangka pendek. Indeks Kualitas Air (WQI) dalam penelitian ini didefinisikan sebagai klasifikasi kesesuaian kualitas air berdasarkan standar optimal untuk kehidupan ikan nila, yaitu pH 7,0–8,0, suhu 25–30°C, dan TDS 310–440 ppm. Nilai prediksi yang dihasilkan kemudian dikategorikan ke dalam kondisi Sesuai, Waspada, atau Tidak Sesuai untuk mendukung pengambilan keputusan preventif. Secara keseluruhan, penelitian ini menunjukkan bahwa pendekatan LSTM dapat digunakan sebagai sistem pendukung keputusan dalam memantau kualitas air kolam biofloc, dengan model univariat menunjukkan stabilitas kinerja yang lebih baik dalam konfigurasi data penelitian ini.

Keywords: Long Short-Term Memory (LSTM), Prediksi Kualitas Air, Internet of Things (IoT), Time Series Forecasting