



UNDERGRADUATE THESIS

VISUALIZATION OF MINUTE-LEVEL SOLAR RADIATION PREDICTION IN MEDAN CITY USING A CNN-GRU MODEL

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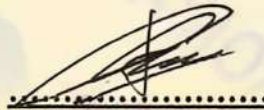
VISUALIZATION OF MINUTE-LEVEL SOLAR RADIATION PREDICTION IN MEDAN CITY USING A CNN-GRU MODEL

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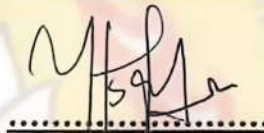
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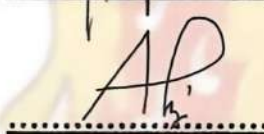
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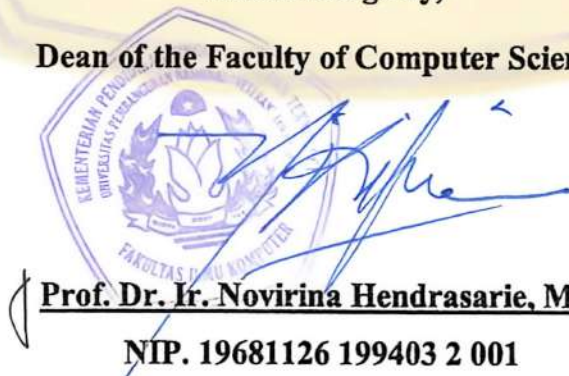
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ABSTRACT

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Thesis Title : Visualization of Minute-Level Solar Radiation
Prediction in Medan City Using a CNN-GRU
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This study develops a hybrid CNN-GRU model to predict per-minute solar radiation in Medan City to support the operational efficiency of Solar Power Plants (PLTS). The proposed model integrates three 1D CNN layers with 64, 32, and 16 filters to extract spatial features and two GRU layers with 50 and 32 units to capture long-term temporal dependencies in time-series data. The dataset consists of local meteorological data from Medan City with seven main features, processed through data filtering, missing value interpolation, smoothing, MinMaxScaler normalization, and sliding window sequencing. Systematic hyperparameter tuning identified the optimal configuration with a window size of 30, a learning rate of 0.001, a batch size of 512, and a data split ratio of 90% for training, 5% for validation, and 5% for testing. The final model achieved high prediction performance with an R^2 of 0.9923, an RMSE of 12.9430, an MAE of 6.3709, and a MAPE of 8.50%, demonstrating its effectiveness in accurately predicting minute-level solar radiation. The prediction results were further visualized through an interactive web-based system using Folium and TimestampedGeoJson, providing a spatio-temporal digital map of Medan City with per-minute animation, color gradients representing solar radiation intensity, and daily and monthly prediction dashboards.

Keywords: Solar Radiation, CNN-GRU, Deep Learning, Spatio-Temporal Visualization, Medan City, Solar Energy

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The author realizes that this thesis still has limitations and welcomes constructive criticism and suggestions for improvement. The author hopes this thesis will provide useful insights and serve as a reference for future research.

Surabaya, July 06, 2026

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