

CHAPTER VI

CONCLUSION

This chapter presents the essence of the results of research that has been carried out regarding the visualization of solar radiation prediction in Medan City using the CNN-GRU hybrid model. Based on the entire series of processes ranging from data acquisition, preprocessing, model training, to testing evaluation metrics that have been discussed in the previous chapter, conclusions are drawn as an answer to the formulation of the problem set. In addition, this chapter also contains strategic suggestions aimed at the development of further research to improve the quality and coverage of solar radiation prediction systems in the future.

5.1 Conclusion

Based on the results of research, testing, and analysis that has been carried out regarding the prediction of solar radiation in Medan City using the CNN-GRU hybrid model, the following conclusions can be drawn:

1. The application of the CNN-GRU hybrid algorithm is carried out through the integration of two main processing stages, namely the use of 3 layers of CNN with a configuration of units [64, 32, 16] as a feature spatial extractor, and a GRU layer (with an optimal configuration of 2 layers with a capacity of [50, 32] units) to capture long-term temporal dependence. The hyperparameter tuning process systematically succeeded in establishing the optimal configuration with a historical memory range (window size) of 30, a learning rate value of 0.001 to maintain convergence stability, a batch size of 512 to reduce gradient noise, and a data sharing ratio of 90% trained: 5% validation: 5% test which is proven to provide the most powerful model generalization ability against data fluctuations.
2. The CNN-GRU hybrid model has been proven to have a very high level of accuracy in predicting solar radiation in Medan City, while showing very significant performance advantages when compared to single CNN and single GRU architectures. The synergy between spatial feature filtering and time sequence processing is shown by the results of the final model evaluation which recorded a determination coefficient value (R^2) of 0.9923, which means that the model is able to explain 99.23% of the actual data variability. The level of prediction accuracy is also strengthened by the acquisition of very minimal error values, namely RMSE of 12.9430, MAPE of 8.50%, and MAE of

6.3709, proving that the hybrid approach makes the model much more stable and responsive in mapping changes in light intensity compared to a single model that is susceptible to spatial and temporal noise distortion.

3. The results of solar radiation prediction were successfully visualized spatially-temporally through an interactive website using the Folium and TimestampedGeoJson libraries. The visualization is implemented in the form of a digital map of the city of Medan which is equipped with per-minute animation features and color gradations to represent the intensity of solar radiation intuitively. The website system includes full functionality from a security login page, a dataset management panel for administrators, to daily and monthly prediction dashboards for general users.

5.2 Development Suggestions

Based on the results of the research that has been conducted, there are several suggestions that can be given for the development of further research, namely:

1. Researchers are further advised to explore the use of more complex Attention mechanisms or transformer architectures to improve the model's ability to capture long-term relationships on broader time series data.
2. The development of a website visualization system can be improved by adding a Real-time Data Acquisition feature that is connected directly through field sensors or weather APIs, so that the process of predicting and spatial-temporal visualization can run automatically without the need for manual dataset uploads by administrators.