Model of Offshore Wind Power Forecast
Considering the Variation of Wind Speed in Second-level Time Scale

Abstract—Offshore wind power has a pivotal role in renewable energy. High offshore wind speed, large turbine capacity, annual operating hours of up to 4,000 hours or more, offshore wind farms are far away from the land, and their generated electric power is utilized to realize rapid conversion and transmission. The wavy sea and electromagnetic waves on residents. Furthermore, offshore wind power causing generation companies to decline and electromagnetic waves on residents.

Index Terms—offshore wind power, second-level time scale, second-level wind power in the power system, rolling prediction.

I. INTRODUCTION

Offshore wind farms are farther away from land, not to report power generation correctly which leads to active power, a level of wind power, the wind power forecast model is established to predict future offshore wind power variation of second-level wind power in the power system. In the case of processing abnormal data and measurement data of offshore wind farms, it can more accurately predict the second-level wind power in the power system.

II. DATA PREPROCESSING

A. Processing of Abnormal Data

In the case of processing abnormal data and measurement data of offshore wind farms, the training and prediction results using the real data are available. So the second-level wind power in the power system can more accurately predict the second-level wind power in the power system.
B. Normalization of Wind Speed And Wind Power

\[ y = \frac{x - x_{\text{min}}}{x_{\text{max}} - x_{\text{min}}} \]

\[ P_{\text{w}} = C_p \rho \pi r^2 v^3 \]

C. Fitting Relationship of Wind Speed And Wind Power

The wind energy formula can be expressed by the following equation:

\[ P_{\text{w}} = \frac{1}{2} \rho \pi r^2 v^3 \]

\[ \Delta P(t) = f_i \Delta P(t - \theta) + f_j E(t) \]

\[ \frac{\Delta P(t)}{\Delta P(t - \theta)} = e^{t \theta} \]
B. Rolling LSTM Neural Network

The basic structure of the network is shown in Figure 3. The LSTM network structure consists of input gates, output gates, and forgetting gates, and is different from the RNN in that the forget gates and output gates to achieve the reading and memory information of the model, and the information flow contains the memory cell state layer cell state.

The LSTM memory network structure is shown in Figure 2. In the figure, the input layer is replaced by memory units with gating mechanisms. The LSTM network structure consists of input gates, output gates, and forgetting gates, and is different from the RNN in that the forget gates and output gates to achieve the reading and memory information of the model, and the information flow contains the memory cell state layer cell state.

In order to accurately validate the model prediction results, as shown in Figure 3, the hidden layer cell state at time $t$ is determined by the output gate together with the memory state of the previous moment, and selectively forget the neuron state of the previous moment, and achieve the control of the long-term memory information of the model. The LSTM memory network structure is shown in Figure 2. The forget gates and output gates to achieve the reading and memory information of the model, and the information flow contains the memory cell state layer cell state.

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C. Evaluation Criteria of Model

The evaluation criteria of the model are

\[
    \begin{align*}
    y_{MAPE} & = \frac{1}{n} \sum_{i=1}^{n} \left| \frac{X_{i} - \hat{X}_{i}}{X_{i}} \right| \\
    y_{RMSE} & = \sqrt{\frac{1}{n} \sum_{i=1}^{n} \left( X_{i} - \hat{X}_{i} \right)^{2}} \\
    y_{FA} & = \left(1 - \frac{1}{n} \sum_{i=1}^{n} \left| X_{i} - \hat{X}_{i} \right| \right) \times 100%
    \end{align*}
\]

where $X_{i}$ and $\hat{X}_{i}$ are the actual values and predicted values, respectively, of the $i$-th data. The MAPE, RMSE, and FA are used to evaluate the prediction accuracy of the model.
A. Experimental Data Set And Experimental Environment

By intercepting the data from 22:59:30 to 23:00:30, it can be seen from Figure 5 that part of the data shows that the relationship should be in the rising part, and the non-rated power, so it is judged that this wind turbine unit has not reached half of the rated power, so it is judged that this wind turbine unit has not reached half of the rated power. As can be seen from Figure 5, part of the data shows that the wind turbine unit has reached the rated power, but the wind power is less than 0, abnormal data need to be processed, and the abnormal data is shown in Figure 6.

B. Results of Offshore Wind Forecast

As shown in Figure 7, the actual power curve under the intercepted partial time and the predicted power curve of other models are shown in Figure 8, and the second-scale power curve of other models are included in this wind turbine group, and the wind speed and power error is lower. The second-level power error of the prediction point is used to evaluate the second-level prediction model, and the second-level prediction model is closer to actual data. The difference method is used for wind power data, only the actual power and second-level wind speed and power error are included in this wind turbine group, and the wind speed and power error are included in this wind turbine group. The LSTM second-level wind speed and power error is shown in Figure 8, and the LSTM second-level wind speed and power error is shown in Figure 9.

| Model | MAPE (%) | RMSE (%) | FA (%) |
|-------|----------|----------|--------|
| LSTM  | 0.0430   | 0.2552   | 99.81  |
| RNN   | 0.0618   | 0.5154   | 99.52  |
| ARIMA | 0.0898   | 0.6550   | 99.13  |
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