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光伏发电短期功率预测模型与电站监控系统设计

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摘 要:

关键词: ; ;

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The Short-term Prediction Model of Photovoltaic Grid Power Generation and the Design for Monitoring System of a Power Station

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Abstract: At present, there is a large fluctuation and randomicity in output power of the large-scale photovoltaic (pv) grid power generation system. To accurately predict the output power in order to solve problems of peak regulation and schedule in photovoltaic grid, this paper set up a low cost small meteorological station real-time monitoring the environment parameters such as radiation intensity, temperature, humidity, wind direction, wind speed etc. and a monitoring system to monitor the operation condition of the photovoltaic power station and gather the data of meteorology to apply to the identification of the meteorological conditions and the prediction model of a short-term power in the photovoltaic power generation system of wavelet neural network so as to realize the accurate prediction for an output power in the large-scale photovoltaic (pv) grid power system and it could have an important significance to generate and apply in a large-scale photovoltaic (pv) grid power generation system.

Keywords: Photovoltaic power generation system; power prediction model; photovoltaic power station monitoring system

[1-3] Ryukyus

Oldenburg

[4,5]

1 预测模型研究与监控系统实现

1.1 基于小波神经网络的预测模型研究

[6,7] BP

15 min

5 d 4 d 5:30 18:00 $M_i(t\text{-}1)$

$M_i(t\text{-}2)$ $M_i(t\text{-}3)$ $M_i(t\text{-}4)$ 1

$M_i(t\text{-}1)$ $M_i(t\text{-}2)$ $M_i(t\text{-}3)$ $M_i(t\text{-}4)$ $M_i(t)$

ω_{ij} ω_{ik} $h(j)$

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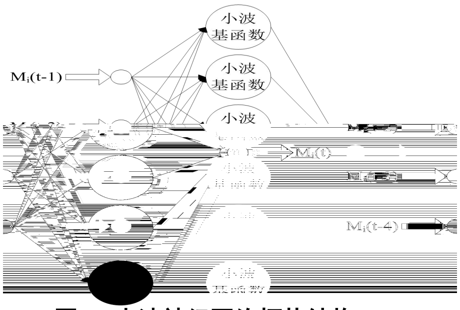

图 1 小波神经网络拓扑结构
Fig.1 Topological structure of wavelet neural network

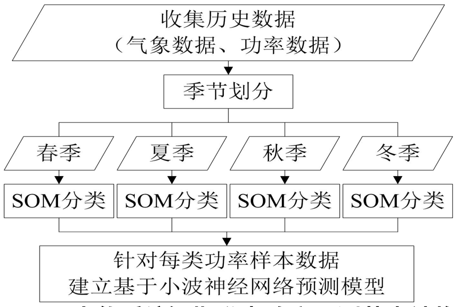

图 2 光伏系统短期发电功率预测基本结构
Fig.2 The basic architecture of short-term power prediction for the photovoltaic system

j $y(k)$ k b_j h_j a_j h_j h_j Morlet X_i j k 1 2

$$h(j)=h_j\left(\frac{\sum_{i=1}^{k}\omega_{ij}x_i-b_j}{a_j}\right) \quad 1 \qquad y(k)=\sum_{j=1}^{6}\omega_{jk}h(j) \quad 2$$

1.2 气象条件聚类识别的预测模型

SOM

2

1.3 小型气象站设计

SM3560M SHT11 JL-FX2 JL-FS2 56F8013 DSP 4~20 mA 0~3.3 V DSP ADC A/D DSP ADC ADC

3 4 5

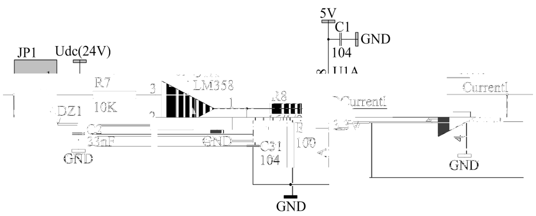

图 3 辐照强度信号调理电路
Fig.3 The regulation circuit of the irradiation intensity signal

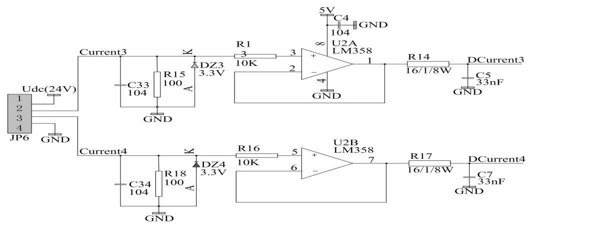

图 4 风向传感器信号调理电路
Fig.4 The regulation circuit of the wind direction sensor signal

6

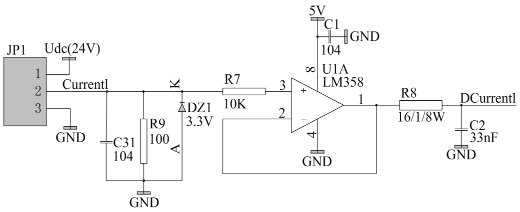

图 5 温湿度传感器信号调理电路

Fig.5 The regulation circuit of the temperature and humidity sensor signal

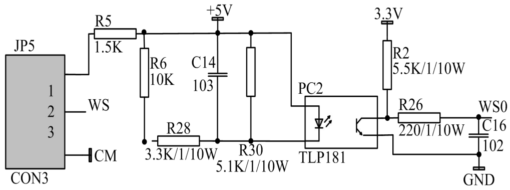

图 6 风速传感器信号调理电路

Fig.6 The regulation circuit of the wind speed sensor signal

100 m/μs DSP 1 s

Labview SQL Server

1.4 光伏电站监控系统设计

B/S

TCP/IP

2 结果与分析

2.1 小波神经网络预测模型与 BP 神经网络预测模型对比实验

4 d

BP

7 1

7

BP

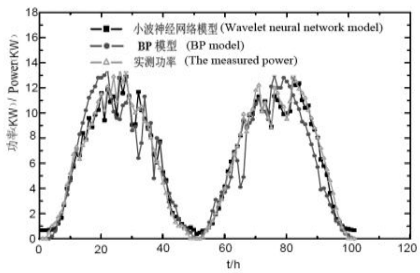

图 7 预测结果对比

Fig.7 Comparsion between prediction results

BP

表 1 预测结果评估表

Table 1 Evaluation on the prediction results

NO.	Absolute error percentage BP BP model	Absolute error percentage Wavelet neural network	Root-mean-square error BP BP model	Root-mean-square error Wavelet neural network
1	16.64	9.57	18.55	11.92
2	17.09	9.86	0.87	12.16
3	16.22	8.58	18.37	11.63
4	23.78	9.61	27.82	11.97
5	18.45	9.43	21.41	11.93

1 BP 4 d

BP 9.01%

BP 9.49%

2.2 气象条件聚类识别的小波神经网络模型与其它模型的对比实验

m

$x(m\times 5)$

A1
BP A2 B1 BP
B2
8 A2 B2

9 B2
B1 B2
BP

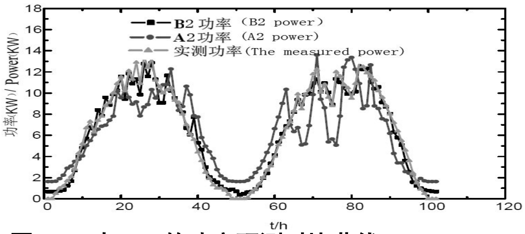

图 8 B2 与 A2 的功率预测对比曲线
Fig.8 Contrsative curves of the prediction for A2, B2 powers

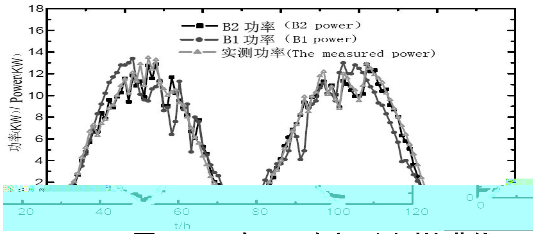

图 9 B2 与 B1 功率预测对比曲线
Fig.9 Contrastive curves of the prediction for B2, B1 powers

2 A1 A2 B1 B2
B2 A2 B1 A1 B2 A2 B1 A1
B1 A1 5.75% 7.74% B2
A2 2.18% 2.16%
A2 A1 9.01%
9.49% B2 B1 5.44%
3.91%

表 2 预测结果评估表
Table 2 Evaluation on the prediction results

Item	Absolute error percentage				Root-mean-square error			
	A1	A2	B1	B2	A1	A2	B1	B2
1	16.66	9.60	12.73	7.14	18.53	11.92	13.94	9.78
2	17.07	9.88	12.81	7.59	20.87	12.14	13.02	9.82
3	16.22	8.60	12.55	6.97	18.35	11.62	13.81	9.66
4	23.78	9.61	12.62	7.24	27.80	11.97	13.88	9.75
Average	18.43	9.42	12.68	7.24	21.40	11.91	13.66	9.75

2.3 小型气象站的测试实验

DSP DSP

3

表 3 小型气象站实验结果
Table 3 Experimental results in small meteorological stations

Parameters	m/s Wind speed	° Wind direction	Lux Irradiation intensity	Temperature	%RH Humidity
	0~60	0~360	0~200000	-20~80	0~100%
	0.1	1.0	1	0.5	1.0
	±3%	±6	±7%	±0.3	±4.5%

2.4 光伏电站监控系统功能实验

Excel

Excel 4

表 4 历史数据查询报表

Table 4 The historical data query statements

ID Unit ID	Receiving time	Dc voltage	Dc current	Daily output	Total output	Grid equency
40877	13:43:24	658	690	267160	46505680	50.0
40866	13:43:02	642	72	266480	46505000	50.0
40970	13:42:28	648	71	266240	46504720	50.0

3 讨 论

[8]

4 结 论

4.1 光伏发电短期功率预测模型研究

4.2 小型气象站与电站监控系统的设计

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