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Ship Power Station Monitoring System and Method Based on CAN Bus

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Abstract*:* This paper designs a ship monitoring system and method based on CAN bus. The ship monitoring system based on CAN bus includes: current detection module, voltage detection module, temperature detection module, short circuit detection module, main control module and communication module. , management module, data storage module, display module. The communication protocol based on the CAN bus intelligent control instrument through the communication module is simple, formatted, comprehensive, and can be used as a broadcast or multicast address together with the filter, which is very useful for improving the flexibility of communication; The module improves the utilization rate of the unit, saves energy, improves the safe operation capability, reduces the running cost, has wide utility, and has strong market value.

Keywords CAN bus, ship power station, monitoring

FOREWORD

A ship power station is a device that converts mechanical energy into electrical energy and monitors, controls, measures, distributes and protects it. It consists of ship power, ship power network, power distribution system equipment and power system protection equipment. [Liu, 2018] According to the power supply, it can be divided into main power supply (main generator set), emergency power supply (emergency generator set, battery pack, weak current power supply), auxiliary power supply (auxiliary generator set) and shore power box. The distribution network can be divided into main grid, emergency grid, lighting grid and weak grid. [Zhao, 2018] Power distribution and protection equipment include main power distribution screen, emergency power distribution screen, generator protection equipment and power grid protection equipment. [Fan, *et. al.*, 2018] However, the control instrument in the existing ship power station monitoring system has complex communication and poor flexibility. [Guo, 2018] At the same time, the ship power station unit has low utilization rate, energy consumption and low safety. [Li, 2018] The sensitivity of the prior art current detector is low, and the accuracy of the detected data is poor; the data information such as the detected current, voltage, temperature, and short-circuit state cannot be quantized and stored, and the anti-interference ability of the data information is poor, and noise-free accumulation cannot be performed. It is not conducive to the storage, processing and exchange of information; in the prior art, the display capability of the detection information is poor, which is not conducive to the reading of the data, and the control of the detection data is not timely, resulting in low work efficiency. Aiming at the problems existing in the prior art, this paper designs a ship power station monitoring system and method based on CAN bus, which can improve unit utilization rate, reduce operating cost and improve safe running capacity.

OVERALL STRUCTURE DESIGN OF SHIP POWER STATION MONITORING SYSTEM BASED ON CAN BUS

The block diagram of the ship power station monitoring system based on CAN bus is shown in Figure 1. The main control module is connected with the current detecting module, the voltage detecting module, the temperature detecting module, the short circuit detecting module, the communication module, the management module, the data storage module and the display module, and is used for controlling the normal operation of each module by the single chip microcomputer. [He, 2017] The detection module is used for detecting data information such as current, voltage, temperature and short circuit state of the ship power station; the communication module is used for realizing communication between the control instruments of the ship power station through the improved CAN protocol; and the management module is used for managing equipment optimization of the ship power station unit The data storage module is configured to store the detected current, voltage, temperature, and short-circuit status data information through the memory; and the display module is configured to display the detected current, voltage, temperature, and short-circuit status data information through the display.

Management module

The management module includes a queue management module, a parallel module, an online ten thousand module and an interface module; a queue management module is used for queue processing and management of each program module, and provides power information to the lower layer device, and the lower layer device uses power information for distribution management. ; parallel car module, used for sequential start of the unit, automatic parallel, load distribution; online ten thousand time module, used to manage the weight and demand of each queue, adjust the generator queue; interface module, for external third-party equipment After the third-party device is connected to the ship power station management system, it is abstracted as a virtual device and added to the device management.

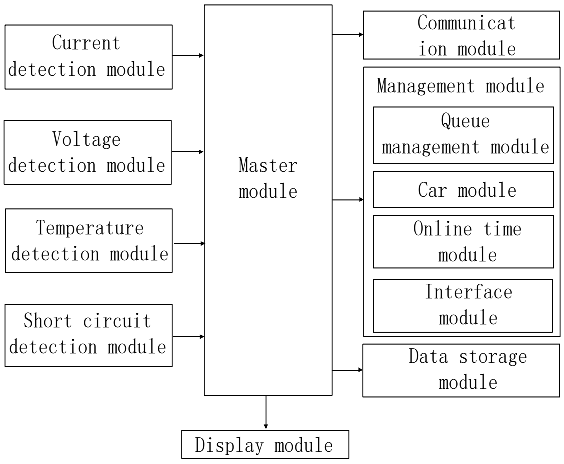

Figure 1 Block diagram of ship power station monitoring system based on CAN bus

Current detection module

The current detection module uses the current detector to detect the current data of the ship power station, selects the linear kernel function to solve the electricity price sensitivity coefficient, establishes the electricity price sensitivity analysis model based on the linear support vector machine, improves the sensitivity of the current detector, and improves the detection data. The accuracy. The specific algorithm is as follows:

$$z = f_t(x, C_t, \varepsilon_t) = \sum_{i=1}^{d}(\alpha_{it} - \alpha_{it}^*)K_t(x_i, x) + b_t \quad (1)$$

Where: K_t is the kernel function that satisfies the Mecrer condition; ε_t Cost function; C_t is the adjustment parameter of the current model of the electricity price of the current detector in the t-transaction period; α_{it}, α_{it}^* Lagrange multiplier.

The electricity price mathematical model is composed of a kernel function K_t, Cost function ε_t and adjustment parameter C_t decision; The current detector is linear; In the formula α_{it}, α_{it}^* Solve by:

$$\max_{\alpha_{it},\alpha_{it}^*} \sum_{i=1}^{d}(\alpha_{it}^* - \alpha_{it})z_i - \varepsilon_t\sum_{i=1}^{d}(\alpha_{it}^* + \alpha_{it})z_i - \frac{1}{2}\sum_{i=1}^{d}\sum_{l=1}^{d}(\alpha_{it}^* - \alpha_{it})(\alpha_{lt}^* - \alpha_{lt})K_t(x_i, x_l) \quad (2)$$

The constraints are:

$$0 \le \alpha_{\mathrm{it}},\ \alpha_{\mathrm{it}}^* \le C_{\mathrm{t}},\ \mathrm{i} = 1, \ldots, d \qquad \sum_{i=1}^{d}(\alpha_{it} - \alpha_{\mathrm{it}}^*) = 0 \quad (3)$$

Satisfy $\alpha_{it}, \alpha_{it}^* \ge 0$, The sample X_i of the detection data of the current detector is a support vector;

$$\mathrm{f}_{\mathrm{t}}(x, C_t, \varepsilon_t) = \sum_{i=1}^{d}(\alpha_{it} - \alpha_{it}^*)(x_i^T x) + b_t = \sum_{i=1}^{d}(\alpha_{it} - \alpha_{it}^*)(x_{i1}x_1 + x_{i2}x_2 + \ldots + x_{in}x_n) + b_t = \sum_{i=1}^{d}\sum_{j=1}^{n}(\alpha_{it} - \alpha_{it}^*)x_{ij}x_j + b_t \quad (4)$$

Calculate the partial derivatives of the above formula for X_k (k=1, 2, ..., n), and for any factor affecting electricity price X_k:

$$\frac{\partial \mathrm{f}_t(x, C_t, \varepsilon_t)}{\partial x_k} = \frac{\partial}{\partial x_k}\left[\sum_{i=1}^{d}\sum_{j=1}^{n}(\alpha_{it} - \alpha_{it}^*)x_{ij}x_j + b_t\right] = \sum_{i=1}^{d}(\alpha_{it} - \alpha_{it}^*)x_k \quad (5)$$

So far, the Lagrange multiplier solved by the quadratic optimization problem of the formula is substituted, and the electricity price sensitivity analysis model is established as follows:

$$\Delta z = \left[\sum_{i=1}^{d}(\alpha_{it} - \alpha_{it}^*)x_{i1}\right]\Delta x_1 + \left[\sum_{i=1}^{d}(\alpha_{it} - \alpha_{it}^*)x_{i2}\right]\Delta x_2 + \ldots + \left[\sum_{i=1}^{d}(\alpha_{it} - \alpha_{it}^*)x_{in}\right]\Delta x_n = \sum_{j=1}^{n}\left[\sum_{i=1}^{d}(\alpha_{it} - \alpha_{it}^*)x_{ij}\right]\Delta x_j \quad (6)$$

Data storage module

The memory of the data storage module quantizes the detected current, voltage, temperature, and short-circuit state data information, and adopts the following model:

$$x_{(t)} = p_{(t)}e^{jp(t)} = p_{(t)}\exp\left[j2\pi f_0 t\right] \quad (7)$$

In the formula, $f_0 = f_s + f_d$, f_d is the Doppler frequency;

Store the detected current, voltage, temperature, and short-circuit status data information signals $x_{(t)}$ to apply phase quantization processing. In the kth channel, increase the phase delay $k\frac{2\pi}{N}$, and then pass through the limiter, using mathematical expressions:

$$y(z_k)\begin{cases}1, z_k \rangle \cos\dfrac{\pi}{N} \\ 0, \quad 其他\end{cases} \tag{8}$$

Where φ (t) is the quantized phase, N=2M is the quantization level, M is the quantized number of detected current, voltage, temperature, and short-circuit state data information; the quantization system consists of N independent channels, numbered k , k =0 to N-1;

The output of the limiter is multiplied by a complex sequence $\exp\left[jk\dfrac{2\pi}{N}\right]$, and then all channels are added to obtain a quantized signal.

Display module

The display module displays the detected current, voltage, temperature, and short-circuit status data information, and uses the RFID technology to drive the information displayed by the display circuit to display the internal data on the screen, which has m pieces of information to be identified, using the L-tree, when searching for depth When 1, the recognition probability of the tag is:

P(1)=[1-L-1]m -1 (9)

In the batch display process of the information displayed on the display, UHF radio frequency identification technology is used to obtain the average search depth of the data:

$$E_{(k)} = \sum_{k=0}^{\infty}\left[1 - P(1)\right]^{k} = \frac{1}{1-\left[1-P(1)\right]} = \frac{1}{P(1)} = \frac{1}{(1-\frac{1}{L})^{m-1}} \tag{10}$$

The average number of time slots displayed by all displays is:

$$T_{1-ary} = E(k)L = \frac{L}{(1-\frac{1}{L})^{m-1}} \tag{11}$$

The empty Hash table data is sent to TABLE. Using the binary tree method, the number of hierarchical fusion slots of the information displayed by the display in batches is:

$$T_{2-ary} = E(k)L = \frac{2}{(1-\frac{1}{2})^{m-1}} \tag{12}$$

The RFID technology is used to drive the information circuit of the display to send the internal data. At this time, the display receives the data in the corresponding order, and the hierarchical fusion result of the information displayed by the display is:

$$T_{4-ary} = E(k)L = \frac{4}{(1-\frac{1}{4})^{m-1}} \tag{13}$$

Through the above processing, the display information of the first output is retained, and the filtered data needs to maintain the original acquisition order.

COMMUNICATION MODULE COMMUNICATION METHOD OF SHIP POWER STATION MONITORING SYSTEM BASED ON CAN BUS

The CAN bus is controlled by the acceptance filter, and communication between the control instruments of the ship power station is realized by the improved CAN protocol; the improved CAN protocol is realized by redefining the identifier in the application layer protocol.

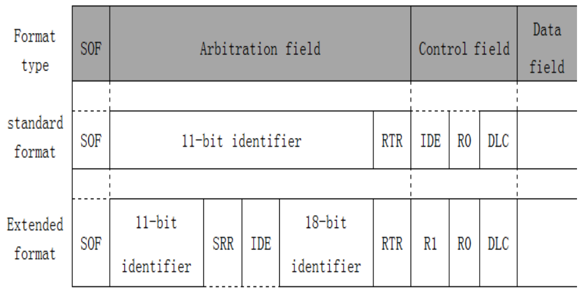

Figure 2 Standard format and extended format data frames

The CAN protocol is CAN2.0B. The application layer protocol of the protocol can adopt two different data frames: a standard frame and an extended frame, as shown in FIG. 2 . The arbitration field of the standard frame consists of an 11-bit identifier and an RTR bit. The arbitration field of the extended frame consists of a 29-bit identifier, an SRR bit, an IDE bit, and an RTR bit. The 29-bit identifier in the extended frame arbitration field is defined as a function in turn. Code, group number, destination address code, source address code, data nature, and multi-frame identification. The function code occupies 4 digits and is used to define the priority of transmitting different packets in the network. The group number is 4 digits, and there are 16 groups. One of them is used to indicate the global broadcast of the network, and 15 groups are available for use. The address code has a total of 8 bits, one of which represents multicast; the destination address code and the source address code are both 8 bits, and both correspond to the unique address of the smart meter. The nature of the data is 4 bits, which is used to define various required data. If the data is larger than 8 bytes, the data needs to be divided into multiple frames; the multi-frame identifier is 1 bit, which is used to identify whether the transmitted data is multi-frame data or single. Frame data, which is convenient for multi-frame transmission of data larger than 8 bytes.

CONCLUSION

The CAN bus-based ship power station monitoring system and method designed by this paper uses the current detector to detect the current data of the ship power station, selects the linear kernel function to solve the electricity price sensitivity coefficient, and establishes the electricity price sensitivity analysis model based on the linear support vector machine. The sensitivity of the current detector improves the accuracy of the detected data; quantifies and stores the data information such as the detected current, voltage, temperature, and short-circuit status, improves the anti- interference ability and noise-free accumulation ability of the data information, and is convenient for storage, processing, and Exchange; using RFID technology to drive the information display circuit of the display to display the internal data on the screen, improve the display capability of the detection information, facilitate the reading of data, facilitate the mastery of the detection data, and improve work efficiency .

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