

The Design and Implementation of Solar System's Network

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Abstract. In order to monitor the running status of the PV system at any time, to view the data or the gain, to track the historical data, It's meaningful to develop a data service system from the terminal to the client. The paper analyzes the feasibility of the whole system, and studies the technical problems and difficulties encountered in the process of transmission, storage and display from the terminal to the user's browser. The requirements of different technologies are realized according to the characteristics of each part. Implement the entire system architecture finally.

Introduction

In a photovoltaic system, the solar panel is responsible for converting the light energy into DC power that varies with the sunlight, while the inverter is responsible for converting the DC power into AC power to provide the user with loads such as televisions, refrigerators and so on. In addition, the battery is often used as an energy storage mechanism. The excess energy stored in the battery in the form of chemical energy in day, and the inverter converts the energy into alternating current to achieve continuous power supply at night.

The inverter is the key of the whole system, which status of working is be concerned by the users. With different installation locations, not all users have the conditions to view these working conditions at any time, therefore, it is necessary to provide a system that can view the work by PC or smartphone.

System Structure Analysis

The inverter's working data will be collected by the built-in or external communication module, and then be transported to the network server via network. The server receives and stores the data, and provide accessible WebServices service. Distribute a website and a smartphone software to access the server to obtain data that can met the requirements of the entire system.

The Structure of this system is shown in Figure 1.

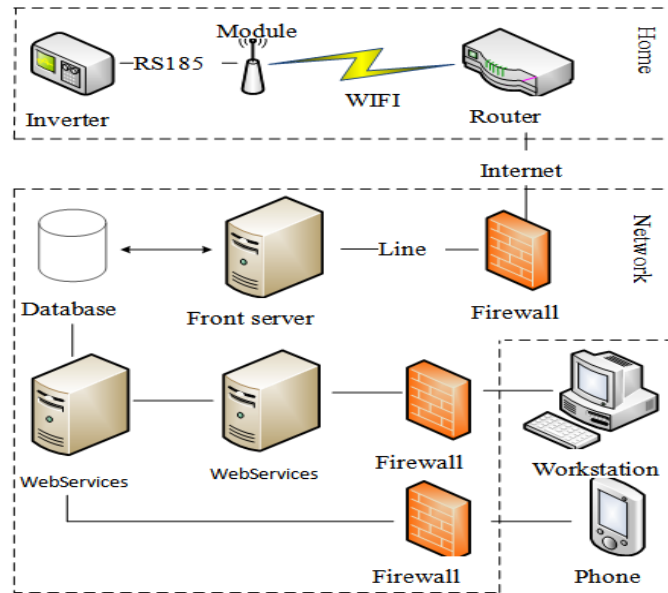


Fig. 1 System Structure

The Main Part of the Analysis and Implementation

The following will analysis the various parts of the system, as well as the implementation process encountered difficulties and technical solutions.

Communication Module

The communication module is connected to the inverter by the local connection, as well as is linked to the router. Therefore, it needs two different communication interfaces to realize the data collection and transmission.

To avoid interference signal when communicating to the inverter, choose RS485 as the communication bus which has a good anti-interference performance and can be connected to multiple devices, saving the resources and costs.

In order to protect the communication chips and reduce common mode interference, it is necessary to use optocoupler between communication module and inverter. But that ordinary optocoupler in the communication will produce waveform distortion found by testing . When the speed more than 9600bps error will occurs and the communication speed cannot be improved . So a optocoupler typed H11L2 is used as the communicate interface. The speed is very fast, it can easily reach 1MHz because of a Schmitt trigger in it, Met the requirements of data collection speed.

To simplify the communication complexity with the inverter, select Modbus as communication protocol between the communication module and the inverter, to read data or write operating parameters.

The use of Wifi signal transmission to the router, which not only reduces the trouble of wiring, but also can reduce the product failure rate with the built-in antenna .

Choose an ordinary Wifi chip as a module device on the market . Manage data transmission tasks by processor in the embedded system. The system is designed that it will not only served as a client to connect the user's wireless router but also will served as a server that can be connected with computer or mobile phone for users to set communication parameters. The communication parameters such as the module's communication address, the server's domain name (or IP) and port number are important. These are the basis of the communication process used to identify the various devices.

Considering the communication module and server identify, so the top layer communication protocol can choose a custom protocol for communication. At the same time in order to ensure security and encrypted transmission. The bottom layer uses the TCP protocol as the transport protocol.

Network Transmission

In the process of sending data from the communication modules to the front of the server, involving the client router, network service providers of various network equipment, computer room router or gateway, finally to reach the server.

In this transmission process, the communication modules need to set the server domain name to IP address firstly, the establishment of the IP address of the server where the TCP connection. But usually the actual owner of the IP address is a router or hardware firewall, and the server is behind it, so it is not possible to directly establish a connection to the server.

This problem can be resolved by port mapping on a router or firewall.

Port mapping is the external network host IP address of a port mapping to a network within the network, to provide the appropriate services. When the user accesses the port of the IP, the server automatically maps the request to the machine on the corresponding local area network.

You also need to open the port on the server's software firewall so that the server can receive connections to this port.

After the completion of the hardware port mapping and software port open, the communication module will be able to successfully establish the connection to the front server, achieving communication transceiver.

Pre-server Receiving Software

By running the receiving software on the front-end server, it is used to receive the data of the terminal, decode it, and store it in the database.

Meanwhile maintaining the system connection, the connection status to judge. If there is no data for a long time, take the initiative to disconnect.

While providing the ability to determine the legitimacy of the connection: only the data conforms to the specified format, and the data is valid using the correct algorithm to transfer the data. Format does not match, the transmission frequency is abnormal (frequent), the connection is always no data, are considered illegal data or illegal connection. For illegal connections to refuse to connect and log in for a period of time, to prevent port detection or network attacks.

The front-end server also periodically retrieves the database's command table to allow the user to issue commands to the database, such as a shutdown command. If a command is detected, it is converted to communication data and sent to the terminal for execution. While the results of the feedback on the feedback.

Web Services Service

Using Microsoft Visual-Studio as a programming language, the use of ASP prepared WebServices services, the inherent logic of the use of WebServices services packaged services, reducing the site or mobile phone business logic, so that it can focus more on the performance of data rather than the inherent logic of the data.

Here are a few typical services for using WebServices:

Log on the service, register the user's authority, and provide the different data content according to the different authority of the user after the service.

Data services, data retrieval services, can retrieve the object, including equipment, time range, data category (voltage, current, power, electricity, etc.).

Parameter setting service that allows the user to submit new parameters, such as adding a new device, or modifying the parameters of an existing device.

Website and Mobile Phone Side

Web site using HTML5+CSS3 , through the embedded JQuery to enhance the user experience.

The smartphone side only considers the Android platform, limited to the display screen size, further simplifies the function, only provides the device data and status of the query, as well as key shutdown operations and a few control functions.

System security

Since the entire system is exposed to the public network during transmission, a higher requirement is made for system security. To this end, the following measures are deployed to enhance the security of the system:

- Authentication of the terminal device: At the time of terminal transmission, the terminal itself has authentication information with the authentication algorithm, and it will not be accepted if it does not meet the verification rules.
- There is encryption using a non-public algorithm, and data that does not conform to the encryption algorithm is not received.
- Each server uses a strict algorithm to encrypt configuration information, especially the login user name and password.
- Strict user password policy
- In the database, the user's password is encrypted and stored. All WebServices use strict algorithms to prevent SQL injection
- Dispose of IIS's site directory and create a software run log.
- responsible person, regular inspection
- Regularly fix vulnerabilities for the system, using the latest and reliable operating system.

System Reliability

Network services are usually run in the room under the conditions of unattended, and the number of connections and visits are relatively high, in order to enhance the reliability of the system, enhance the user experience, the implementation of the following measures to enhance:

- Set the send-echo mechanism. Each message needs to echo to the sender. No echo message need to resend, resend maybe cached, waiting for a period of time to resend again.
- Front software for strict preparation and testing, to avoid the existence of memory loopholes affect the system resources.
- Write a caregiver to detect if the FEP software is abnormal and restart it if there is an exception.
- Stress test on the website
- Choose a reliable host service provider and host product

Scalability

The front server, the database server, the WebServices server, and the web server can be split and assembled according to the performance, and the site can be a host as a server, and in the later stages, multiple hosts can be used to form a service network. Taking into account the economy and the final performance.

Test

The following tests, the system can run properly:

- disconnection test

The communication line of the terminal device is randomly disconnected for at least one minute, and the terminal device has no data during disconnection. After the re-connection, the data can be restored normally. This test proves that the embedded software can adapt to data line disconnection and data frame for the field and so on.

- broken network test

Disconnect the Wifi router or unplug the upstream cable for at least half an hour before turning it on. The system can retransmit all data during disconnection. It is proved that the system adapts to the disconnection condition.

But limited to storage capacity, broken network for more than 3 days the data will be overwritten storage.

- Server maintenance test

Turn off the server, or turn off the FEP software for at least half a day to run again, and the terminal can retransmit the data during maintenance to the server. Proving that the system is suitable for server maintenance work.

- Stress test

Use the OpenSta recording script to simulate at least 100 users logging in to the system at the same time, browsing different data for stress testing. The system does not have a delay of more than 3 seconds. Proved that the Web system services are relatively stable and reliable.

Conclusion

Since the deployment of the system in a year, the site's service has always been relatively stable, there is no serious crash and other serious problems, the front server is also stable operation, and in the log can be found in non-terminal network connection (send content For HTML data), but the ability to correctly handle these network connections (timely disconnection and refused to connect), the complex network environment has a certain resistance. Mobile phone side can also be stable and reliable service, the system's resource requirements are relatively low, you can run for a long time on the phone in the foreground or the background.

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