

Design of MPPT Controller Monitoring Software Based on QT Framework

X Z Meng¹ and P G Lu²

¹Qingdao University of Science & Technology, Qingdao, China

² Qingdao University of Science & Technology, Qingdao, China

Email: *942105626@qq.com

Abstract. The MPPT controller was a hardware device for tracking the maximum power point of solar photovoltaic array. Multiple controllers could be working as networking mode by specific communicating protocol. In this article, based on C++ GUI programming with Qt frame, we designed one sort of desktop application for monitoring and analyzing operational parameter of MPPT controller. The type of communicating protocol for building network was Modbus protocol which using Remote Terminal Unit mode and The desktop application of host computer was connected with all the controllers in the network through RS485 communication or ZigBee wireless communication. Using this application, user could monitor the parameter of controller wherever they were by internet.

1. Introduction

The output characteristics of photovoltaic array are a typical nonlinear model [1], and are easily disturbed by various conditions such as temperature, light intensity and variable Load. The MPPT controller can use properly algorithm to real-time adjust the working point of photovoltaic array (by adjusting output voltage), to make sure the working point is near at maximum power point. Therefore, it's necessary to monitor the real-time operational parameter of MPPT controller.

Qt developing frame is designed by C++ language which is supplied by third party. Using Qt developing frame to design Graphical User Interface is convenient and safe. Qt developing frame is supplying cross-platform [2] development. Now, the cross-platform feature of Qt supplies x86, SPARC, ARM and so on. It is also compatible with various kinds of operating system such as Windows, Mac OS X, Linux, Android, iOS and VxWorks, Embedded Linux. In this paper, we based on the Qt development library, developed a desktop application named Solar MPPT Controller Monitoring Software under the Windows system. The application contained serial read and write module, could parse and organized Modbus instruction, and the network function of the maximum power controller also could be implemented according to the master-slave communication mode in the Modbus protocol.

2. Monitoring System Structure

Every solar photovoltaic array would configure one MPPT controller, when all controller were allocated a unique address, they could work in a same network. The host computer monitoring software was connected with all the controllers in the network through RS485 communication or ZigBee wireless communication. Due to that the MPPT controller has



been embedded the Modbus communication protocol, Modbus specification pointed it out clearly that each slave device had a unique address. In this way, host computer monitoring software could use this address to distinguish each device.

In this system, the MPPT controller was used as the server and the desktop application played as client so it could access the server by polling mode. The working parameters of each controller will be processed, displayed and stored separately in desktop application. Besides, we design one kind of Network management model, This model is used to build and Manage the MPPT controller network, Desktop applications need to dynamically add or exit a controller in the network, and also need to determine whether the communication of controllers are in the regular state in order to change the network topology properly. In totally, the host computer and the MPPT controller constitute the entire monitoring system by Modbus protocol. This type of building MPPT controller system is flexible and stable, user can rebuild the system easily according to their specific purpose. Figure 1 shows the whole system structure including MPPT controller, solar photovoltaic array and monitoring software.

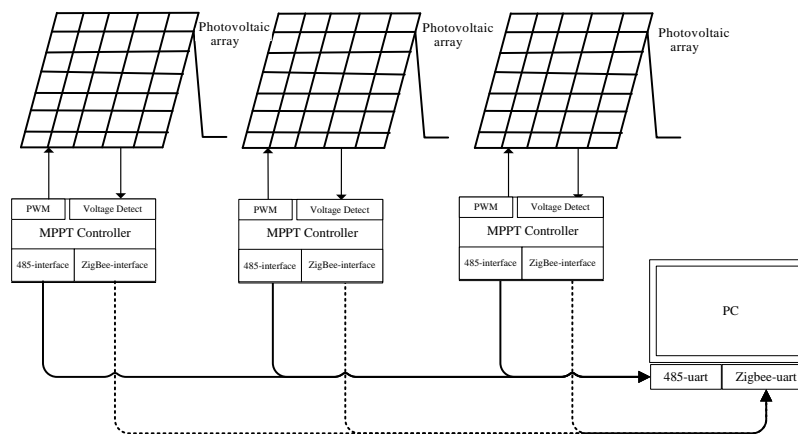


Figure 1. Monitoring System Structure

3. Monitoring Software Structure

3.1 Communication Module. MPPT controller uses the Modbus protocol which bases on serial port or ZigBee technology, and it will save all parameters of itself to the registers which are possessing continuous register address. Accordingly, the monitor also using serial port or ZigBee technology to adapt to controllers communication port and supplying the function of resolving data instructions which are stipulating by Modbus protocol. The monitor plays master part for requesting data from slave part i.e. MPPT controller. Figure 1 shows this model.

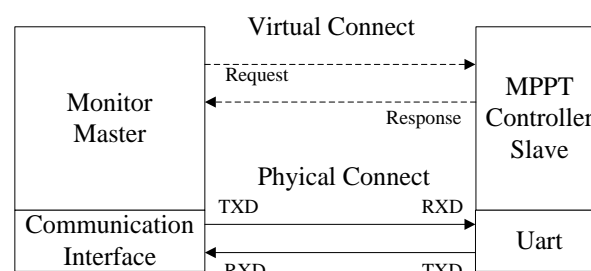


Figure 2. Communication Module

3.2 Network Management. The way to manage network is based on a specific kind of registry [3]. When multiple MPPT controller are joining to the same monitor software, the monitor

software can recognize every single MPPT controller by slaver's address, and it works by the way of periodically polling. This need the monitor software to maintain a registry which contains the status of each slaver, The status will illustrates whether slaver joins the polling cycle or not.

Background program will refresh the registry according to the action of interface, only if one certain slaver is confirmed by user to join to the network, monitor will send data request instructions to the slaver. Besides, when monitor has been sent the data request instructions to the slaver but never received response instructions from slaver during the Tolerance time, then background program will mark the status of this slaver as false to indicate that current slaver is in bad communication situation. Figure 3 illustrates the condition of 5 slavers join in the network and 2 slavers whose address is 1 and 3 are in bad communication situation.

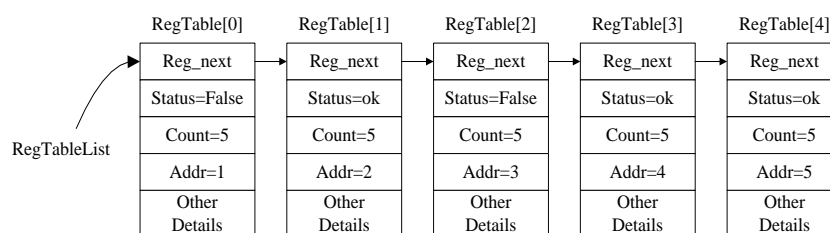


Figure 3 Network Status Registries

As show by the figure above, the whole registry is organized based on linked list structure, Registers List represent the address of first table, and every single table contains a special pointer which point to the next table, status of communication condition, total numbers of slaver, address of slaver and some other details. GUI application possess main thread named GUI thread, because of that GUI thread is the only thread to be allowed to run the operation about GUI. For some operations which need to respond swiftly or may be very time consuming, we must move this operation to an individual thread we call that is multithread programming.

To implement the multithread programming [4] based on Qt frame is very convenient. We just need to instantiate the QThread class and overload its run () function of the instantiated objects. In addition, the QSerialPort class is a thread-safe class, and all the member function must be thread-safe and re-entrant, so move all the operation such as serial port to single thread is absolutely safe.

3.3 Database Storage. For the purpose of obtaining long-time running parameter of MPPT controller, it's necessary to store long-time running parameter of MPPT controller by using data base technique. We choose MySQL [5] database supplied by Oracle Company. Qt library contains QSql module which supply platform-independent interface for accessing to database. This module is constituted by two parts, one part is Model-View-Controller, and the other one is user interface class.

When users configure the Qt library, there are two choices for getting database driver, one choice is using the database driver which is included by Qt library, the other choice is to compile database driver by the form of plug-in. For now, Qt5.5 has been supplied the database driver to MySQL, so using Qt library to develop database is more convenient. Figure 4 shows the window of database configuration and the window of loading data from database.

Item ID	Record Time	Input Voltage	Input Current	Output Voltage	Output Current	Output Power
1	2016-01-22 16:14:47	45	8	40	7	280
2	2016-01-22 16:14:48	45	8	40	7	280
3	2016-01-22 16:14:49	45	8	40	7	280
4	2016-01-22 16:14:50	45	8	40	7	280
5	2016-01-22 16:14:51	45	8	40	7	280
6	2016-01-22 16:14:52	45	8	40	7	280
7	2016-01-22 16:14:53	45	8	40	7	280
8	2016-01-22 16:14:54	45	8	40	7	280
9	2016-01-22 16:14:55	45	8	40	7	280
10	2016-01-22 16:14:56	45	8	40	7	280
11	2016-01-22 16:14:57	45	8	40	7	280
12	2016-01-22 16:14:59	45	8	40	7	280
13	2016-01-22 16:15:00	45	8	40	7	280
14	2016-01-22 16:15:01	45	8	40	7	280
15	2016-01-22 16:15:02	45	8	40	7	280
16	2016-01-22 16:15:03	45	8	40	7	280

Figure 4 Loading data for database

The MySQL database can be used as a web server and allowing remote client accesses to the database of server by internet. For to implement this function, user should make a simple configuration just using the standard SQL language as bellows:

```
MySQL> GRANT ALL PRIVILEGES ON *.* TO 'user'@'%' IDENTIFIED BY '123'
WITH GRANT OPTION;
```

3.4 Workflow of Software. The workflow of monitor software contains serial data dispatch, Modbus protocol instructions analysis, data storage and so on. In Qt frame, all interface action is transmitted by event mechanism in the whole application system. The QApplication class is used to control the event mechanism and when a specific signal of event is emitting, event mechanism can transfer the signal to the corresponding slot, then the slot will call specific function unit to handle the event immediately. This process is shown in Fig. 5.

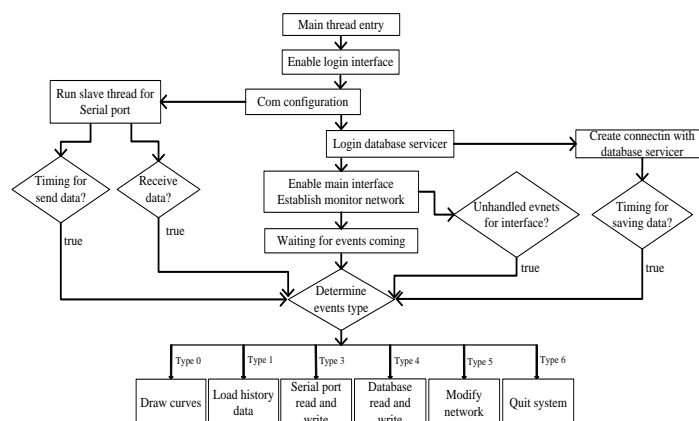


Figure 5 Workflow of Monitoring software.

When users log into the monitor software, the main window will display. The main window contains Data display unit, Alarm parameter setting unit, and debug information. Some other functions are embodied in the menu bar. When users choose specific slave devices to join into the working network and click the Start button, the software will be running the event loop and process the ready event according to priority. The main window is shown in figure 6.

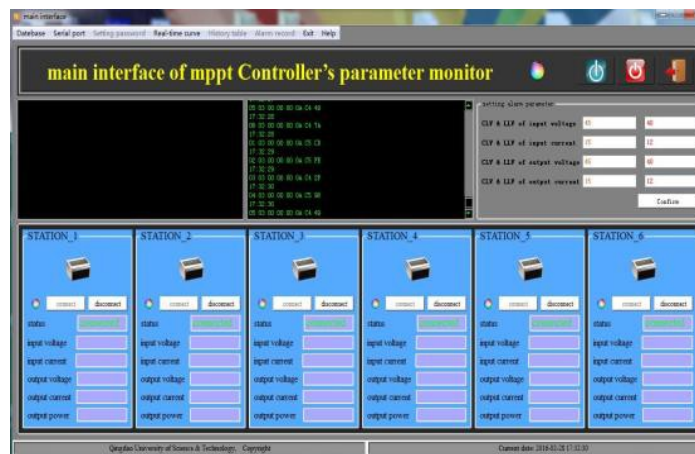


Figure 6 Main-window

4. Conclusions

This article used Qt frame to design cross-platform software to monitor the MPPT controller's operational parameter. Through analysis and comparison of test results, this software can build a stable network between multiple MPPT controllers, and also can indicate the status of controller timely, additionally, this application of monitoring software is based on multiple threads programming technology, and this makes the software more stable and responsive.

References

- [1]Zhao Z M, , Liu J Z, Sun X Y 2005 Solar photovoltaic and applications. *Beijing Science Press*, 201-255.
- [2]Gordon H 2007 C++/C the Visual C++ Language For .Net. *Wiley India Pvt Ltd*, 168-205.
- [3]Jeff C, John P M 2009 C++ All-In-One Desk Reference for Dummies. *Wiley publishing*.
- [4]Stephen R. D 2008 C++ for Dummies. *Wiley publishing*, 544-561.
- [5]Thomas M. C, Carolyn E B 2009 Database systems: a practical approach to design, implementation, and management. *Addison-Wesley*.