RTU Hardware and Software Design in the Process of Nano Material Production Control

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Abstract. "Nano-storage" based on organic molecules is a new type of data storage system with a trend to replace the currently widely used semiconductor memory devices. At present, there are two kinds of "molecules" that are potentially applied to "nano-storage", one is molecular electronic devices, including molecular wires, molecular rectifiers, molecular switches, and molecular transistors; and another material that uses nanostructures, such as nanometers. Tubes, nanowires, and nanoparticles. In this paper, nanomaterials are used as raw materials to invest in R&D and hardware design of remote data terminal control software (RTU) of electrical engineering. The development of nano-charge storage such as characteristics of remote terminal controls and charge transfer is discussed. Embedded design method. The design steps of the embedded method and the overall structure of the control software are introduced. Finally, the characteristics and practical applications of the method are discussed.

1. Introduction
There are currently two methods for the preparation of nanoscale devices and systems: top-down miniaturization and bottom-up construction [1]. For the top-down approach, R. Feynman [2] has proposed in 1959 that instruments will become more and more miniaturized, such as researchers using STM [3-5], SPM [6] and other microprobe technologies [7]. Designing devices at the single-molecule level; in response, KE Drexler [8] proposed a bottom-up design approach in 1981, namely molecular devices, where each molecular building unit passes through precise sites. The connection is assembled in a predetermined specific area, for example, a single molecule electronic device can have a single molecule property of memory and data storage functions through a combination of molecular lines, molecular switches, or memory cells.

The task of the RTU control software design is to implement software that controls the hardware operation of the RTU system to meet functional requirements, reliability requirements, and quality requirements. The functional requirements of the RTU control software design include two parts: the functions specified by the protocol for data transmission between the RTU and the dispatcher or the control center; local functions such as display and printing are provided, and the user is provided with a large amount of information and is friendly to the operation. Human machine interface. The reliability requirements of the RTU control software design mean that the RTU control software must have the functions required to enable the RTU to operate reliably against the interference in the actual
industrial environment. The quality requirement of RTU control software design means: From the perspective of software engineering, RTU control software should have good structure and readability, easy maintenance, and easy to add and modify software functions. In order to efficiently complete the task of RTU control software design, the design requirements can be met from the way of nanomaterial production to develop a standardized and systematic RTU control software design method, and to guide the specific design work.

2. System design
The device consists of the management CPU plug-in, the DSP plug-in, the AC plug-in, and the IO Sampling plug-in. The overall structure is shown in Figure 1.

![Figure 1. RTU system structure framework.](image-url)

The management CPU and DSP plug-in adopt dual-core processing, in which the CPU frequency is 700MHz, which is mainly responsible for the management of the device. The DSP plug-in is primarily responsible for the calculation of the analog acquisition calculation/control output. High-performance floating-point DSP is used as the processor. The maximum frequency is 600MHz. There is 256kB of on-chip space for storing instructions and some data. The external extended 128MB high-speed DDR2 is used to store large amounts of data. The front end uses 16-bit high-precision parallel AD to ensure high precision requirements for sampling. The AC plug-in is responsible for collecting the conventional analog inputs and transmitting them to the AD front end of other plug-ins via the analog bus. The IO plug-in is a smart plug-in, configures the single-chip microcomputer, independently completes the input/DC input information acquisition, and can perform the output/DC output, and the main frequency reaches 133MHz. Up to 20 plug-ins (including power strips) can be configured in one device chassis. In addition to managing the CPU plug-in and power plug-in, the other plug-ins can be flexibly configured according to the actual application needs. Each board performs its own duties, and
many boards cooperate to complete the target application function. In order to solve a large number of real-time reliable exchange of data between multiple high-performance plug-ins, a high-speed data bus technology has been developed, which effectively solves the problem of large-capacity high-speed data transmission between plug-ins in the device. At the same time, the CAN bus is used for system initialization management message exchange and variable exchange between boards.

3. Demand Analysis of RTU Control Software

The task of demand analysis is to determine the full functionality of the RTU control software. From the role of the RTU and the analysis of the use environment, the functions of the RTU control software can be reduced to four categories: functions specified by the protocol, local functions, improved software reliability and anti-jamming. The capabilities required for the capabilities, the functions required to build and manage the software's operating environment. Since these four types of functions have different characteristics, the corresponding methods and contents of the requirements analysis are also different, which are discussed separately below.

3.1. Functions specified in the Statute

This type of function is the basic function of the RTU, and the specific content is determined by the communication protocol of data transmission between the RTU and the dispatcher or control center. The analysis of requirements for this type of functionality is based on the content of the communication protocol, identifying or deriving the functionality needed to implement the content.

3.2. Local functions

The local function realizes the human-machine interface of the RTU system. The goal of configuring local functions is to provide users with a convenient means to understand the power load situation and the working status of the RTU, so that users can reasonably plan to use electricity. The requirements analysis required by the local function is based on user requirements, determining the content displayed/printed by the RTU system and the keyboard operation method for controlling display/printing.

Figure 2. Schematic diagram of RTU control software management program.

3.3. Functions required to improve software reliability and anti-jamming capability

The task of this type of function of the RTU control software is to ensure the reliable execution of the functions and local functions specified in the protocol. This type of functionality can be divided into two subclasses. The functions in the first subclass are used to ensure the correctness of important
parameter/data/status information in the RTU control software. The required requirements analysis includes: determining the object to be protected; selecting a method for verifying the correctness of the protected object; and determining the backup method for the protected object. The function in the second subclass is to monitor the normal operation of the RTU control software. The analysis of the demand is mainly through the prediction of the interference that the RTU control software may be subjected to, to determine and eliminate the interference, and to restore the normal operation of the control software, such as the software Watch-dog, the monitoring of the timing interrupt in the system.

3.4. Functions required to establish and manage the software operating environment
This type of function is to ensure that the RTU system hardware works in the required state, and the content is determined by the hardware design of the RTU system. Based on the results of the above four types of functional requirements analysis, a complete functional description of the RTU control software can be obtained.

4. RTU hardware design based on nano molecular materials
Charge transfer through a nanosized molecular junction is generally considered to be an electron tunneling process. Molecular junctions can be classified according to temperature, bias, and molecular properties (such as molecular binding sites and molecular lengths): continuous non-resonant tunneling (or classical tunneling), continuous resonance (super-exchange) tunneling and discontinuous "diffusion" tunneling. Studies have shown that discontinuous tunneling is the dominant mechanism at high temperatures, while continuous tunneling is low temperature tunneling. Theoretical calculations suggest that the charge transfer through the molecular junction is very sensitive to molecular line defects, molecular vibration excitation, and electrode/molecular interface states in the external optical region [4]. These inferences have been confirmed by recent research results, for example, it has been demonstrated that DDMS printed molecular junctions do respond to stimulation of external optical signals of different wavelengths [5]. On metal/insulator/metal junctions, electron tunneling through a rectangular barrier can be expressed in the Simmons formula, which is widely used to analyze experimental I-V characteristics. In the low bias domain, the equation is simplified to

\[
J = J_0 \exp\left(-\beta d\right)
\]

\[
\beta = \frac{2\alpha \left(2m\Phi\right)^{1/2}}{\hbar}
\]

Where: \( J \) is the current density; \( J_0 \) is the constant; \( \beta \) is the electron attenuation parameter inside the molecule; \( d \) is the tunneling distance; \( \alpha \) is the correction coefficient; \( m \) is the mass of the electron; \( \hbar \) is the Planck constant; \( \Phi \) is the barrier height. The combination of molecules and the effect of molecular length on the electron transport through the molecular junctions demonstrate that this simplified formula is applicable. The Fowler-Norheim tunneling and Schottky-Richardson thermoelectric emission modes are suitable for I-V data analysis in high bias and high temperature regions when the effects of the electrode/molecular interface need to be considered.

Drop coating, spin coating and vacuum deposition techniques can be applied to the preparation of various substrate surface dendrimer films. Studies have shown that most dendrimer films are in an amorphous state and have an island-shaped distribution due to their large, symmetrical and spherical high-density molecular structure. In addition, PDMS printing technology, solution adsorption and LB membrane method can also be used to prepare multilayer or even monomolecular membranes of dendrimers, but due to their mutual contact, reagent effects and layer shift, they are widely present on the membrane. Defects. In contrast, traditional SAMs technology may be a good choice, the thiol tail group can be bound to the periphery of the dendrimer, and can greatly reduce the occurrence of SAMs defects [6]. The usual methods for preparing solid dendrimer films are listed in Table 1.
Table 1. Application possibilities of nano information storage in RTU hardware design.

| Preparation               | Number of layers of the film | The possibility of applying to nano information storage |
|---------------------------|------------------------------|--------------------------------------------------------|
| Drip method               | Multilayer film              | impossible                                             |
| Rotation cover method     | Multilayer film              | impossible                                             |
| Vacuum deposition         | Multilayer film              | impossible                                             |
| Printing method           | Multilayer film to monomolecular film | may                                               |
| Solution adsorption       | Multilayer film to monomolecular film | may                                               |
| L-B membrane method       | Monolayer                    | may                                                   |
| SAM’s method              | Monolayer                    | Very likely                                            |

Redox-active dendrimers promote the development of molecular size charge storage, and researchers have studied a series of zinc porphyrins by electrochemical methods. In these porphyrin molecular structures, each porphyrin molecule is linked to a thiol tail group, which allows it to form a self-assembled film on the surface of the gold electrode. Electrochemical measurements of the gold electrode surface were performed in a two-terminal electrochemical cell. The storage of information is achieved by applying an electric potential to the electrode that exceeds the oxidation state of the porphyrin, and the porphyrin group loses electrons to form its oxidation state. Studies have shown that the multiple oxidation states of porphyrins (such as neutral molecules, monovalent oxidation states, bivalent oxidation states) can be obtained reversibly. The charge retention time can reach hundreds of seconds. Similar redox activity information stores can also be obtained by electrochemical experiments with other dendrimers such as 4AA/PD, CN-4AAPD [7].

5. RTU function implementation

5.1. IO subsystem implementation
The calculation of two busbars and eight intervals is completed in the subsystem. A total of six voltages and 24 currents are used. All the sampling and calculation modules are calculated according to the standard requirements and are placed in the same interrupt by rotation, in order to divide the DSP load equally. Reduce the load [8].

5.2. Communication Function Subsystem
As an important part of the RTU function, the communication function acts as a data aggregation and forwarding function, and has the functions of remote NCC dispatch center communication and IED device access in the station. The device adopts the Linux operating system, and the communication function is designed according to modularity. Each module is a single process, which is decomposed into several software subsystems to realize relatively independent functions. The system architecture is shown in Figure 4. It includes several subsystems such as real-time library, historical library, upper protocol, and lower protocol.
6. Conclusion

Practice has shown that R T U control software development under the guidance of nano material hardware design methods can make development work in an orderly and efficient manner in accordance with clear steps. Since the whole development work is carried out under the guidance of the definition of the overall structure of the software and the normative method of functional analysis and implementation, the developer is prevented from arbitrarily designing according to the familiar thinking logic, so that the software has the same from the module structure to the function realization. Sexual, easy to maintain and redevelop.

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