The Design of Upper Computer Integration Software in Radar Working Status On-Line Monitoring System

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Abstract: This paper design a kind of design scheme used for the upper computer integrated software system of radar state detecting system, making the general computer has the function of controller, terminal display, and data processor. Using three-tier architecture design of the hardware control module, and the object-oriented method to analyze and design information processing module, and powerful computing and display function of Matlab, it realizes command of human-computer interaction, hardware control, detection and management, data processing, data storage, and visualization. What's more, this software provides the benefits of good architecture, stability, high reuse rate, easy to be upgraded, etc.

1. Introduction

With the development of general computer, the controller, terminal display, data processor and other special equipment in traditional radar system are replaced by general computer more and more. General computer is generally responsible for the interaction with people. People can directly issue control command, which is often referred to as upper computer. The upper computer of radar working status on-line monitoring system can be a PC or card computer. Under the control of the PC software, PC can complete human-computer interaction, hardware control, detection and management, data processing, data storage, visualization, etc.

Each part of the traditional radar is scattered, therefore, the exploitation of radar software is usually for one function[1, 2], or introduce some kind of technology to be used in the application of software [3]. With increasing software level of radar system, and even the production of the concept of "software radar", using the engineering approach to develop integration software, which is characterized by stability, high reuse rate, good upgrading, is getting more and more attention [4-7]. This paper will introduce the design of radar working state on-line monitoring system for PC integrated software system from the angle of system.

Firstly, this paper introduces structure of radar working status online monitoring system, introducing the complexity of the system equipment from static angle, introducing the diversity of the system detection process from dynamic angle. And the information-processing method is continuously developing and updating, which brings difficulty for the development of software system. Then this paper introduces a kind of design scheme of upper computer software system, hardware control module uses the three layers of system, information processing module adopts object-oriented design method, and use the Matlab powerful computing and display function, better realize the radar working status of on-line monitoring system for demand. And this designed software provides the benefits of good architecture, stability, high reuse rate, easy to be upgraded.etc.

2. The Design of Rader Working Status Online Monitoring System

2.1. The Structure of Rader Working Status Online Monitoring System

Radar working status online monitoring system can be divided into upper computer, waveform

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generator, transmitter, receiver, data cache and antenna, etc. The hardware structure of radar working status online monitoring system is shown in Figure 1.

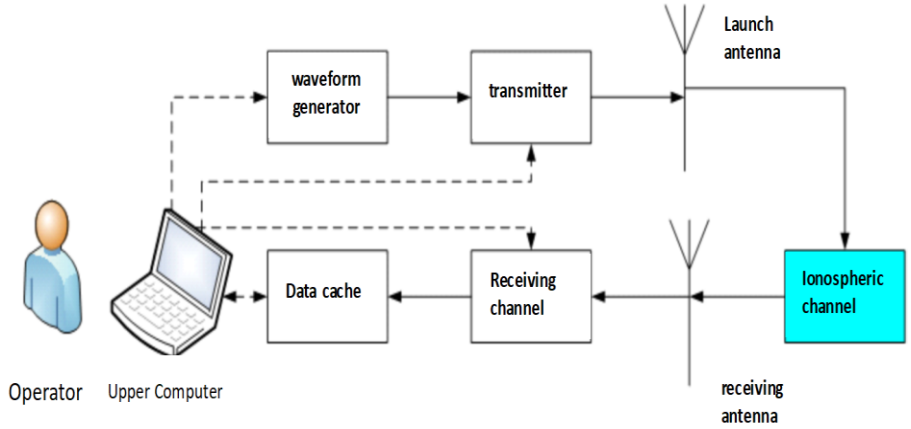

Figure 1 The hardware structure of radar working status online monitoring system.

Figure 1 Dotted lines represent numbers control signal, and the solid lines show the analog signal. Each part is as follows:

1) Upper computer. It is a computer controlled by people's command, and it is responsible for the interaction with people. In radar working status on-line monitoring system it may be a PC running windows XP, or based on a bus card computer, or a laptop.

2) Waveform generator. Generate a pseudo-random code phase modulation waveform. In radar working status on-line monitoring system, DSPs produces sequence control, and the FPGA generates pseudo random code phase modulation signal, and the direct digital carrier wave generates circuit (DDS). The three together produce code length, arbitrary frequency of pseudo-random code phase modulation waveform.

3) Transmitter. It is a power amplifier, amplifying emission waveforms, which can be controlled by the upper computer through serial port.

4) Receive channel. It is responsible for the frequency conversion and filter processing of echo signal received by antenna, and it's also responsible for the digitization. It adopts super heterodyne structure.

5) Data cache. It stores digital echo signal temporarily, waiting for being read by upper computer. Also it can be done with correlation calculation.

6) Antenna. Role is sending and receiving antenna radiation power. For the rotating antenna, it can also be controlled by upper computer digitally.

Every module of radar working status on-line monitoring system has a different complementation model, each of which has different port with the upper machine. Along with the expansion and upgrade of system function, more and more different types of hardware devices will be added. For system adaptability under different demand, and doing comparison tests with different equipment throughout the system development process, it's very necessary to keep the diversity of the system. But this puts forward higher requirements for the development of control software. It can control different devices as well as maintain scalability of software system.

2.2. The Diversity of Radar Working Status On-line Monitoring System

The detection of radar working status on-line monitoring system refers to the process of controlling hardware devices work orderly, achieving digital echo, processing data, and extracting the dual response or p-f function information, as well as other ionosphere information to display. Therefore, the detection is involved hardware control and data processing, display and storage process. There are two basic detection process:

1) Fixed Frequency Detection: A detection for the purpose of getting the ionosphere double response and scattering function. Radar working status on-line monitoring system launches modulation wave at a fixed frequency, and receives the echo to carry out correlated correction to get

double response function of ionospheres, and then to carry out power spectrum estimation on the double response to get the scattering function.

2) Sweep Frequency Detection: A detection for the purpose of getting the ionosphere p-f function. Radar working status on-line monitoring system launches modulation wave changing frequently at a fixed step. If each frequency point accumulates for a certain amount of time, it can not only obtains p- f-A function, but also change rule of doppler spectrum.

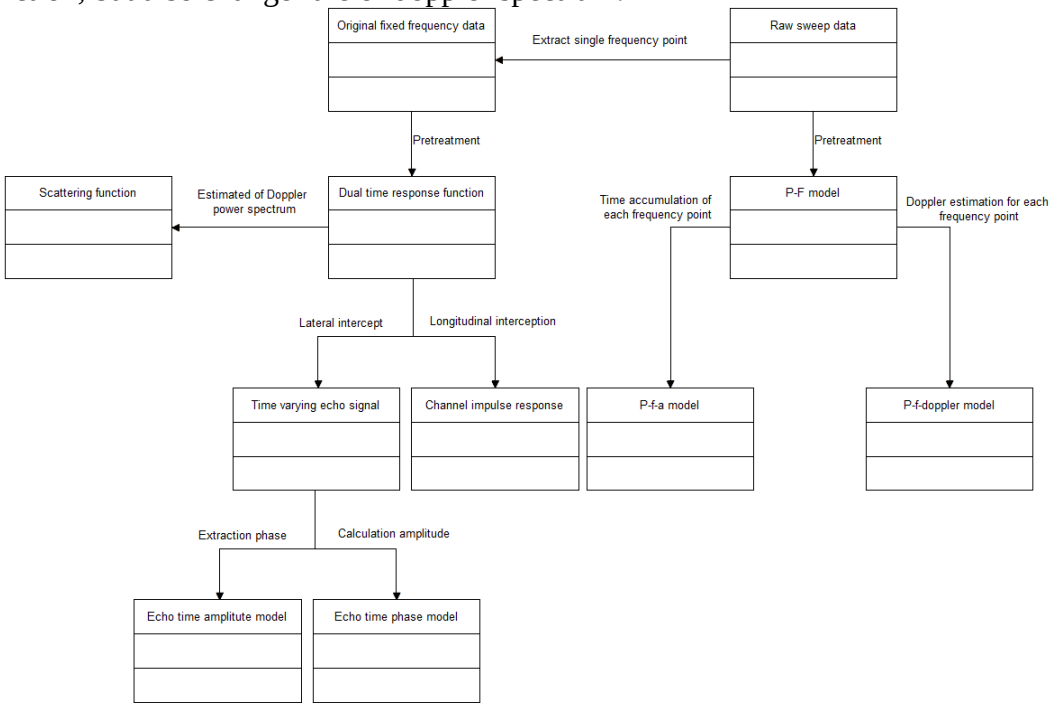

Figure 2 Transition diagram of information model.

Besides these two basic detection, corresponding to different detection need, radar working status online monitoring system can also do following detection:

Hopping Frequency Detection: sometimes it only need to observe the influence of the ionosphere to a handful of fixed frequency waves, on this occasion, frequency hopping could be chosen. For example, to detect whether there are plasma scatterers in the ionosphere. Radar working status on-line monitoring system emits modulation wave of a certain frequency circularly, and accumulates time in each frequency point, to get scattering function of each frequency point. The specific modules are shown in Figure 2.

3. Design of Upper Computer Software

3.1. Software System

The function of upper computer software is to control hardware devices to complete the above detection, so the upper computer software should have the function of hard control, data storage, data processing and display and other functions, as well as friendly man-machine interface. According to the above requirements, the radar working state on-line monitoring system for upper computer software is divided into several main modules by functions as shown in figure 3.

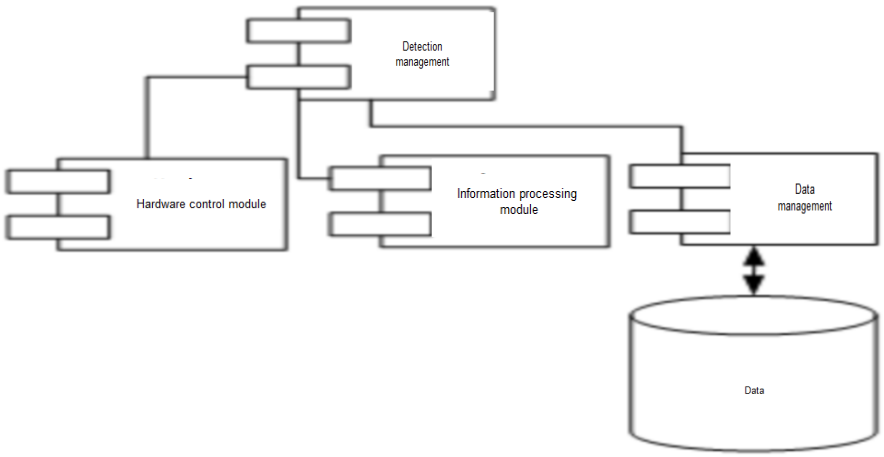

Figure 3 The software structure of upper computer in the radar working status on-line monitoring system.

Hardware control module detects hardware equipment of parameters control to work orderly based on user set, until reads the detection original data from the data cache. Hardware control module will be encapsulated with operating related to hardware. Change or upgrade of hardware in radar working status on-line monitoring system will not affect other modules.

Information processing module is responsible for data processing, extracting information such as scattering function, p-f function from the original data-, and then displaying in a graphic form. This module encapsulates all of the information processing method and display method in the radar working status on-line monitoring system.

Data management module is responsible for data storage, reading, sorting, search, and other functions.

Detection management module is responsible for managing other modules' starting, stopping, and the sequence of execution. These three modules are running under the detection of scheduling management module.

Among these modules, hardware control module and information processing module are the most important. They provide the key function of upper machine software system.

3.2. Hardware Control Module

Hardware control module encapsulates hardware operation of the radar working status on-line monitoring system. After setting up and starting detection parameters, the module can control waveform, and set the parameters of the receiver and transmitter, and read detection data from the cache. The design difficulty of this module lies in 2 points. Firstly, there are a diversity of hardware equipments and different interface in radar working status on-line monitoring system; Secondly, there are several different ways of detecting, each of which has different hardware control process. In this way, for different ways of detecting and different hardware, the code reuse rate is low, and the program is bloated.

In order to solve this problem, the hardware control module uses a three-tier hierarchy system. The bottom layer is a physical device, providing software interface of each hardware equipment.

The second layer is the logical device layer. This level divides the hardware equipments of radar working status on-line monitoring system into six logical devices by function. Each logical device is provided interface to achieve its function by the underlying physical device layer. The waveform generator, for example, can be implemented by 713 waveform module implementation, or cooperate with DSPs. Logical device layer provides mapping configuration man-machine interface, which can select both physical and logic devices artificially.

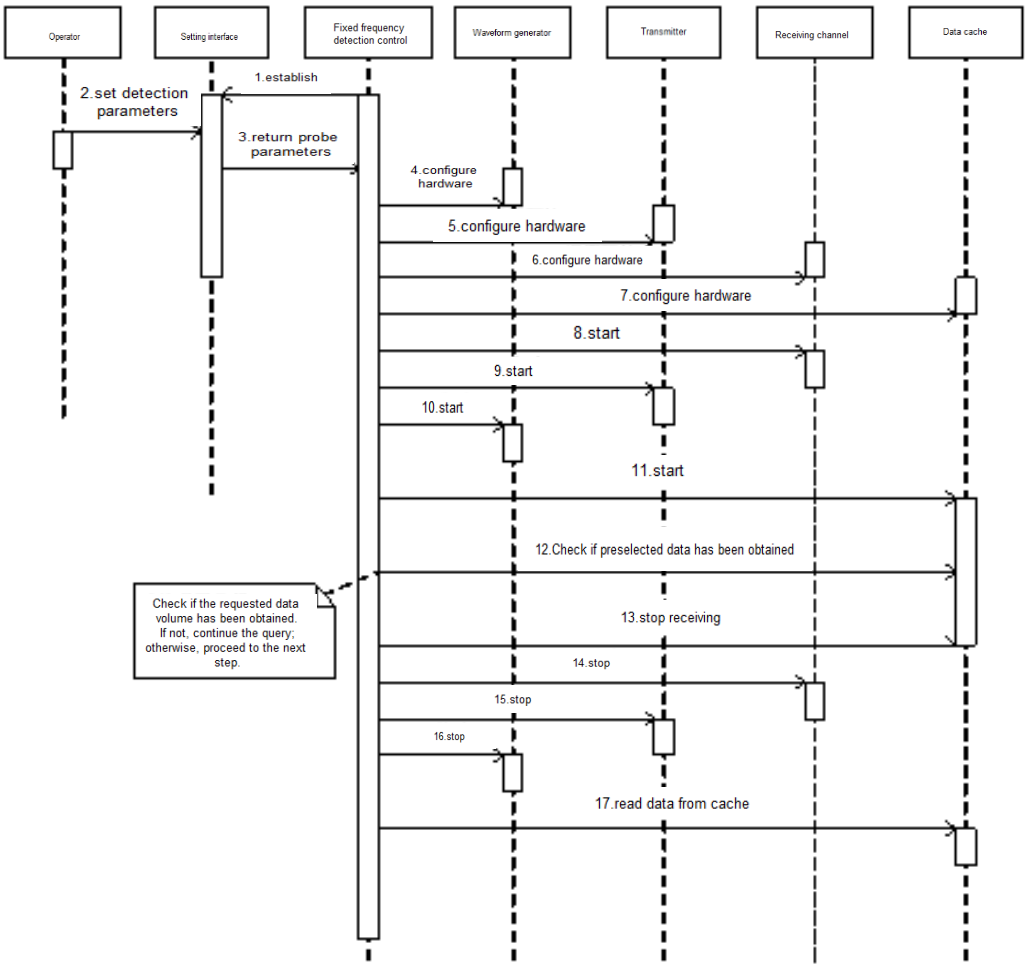

Figure 4 Sequence diagram of fixed frequency.

The third layer is the control layer. This layer provides a wide range of detection methods, and each kind of detection method is corresponding to different logical device process. This level also provides man-machine interface to select probe types and to set up the detection parameters. This layer focus on detecting process and collaboration among each logical device, to complete the detection function. Figure 4 is the collaborative work process of each module during the fixed frequency detection. Firstly, the fixed-frequency detection control class creates a human-machine interface and sets the detection parameters; Then it changes detection parameters into equipment, and sets various logical device parameters; After, it starts the logical device in turn, and then waits for data cache notifying that it has achieved data. Finally, stop all logical devices and read the detection data from the cache. The difference between sweep frequency detection and fixed frequency detection about the collaboration of each module is that the frequency sweep detection need to change the parameters and collocate parameters of logic device for many times, until detecting all the frequency point.

This three-layer system can solve the hard problem of different detecting ways and hardware. When a new hardware device is add, it only need to add software interface on the first layer and mapping relationship on the second layer, which will not affect the detection process. While, when a new detection method is add, it only need to add detection process on the third floor, which will be turn out to be applied to all the hardware devices of radar working status on-line monitoring system immediately.

3.3. Information Processing Module

Information processing is an important function of upper machine software system. And the

processing and information extraction method of detection data are developing constantly. After each design of new processing method being finalized, there will be practical value when it is implemented in radar working status on-line monitoring system. While, radar working status on-line monitoring system will obtain new function for the addition of new information processing method. It requires information processing module to be easy to upgrade, at the same time, it also requires every information processing method to have clear physical meaning.

3.3.1. Information Model

The concept of information model is put forward in the software design of radar working status on-line monitoring system. The information model refers to mathematical model containing change rule of ionosphere or shortwave channel. Actually it is a function that reflects the change rule of some amount (amplitude and phase of transmitted wave etc.) changing alongside with the other amount (time, frequency) in ionosphere or some shortwave channel. This function can have several independent variables, but only one dependent variable. The transformation relationship between concepts and models of information model forms the basis of the information processing module. When there is new information model to join, it simply need to inherited from existing information model. It can reuse a lot of code and develop only a small amount special algorithms for the new information mode. When there is a new processing method to join the existing information model, the subclasses of information model can also obtain a new processing method.

3.3.2. Experiment

The system will continuously find reflectors over a period of time. In a certain statistical period, when the found reflector does not match the added fixed reflector, it will write the new reflector into the current dynamic reflection storage area. The format displayed on the screen is as shown in Table 1:

Table 1 The format displayed on the screen.

CURRENT DYNAMIC REFLECTORS					CUANG_CHB	
		START	END	ORENT	REV	
INDEX	RANGE	AZIUTH	AZIMUTH	AZIMUTH	NUM	HITS
	Nm	Deg	Deg	Deg		
00000	6.33	199.58	199.99	98.50	000066	00001

The dynamic reflector of the previous cycle is stored in the non current dynamic reflector storage area, and the newly found reflector is stored in the current reflector area. In this cycle, the display format of the non current dynamic reflector on the screen is as shown in Table 2:

Table 2 The display format of the non current dynamic reflector on the screen.

NON-CURRENT DYNAMIC REFLECTORS					CUANG_CHB	
		START	END	ORENT	REV	
INDEX	RANGE	AZIUTH	AZIMUTH	AZIMUTH	NUM	HITS
	Nm	Deg	Deg	Deg		
00000	11.90	143.33	144.04	33.15	01994	00001

4. Conclusion

This paper introduces the design and development of upper computer software of radar working status on-line monitoring system from the perspective of system design. The software integrates with human-computer interaction, hardware control, detection and management, data processing, data storage, visualization, and other functions, making radar working state on-line monitoring system upper machine be equipped with the comprehensive function of the controller, radar data processor and display terminal, reducing the development cost and making the system have the characteristics of software radar.

For system adaptability under different demands, there are several different ways of hardware

implementation and interface of each module of radar working status on-line monitoring system, and a variety of detection methods such as fixed frequency, sweep frequency, frequency hopping and so on. Unlike most detection software design for a set of hardware equipment, in this paper, the software system of hardware control module USES the three layers of hierarchy structure scheme, concise and efficient to control for a variety of hardware equipment, and can be easily upgraded to adapt to the new hardware control requirements.

In the design of information processing module, according to the characteristics of information processing of the ionosphere detection, this paper puts forward the concept of information model class, the radar working status of on-line monitoring system for the information processing and display are encapsulated as method of members in the category "information model", and radar working status online monitoring system information model is established between the transformation model, designed the logic code reuse rate is high and easy to upgrade the software system. Finally, the meaningful data obtained from the verification will be transmitted and provided to the program interface. After a long time of reflector discovery, the system will count the dynamic reflector data, and then calculate the start orientation and end orientation of each reflector and other relevant data.

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