The Application of Embedded System on Shipping Monitoring and Control

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Abstract—**Through the functional analysis of Ship monitoring module, I accomplished the design of hardware, the core of which is Samsung Company's 32-digit embedded microprocessor–S3C44BOX. The writing of the startup code and the transplantation of µC/OS-II operating system have been systemically discoursed on at great length. Have adopted the self-defining interface of the method of abstract layer of the driver in this design. Through point to different driver, mount the driver for the operating system. The application of embedded system improves the real-time and reliability of Ship monitoring system. Power consumption has been reduced.**

Keywords-Embedded System; Shipping Monitoring and Control; Boot Loader Development; Transplantation of Operating System

I. INTRODUCTION

In recent years, along with the network, the computer and control technology's unceasing progress, the ships automated system turned toward digitized, intellectualized, the network direction to develop. The ships automation technology already broke through the unmanned engine room, machine to harness unites, concepts and so on entire ship automation, the information and the control integration ships information integration system (the IAS system) becomes now one of world front research subjects. Shipping information integrated system is based on on-site network as the underlying network, Ethernet for the upper network; to satellite communications for remote information exchange link between the new ship automation solutions, combining ship's real-time monitoring with management information to achieve the ship's integrated monitoring and integrated management of ship and shore.

On-site equipment monitoring, commonly used field bus networks to achieve, with the maximum for the CAN bus. Lower in the system network (CAN bus) and the upper network (Ethernet) data communications between the use of data communication through CANPC device adapter card from the field to obtain the required real-time data, and then through the network communication technologies, the data sent to the Management Network Server database to achieve data sharing. Not difficult to find the upper and lower communication network monitoring network data sharing between the data transfer to become a "bottleneck." Once the "bottleneck" problems, on-site network, all of the information is lost. The underlying network information data volume is small, slow, and unable to meet the information and data, voice and image data transmission. In addition, the summary of the low-level network performance is poor, and the degree of standardization is low, affecting the performance of the new network to play. In order to solve this problem, the adoption of international standards of 1000 trillion high-performance Ethernet technology, LAN network as the ship public network. On-site monitoring modules directly affect the performance of the entire integrated system for real-time, reliability of the whole system, which is a critical link in the system and is also relatively weak link at this stage. Ship automation systems require on-site monitoring module network of digital, networked. Developed a real-time high, good reliability, small size, with Ethernet interface, the control module is an integrated ship information system, a crucial element.

The rise of embedded technology brings new vitalities and opportunities in the field of maritime. Embedded Systems is based on application-centric and computer-technology-based, and cutting hardware and software are available, and can meet the application systems for functionality, reliability, cost, size, power and other indicators of the stringent requirements of the dedicated computer system. It can realize the control of other devices, monitoring or management functions. It is built on a high-performance processor (as opposed to SCM) based on the hardware, to a sophisticated real-time multi-tasking operating system, based on a platform. The ability of this platform is a reconfigurable microcontroller past that can not be compared. The application of embedded technology developed real-time high, good reliability, low power consumption, small size, with a network interface control module, providing technical support and possible. Embedded devices need to be able to access the Internet with TCP / IP network protocol, since 8 / 16 SCM fast enough, and memory is not big enough. The Internet is more difficult to meet the equipment requirements. With the development of integrated circuits, 32-bit processors, prices continued to fall, it will be large-scale use, on-site monitoring module of the access issues can be a good solution.

II. ON-SITE MONITORING MODULE OF THE PERFORMANCE AND FUNCTIONAL ANALYSIS

The ship is a special application environment, often for months on ocean-going vessels sailing in the ocean, which

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requires the use of the ship automation and computer systems requires a high reliability, to ensure the long-term reliable operation of the system. Ship-site monitoring module should meet the conditions of work as follows:

1、Environment (air) temperature: 0～55℃；

2、Tilt swing:

（1）Heeling：30°； Roll：30°；

（2）Trim：10°； Pitching：10°；

（3） 9s,as well as the vertical direction swing cycle, the linear acceleration ± 9.8m / s work.

3、Humidity：

（1）When the temperature ≤ +40 ℃, relative humidity of 95% ± 3%.；

（2）When the temperature is higher than +40 ℃, relative humidity of 70% ± 3%.；

4、Shall not be less than GB/T10250-1988 electromagnetic compatibility requirements.

5、Vibration, salt spray, oil mist, and mold and dust.

Marine Automation System in the nature of the equipment, the type of data to be collected and collection locations are different. In this paper, the analysis of the cabin equipment, and abstract out the common ground of their design a common hardware platform, that is, the standard function module (Standard Function Blocks, SFB).

After careful analysis, the standard function module performance and functional requirements are as follows:

1、Real-time high, good reliability, small size

2、With switching value, analog input and output

3、With CAN interface

4、LAN network interface can be expanded

5、You can add TCP / IP network protocol.

Using standard function module, you can improve the system of standardization, modular, universal level, and improve the maintainability of the system. Because the maintenance of equipment just to replace the module can be realized, so that maintenance work is extremely easy.

III. THE HARDWARE DESIGN OF ON-SITE MONITORING MODULE

According to on-site monitoring module of the functional analysis, we can see, LAN network interface can be expanded. Adding the TCP / IP network protocol is the ship automation system on-site monitoring module of the basic requirements. Since 8 / 16 SCM fast enough and memory is not big enough, the Internet is more difficult to meet the requirements of embedded devices. With the development of integrated circuits, 32-bit processors, prices continued to fall, it will be large-scale use. 32-bit RISC processor is to find favor, which is the leading ARM embedded microprocessor family. ARM microprocessor-based embedded systems with real-time, the code is small, fast execution; special compact, uses a fixed, cost-sensitive; and high reliability. Fully in line with on-site monitoring module features functional requirements.

This design used in Samsung's ARM7 microprocessor S3C44B0X, work in the 66MHZ, using the ARM7TDMI core. ARM7 family microprocessor for low-power 32-bit RISC processor, suitable for use on the price and power demanding applications, is a general-purpose chip. The chip's storage temperature range is -65 ℃ ~ 150 ℃, commercial temperature range of 0 ℃ ~ 70 ℃, and industrial temperature range of -40 ℃ ~ 85 ℃, which can meet marine requirements.

On-site monitoring module interface circuit includes: power supply circuit section, part of the crystal oscillator circuit and reset circuit, FLASH memory circuit parts, SDRAM interface circuit parts, CAN interface circuit parts, parts of the serial interface circuit, JTAG interface circuit part. In addition to these interfaces, there are switches in the hardware circuit volume and analog input and output, LCD display. S3C44B0X chip has 71 general-purpose I / O ports, 8-channel 10-bit ADC, LCD controller (maximum support 256-color STN, LCD with dedicated DMA), a wealth of on-chip resources to fully meet the functional requirements. S3C44B0X microprocessor interface circuit informative, also more detailed description of hardware structure is easier.

IV. THE DEVELOPMENT OF START-UP CODE AND THE MIGRATION OF OPERATING SYSTEM

A. Boot Loader Development

Boot Loader to run after the system power-up the first paragraph of software code. The system power-on (or reset) after the address space of the 0x0 process from the beginning, that is, PC (program counter) pointer 0x0, starting from this address reads the instructions and run it. Usually this address corresponds to Bank0, in the 0x0 this address is usually arranged by the system Boot Loader program.

Boot Loader boot operating system is one of the main functions. The so-called guide refers to the: Boot Loader program first obtain control of the system, the pairs of critical hardware self-test did not find fault and did not issue any instruction from the console, and from the FLASH to read the operating system or application code to the SDRAM designated location, then move the pointer to the location process, so that the operating system access control, complete the boot process.

The code does not achieve the guiding function of the complexity of the code is as follows:

```
#define  pbootfile_address,  (0x080000)
#define object_address (0x0c100000)
void boot(unsigned char *pbootfile_address,
unsigned char*object_address)
{
  int i=0;
  while(i<=64*1024)
  {
   *object_address=*pbootfile_address;
   object_address++;
    pbootfile_address++;
    i++;
   }   /* The operating system and application code from FLASH copied to RAM space */
   Uart_Printf("\nfile copyed");
```

run();/*Run the operating system and applications */
}

Only the function Main (), the call to the function to complete the boot loading, and then the procedure pointer to the location of achieving the transfer of control. The program defines a function pointer

static void (*run)(void)=(void(*)(void))object_address;

And to specify the location of the address of the above-mentioned cast a function pointer type, then use the run ( ); to run at the instruction of the address.

B. μC/OS-II Port on the ARM Microprocessor

Transplant program design steps are as follows

1. Set includes.h with the processor and compiler-related code

This is the most critical part of the transplant. Kernel applications and the underlying hardware, the combination of organic into a real-time system, to make the same core can be applied to different hardware systems, will require the kernel and a middle layer between the hardware, which is processor-dependent code. Processors, this part of the code is also different. Including the definition of using # define processor-related constants, macros, and data type definitions. Specifically, a system data type definitions, the definition of stack growth direction, close interrupt and open interrupt, and so the definition of soft interrupt.

2. With the C language 6 operating system-related functions (OS_CPU_C.C)

OS_CPU_C.C files need to modify the six functions: OSTaskStklnit (), OSTaskCreateHook (), OSTaskDelHook (), OSTaskSwHook (), OSTaskStatHook (), OSTimeTickHook (). Actually only need to modify the OSTaskStklnit (), other functions for the hook function is to set the user extensions, and its definition can be empty.

3. Written in assembly language with four processor-related functions (OS_CPU.ASM)

This document includes four functions are related to the handling of registers, with the processor on, due to the different processors have different registers, so the operating system in this file to the user interface, leaving four functions so that users according to the selected compilation of procedures for the preparation of the corresponding processor to complete a fixed function. Four functions are: multi-task start function call OSSTartHightRdy ( ), task switching function OSCtxsw ( ), interrupt task switching function ( ) SIntCtxSw ( ), beat the clock service function OSTick work SR ( ).

C. Driver Development

In this paper, the driver *abstraction* layer approach, the application shown in Figure 1. Is only driven by the operating system abstraction layer and specific communication, both in the abstract layer of the following corresponds to what type of equipment, operating systems and user applications, are unified interface, using C language pointer function method, abstraction layer to achieve the drive's software design. By pointing to a different driver subroutines function pointer, you can mount a variety of operating systems for the same driver. Hardware abstraction layer separation on the system hardware and software play a role, thereby enhancing system software that can transfer the value of and effective use of human resources, shorten development cycles and improve product reliability.

Application-driven program abstraction layers as follows: In the can.h define the structure of CAN bus driver can_driver_t; through the global array can_driver mount CAN bus driver; in can.c achieve CAN bus abstraction layer; in the mcp2510.c achieve drivers; boot the system and loading drivers.

μC / OS-II in the CAN bus driver structure shown in Figure 2.

V. SUMMARY

The application of embedded system improves the real-time and reliability of Ship monitoring system. Power consumption has been reduced. This innovative point is that the ARM core-based high-performance embedded microprocessors and embedded real-time operating system used in vessel monitoring system, developed a real-time high, good reliability, small volume, scalable Ethernet Interface monitoring module. The ship automation system with digital, intelligent, network of great significance.

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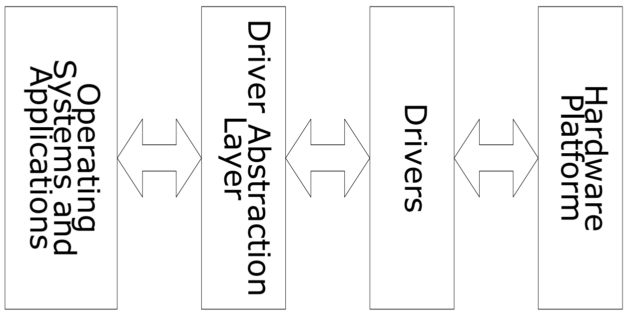

Figure 1. Driver Abstraction Layer Application

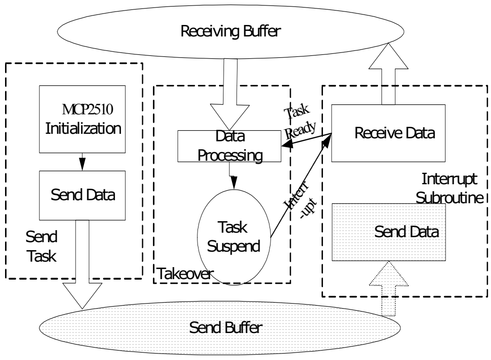

Figure 2. CAN Bus Driver Architecture