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Research Article

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The robot intelligent controller design and implementation base on ARM

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ABSTRACT

For realization the controller of robot automatically recognize the peripherals, add or remove, and auto-complete device initialization and peripheral equipment acquisition to intelligent design of the information displayed in human-computer interaction interface proposed to use the Cortex-M3 and Cortex-A8 dual ARM core system architecture. Use the Cortex-M3 core STM32F103VCT6 processor to monitoring of peripheral devices added or removed to complete the sensor data acquisition; use Cortex-A8 core OMAP3530 embedded processor, embedded Linux operating system as relying on QT / Embedded GUI development environment, human-computer interaction interface structures using the method of cross-compile to complete the development of the ARM-side man-machine interface. Through the serial communication STM32F103VCT6 processor OMAP3530 embedded processor data transfer, completion of the collected sensor information to the human-computer interaction interface. Able to complete the automatic identification verified by experiments the robot intelligent controller and initialize peripherals, collected information to the interactive interface.

Key words: OMAP3530, Linux; ARM, Robot Controller

INTRODUCTION

Since the world's first remote manipulator was born has been more than 50 years history. With the development of the electronic computer, principle of automatic control theory and the needs of industrial production and the progress and enhancement of related technical , the development of robot technology has gone through three generations: the first generation is programmable robot teaching and reappearing; the second generation is based on the sensor control has a certain discriminant ability of autonomous robot; The third generation is intelligent robot with thinking decision-making ability[1-4]. As the key and core part of robot, the robot controller merits of performance is the key factor affecting the overall performance of the robot[5-8]. It affects the progress and development of the robot in a certain extent. Currently, due to the continuous development and progress of artificial intelligence, computer science and technology, sensor technology, and other related disciplines, making robotics research at higher levels, but also putting forward higher requirements for the performance of the robot controller. Therefore, the design of high-performance robot controller is the current trend in the development of robot technology[9]-10].

THE SYSTEM DESIGN

This system adopts OMAP3530 chip of TI company as the man-machine interface display platform, the processing speed is fast, rich in resources, have three UART serial port communication and USB communication. STM32F103VCT6 processor is mainly to complete the automatic detection and recognition of various kinds of sensor module. This system mainly consists of temperature and humidity sensor module, ultrasonic module, motor drive module, obliquity sensor module, color sensor module. Users can realize the function of PC interface display and touch screen through OMAP3530 processor control board .The whole system platform structure is shown in

Fig.1.

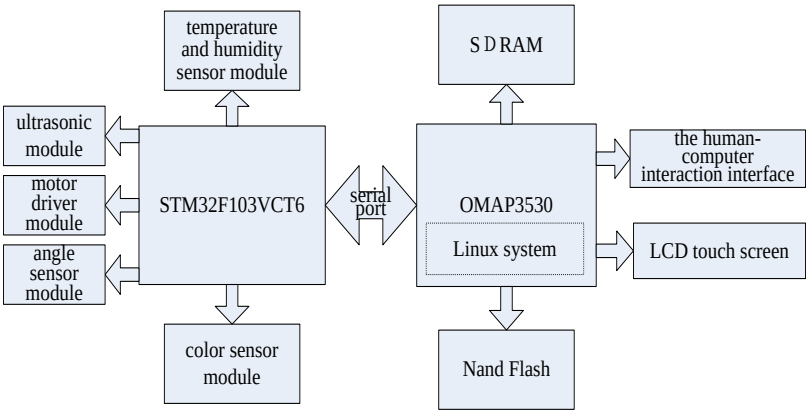

Fig.1 Intelligent Robot Controller System Composition Block Diagram

THE MAIN HARDWARE SYSTEM

Robot intelligent controller hardware management module

Robot intelligent controller hardware module management platform, is designed according to the requirement of the system of independent platform, with STM32F103VCT6 processor as the main control chip. Which mainly contains a serial communication interface, three sensors or motor driver module interface, a JTAG interface, the power regulator circuit, etc. Robot intelligent controller hardware module management platform principle diagram is shown in Fig.2.The platform mainly automatically detects whether there is a sensor module or motor driver module is added to the system, if detected module is added to the system, you need to identify what is added to the module in the system (such as a motor driver module and temperature and humidity sensor module), and completes the initialized to a module, reads sensor data or controls the motor drive, etc. Finally, read information parameters through the serial interface to communicate with the OMAP3530 from the module and transfer to human-computer interaction interface for display.

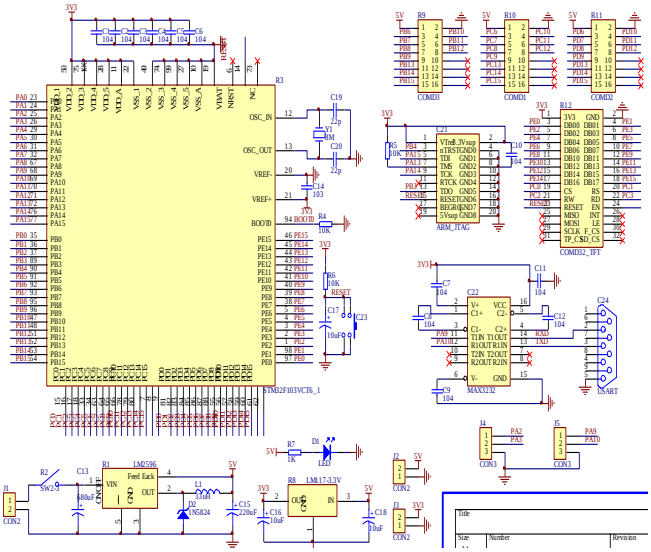

Fig.2 Robot Intelligent Controller Hardware Management Module Schematic

Temperature and humidity sensor module

The module uses DHT11 digital temperature and humidity sensors. DHT11 digital temperature and humidity sensor is a calibrated digital signal output of the temperature and humidity combined sensor. The sensor consists of a resistive element and a sense of wet NTC temperature measurement devices. Have fast response, strong anti-interference ability, high cost performance characteristics, etc. Each DHT11 sensors are calibrated in a precision humidity calibration chamber. Calibration coefficients stored in the form of a program in the OTP memory, the interior of the sensor in the process of detecting signal processing to invoke the calibration coefficient. Single wire system serial bus interface, making the system integration becomes simple, easy and fast. Super small volume, low power consumption, signal transmission distance up to 20 meters, making it becomes a better choice for various

applications. The principle diagram of the temperature and humidity sensor module is shown in Fig.3, mainly includes a DHT111 temperature and humidity sensor, a 16 feet double row needle, among which pin 11,12,13 are the hardware module circuit coding part, making the main controller can automatically detect and identify the module.

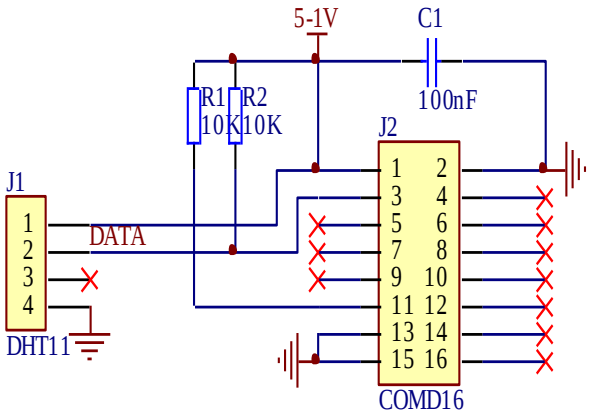

Fig.3 Temperature and Humidity Sensor Module Schematic

Ultrasonic sensor module

The module uses HC - SR04 ultrasonic module, high precision, occupies less I/O port resources, using method is simple, the mouth sends a high level of more than ten us, you can wait to output the high level at receiving mouth .Once having output can open timer timing, when the mouth into a low electricity, you can read the value of the timer, it is the distance of time, then you can calculate the distance. Ultrasonic sensor module schematic diagram is shown in Fig.4, mainly includes a 4 pin HC - socket SR04 ultrasonic module, a 16 feet double row needle, among which pin 11,12,13 are the hardware module circuit coding part, making the main controller can automatically detect and identify the module.

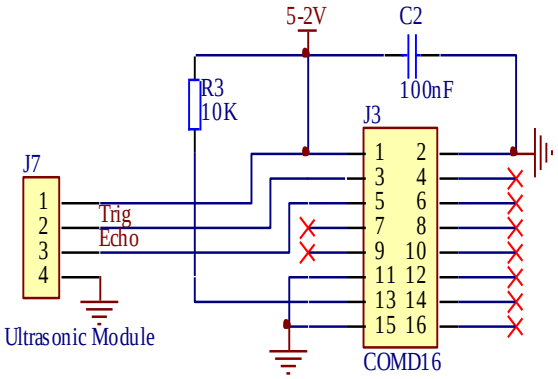

Fig.4 Ultrasonic Sensor Module Schematic

Color sensor module

This module used TCS230 color sensor, TCS230 is programmable control that TAOS company launched, from the color of light to the frequency converter. On a single chip integrated red-green-blue (RGB) three kinds of filter, is the first RGB color sensor with a digital interface compatible in the industry.TCS230 output signal is a digital signal, can drive a standard TTL and CMOS logic input, so can be directly connected to the microprocessor or other logic circuits. Color sensor module schematic is shown in Fig.5, mainly includes a TCS230 color sensor, a 16 feet double row needle, among which pin 11,12,13 are the hardware module circuit coding part, achieving this module encodes, making the main controller can automatically detect and identify the module.

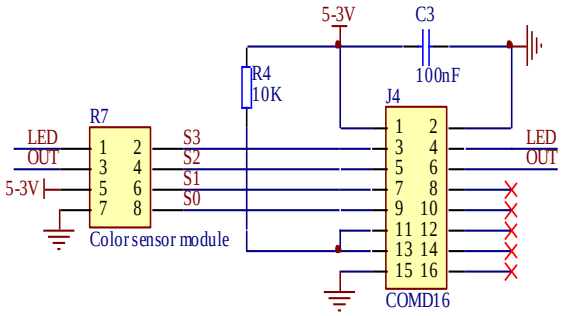

Fig.5 Color Sensor Module Schematic

Acceleration sensor module

This module uses the ADXL345 accelerometer, ADXL345 is ADI's axis digital acceleration sensor, mainly used in micro inertial devices of consumer electronics, the biggest perceived soil 16g acceleration, sensing accuracy up to 3.9mg / LSB, typically angle measurement error less than 1 degree; through its built-in ADC acceleration signals are converted to digital stored in on chip buffer, using the SPI bus to read the data. Tilt sensor module schematic is shown in Figure6, mainly includes a ADXL345 accelerometer, a 16-foot double needle, among which pin 11,12,13 are the hardware module circuit coding part, achieving this module encodes, making the main controller can automatically detect and identify the module.

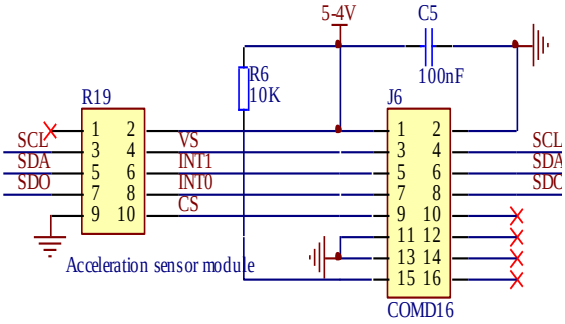

Fig.6 Acceleration Sensor Module Schematic

Motor driver module

This module uses L298N chip drive motor, L298N is a high voltage, large current of motor driver chip produced by ST company. The chip encapsulation uses 15 pin. The main features: high working voltage, high voltage can be up to 46 v, output current is big, instantaneous peak current can reach 3 A, the maximum current to use continuing work is 2 A , rated power is 25 W. Internal contains two H bridge of high voltage and large current full bridge driver, can be used to directly drive dc motor, stepping motor, load relay coil, etc. Motor drive module schematic is shown in Fig.7, mainly includes a L298N chip, a TLP521-4 optical isolation chip, achieving level matching, a 3.3V voltage regulator circuit, a 16-foot double-pin, among which pin 11,12,13 are the hardware module circuit coding part, achieving this module encodes, making the main controller can automatically detect and identify the module.

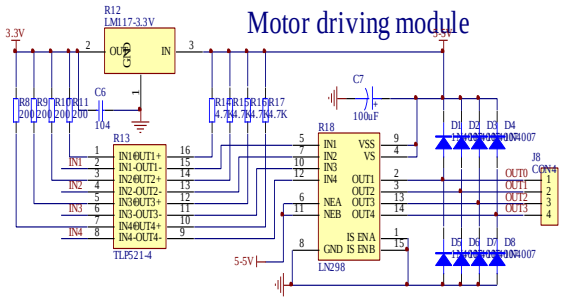

Fig.7 Motor Driver Module Schematic

The description of system automatically recognizes the hardware

Automatic identification system hardware module is mainly depends on the hardware encoding module circuit, the introduction of the design of hardware circuit module is also referred to the corresponding coding for different

modules, so in the system can according to the different code identify the corresponding modules, and complete the initialization for the corresponding modules. Hardware circuit coding schemes is shown in Fig.8, 11,12,13 pin for the module code. Of course, system automatically recognize module needs to know the hardware module is added, so the robot intelligent controller hardware module management platform of hardware module in the interface is connected by software programming to detect hardware module coding of I/O pins on the premise of without inserting hardware module are all the bottom level, once detected all the bottom level is not completely the bottom level, suggesting a new hardware module is added, similarly, when the connection hardware modules coded I/O port is detected, and never the whole of the bottom level turn to the whole of bottom level shows that hardware is removed from the system. System is through continuous testing I/O pins level connected hardware module coding circuit changes, so as to achieve automatic identification hardware modules are added or removed.

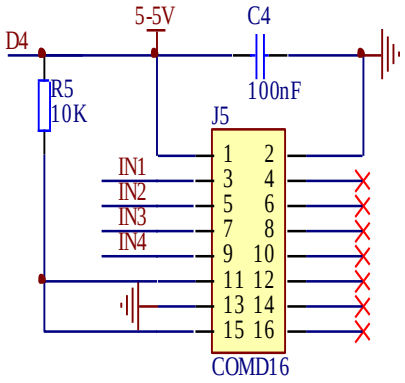

Fig.8 Hardware Module Coding Schematic

THE MAIN SYSTEM SOFTWARE

Hardware management platform programming refers to the program designing of the end of STM32F103VCT6 processor. through the programming completed the various sensor modules or motor-driven modules intelligent management, that achieved automatic detection sensor module added or removed, when you add the module to automatically identify the added module is what modules (such as the temperature and humidity sensor module or ultrasonic sensor module), and then automatically initializes the module based on the identification, and mark the corresponding flag module, the main program through the flags to determine the corresponding module will know that the module is added to the system. Clearing the flag when it detected the corresponding module is removed from the system. The main program flow chart is shown in Fig.9, when the hardware management platform startup, system initialization, including the system clock, the serial port initialization, timer initialization, after the completion of system initialization, entering into while loop to determine the corresponding module flag whether 1 or not, when the flag is 1, indicating that the system has been added to the corresponding module, then the corresponding module operating, Including reading sensor data, serial transmit data, control motor and so on, after completed the corresponding module operation entering the next cycle. When the flag is not 1, directly entering into the next cycle.

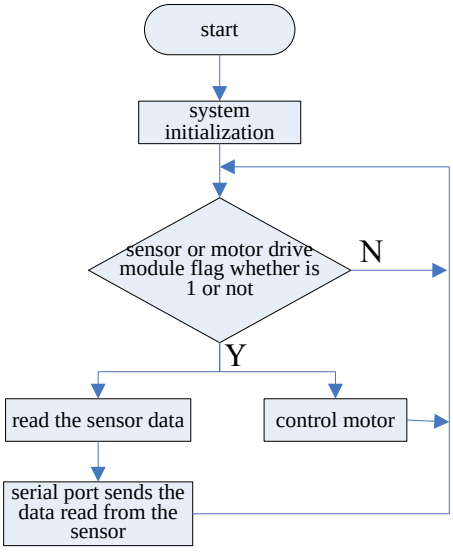

Fig. 9 The Main Program Flow Chart of Hardware Management Platform

Automatic detection sensor module or motor driver module is added to the system or removed from the system, which mainly implemented in the timer interrupt service function. Start the timer interrupt service function, when the regular time STM32F103VCT6 processor jumps into the timer interrupt service function for processing. Timer interrupt service function flow chart is shown in Fig.10, firstly, testing whether there is a new hardware module is added to the system in the timer interrupt service function, if there is a corresponding module logo sign bit is 1, and the newly added hardware modules are initialized, after the completion of the initialization, exiting timer interrupt service function, if not then directly exiting the timer interrupt service function; In detecting whether there is a new hardware module is added, at the same time, also detecting whether there is a hardware module little removed from the system, if there is a new hardware module clears the corresponding flag bit is 0, then exiting the timer interrupt service function, if not then directly exiting interrupt service functions.

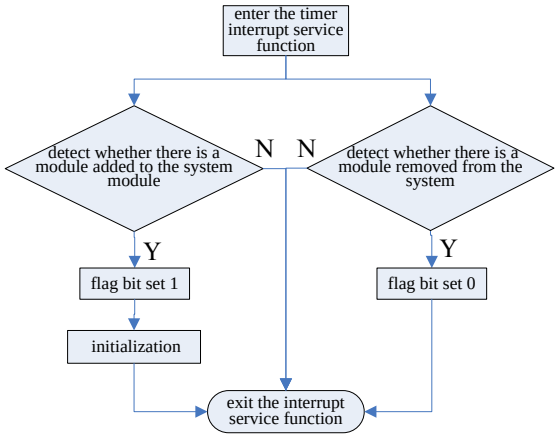

Fig.10 Timer Interrupt Service Program Flow Chart

THE MAIN SYSTEM SOFTWARE

In the Linux system of PC using QT to develop human-computer interaction interface, through crossing compiler ported to OMAP3530 development board, has been tested can run properly in the development board, interactive interface test results is shown in Fig.11.

Fig. 11 The Human-computer Interaction Interface Test Rendering

Robot intelligent controller system overall test renderings is shown in Fig.12, STM32F103VCT6 processor management of the hardware platform has three sockets, each sensor module is inserted into one of the outlets, the system can automatically recognize the sensor module, and initialization, reading sensor values after the completion of the initialization process, system can automatically identify the hardware is added and removed, and sending the information read from various modules to the human-computer interaction interface for displaying.

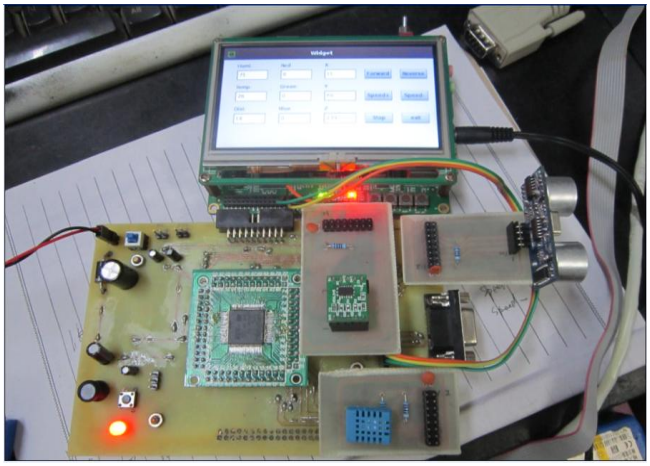

Fig.12 System Automatically Recognizes the Hardware Test Pattern

CONCLUSION

Robot is the product of multiple interdisciplinary, integrated multi-disciplinary field of advanced theory and technology, includes dynamics and kinematics, mechanical design and manufacturing, computer hardware and software, control and sensors, pattern recognition and artificial intelligence, and the robot's controller is the core part of the robot. This design uses STM32F103VCT6 processor and the double ARM ernel of OMAP3530 processor architecture for building platform, making full use of rich STM32F103VCT6 resources, processing speed is moderate, high cost performance, rich OMAP3530 processor resources, high processing speed, convenient for embedded designing and development. Eventually achieved a robot intelligent controller automatically recognizes the hardware, achieving the effect of plug and play, making robot intelligent controller becomes simple and convenient in practical applications, has important significance for the development of robot intelligent controller.

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REFERENCES

[1] Biglarbegian M, Ieee: On the Design of Robust Intelligent Controllers with Application to Mobile *Robot Tracking. In: 2012 American Control Conference*. **2012**: 4879-4884.
[2] Hassanzadeh I, Alizadeh G, Hashemzadeh F, Kharrati H: *P I Mech Eng I-J Sys* **2011**, 225(I3):385-392.
[3] Huang H-C: *Ieee Transactions on Industrial Informatics* **2013**, 9(4):1828-1835.
[4] Huang H-C: *Ieee International Conference on Systems, Man, and Cybernetics*. **2011**: 2267-2272.
[5] Javier Marin F, Casillas J, Mucientes M, Transeth AA, Fjerdingen SA, Schjolberg I:: *Intelligent Robotics and Applications, Pt Ii. Edited by Jeschke S, Liu HH, Schilberg D*, vol. 7102; **2011**: 525-535.
[6] Kumar SM, Kumar MD, Dayal PR, Prasad SM: *Mems, Nano and Smart Systems*, Pts 1-6. Edited by Yuan L, vol. 403-408; **2012**: 4777-4785.
[7] Li T-HS, Yeh Y-C, Wu J-D, Hsiao M-Y, Chen C-Y: *Ieee T Ind Electron* **2010**, 57(5):1687-1700.
[8] Sharbafi MA, Lucas C, Daneshvar R: *Ieee T Syst Man Cy C* **2010**, 40(6):630-638.
[9] Tsai C-C, Wu H-L, Lee Y-R: *International Journal of Nonlinear Sciences and Numerical Simulation* **2010**, 11:91-95.
[10] Peng Jiansheng, Li Xing, Qin Zhiqiang, Li wei. *Journal of Digital Information Management*, **2012**,10:277-283.