http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (24): 8514-8520, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.8514.8520

Design of Smart things Robot System

[1,2]Peng Jian-sheng, [2]He Qi-wen, [2]Wei Qing-jin, [2]Huang Zhuo-cheng,
[2]Chi Sheng-bin and [2]Huang Yi-yong
[1]National Key Laboratory of Communication, UEST of China Chengdu 610054, China
[2]Department of Physics and Mechanical and Electronic Engineering,
Hechi University, Yizhou 546300, China

Abstract: In order to solve the traditional machine of human intelligent control, information interconnection problems, put forward the design method of robot system. The smart things System mainly consists of robot intelligent control module, robot environment temperature acquisition module and the robot surveillance video modules and other components. By using ZigBee wireless network, complete between the robot and robot control information transmission and temperature sensing information, through a Wi-Fi network, in a web browser client control robot, temperature sensing information query robot and robot surveillance video. Compared with the traditional robot system with intelligent monitoring, information interconnection, etc, can be applied to smart home, civilian service robot.

Key words: Smart things, multi-robot, intelligent control, routing, coordination

INTRODUCTION

With the development of modern society Internet of Things (IOT), sensor technology, motor control technology, 3G technology matures (Gao *et al*., 2011; Du *et al*., 2013; Hamblen and van Bekkum, 2013), based on the relevant technology products will be welcomed and supported by the majority of users, while Internet of Things as an emerging science and technology, which combines the application layer, network layer, the sensing layer in one, in order to achieve the target object information network, which will be the future direction of technology development. Combining with the robotics and networking technology is a trend in modern society, based on the development of intelligent robot system (Turcu and Turcu, 2012; Wei *et al*., 2011), break through the traditional design of the robot mode, robotics integration of networking technology, forward the robot intelligent direction, so that the robot can be better used in industrial control, medical equipment, power control, intelligent home and other areas, achieve robot intelligence and information network (Chen and Hu, 2013; Liu *et al*., 2012; Peng *et al*., 2012). Therefore, this study will has a very important significance to improve the people's living standards and people's quality of life .

SYSTEM OVERALL DESIGN

IOT intelligent robot system's overall design is shown in Fig. 1. The design mainly consists of a PC browser client module, coordinating robots and robots routing module. PC browser clients use html language to design, which serves as the robot's user control interface, mainly to complete the data exchange with the robot. Coordinate robot has image video capture and motion control functions; routing robot has temperature sensing information collection, as well as motion control functions. Browser client via Wi-Fi wireless network communication with the coordination robot, while the coordinate robot via ZigBee wireless network communication with the routing robot, coordination work among the various modules, achieving the intelligent robot controlled, image video captured, as well as sensor information collected in the PC browser client.

System contains two types of robots, robot coordination and routing robot, due to each robot's hardware structure is different, they play different roles, achieve different functions. Browser client via Wi-Fi

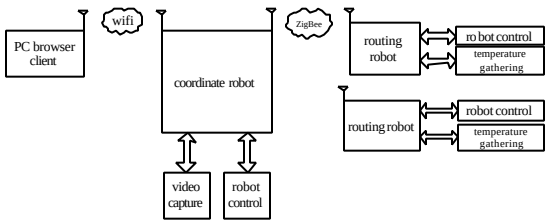

Fig. 1: Overall design structure

Corresponding Author: Peng Jian-sheng, National Key Laboratory of Communication, UEST of China Chengdu 610054, China

wireless network communication coordination of robots, image video data collection and for coordinating robot motion control, Coordination robot through ZigBee wireless network communication with routing robot, achieve the routing robots temperature sensing information collection, as well as routing robot motion control. Here is the origin of name that coordination robot and routing robot, as well as functional description.

Coordination robots: Coordination robot is named as a robot in the position and role of the ZigBee network. It has functions of started, maintenance and management of network in the ZigBee network. Coordination robot also performs an embedded web services configuration tasks, transmiting information to the PC through Wi-Fi network browser client, so that the client can control and query the robot information. The system only has one coordination robot, because the system uses the same ZigBee network.

Routing robots: Routing robot is named after the robot in the position and role of ZigBee network, it has function of joining the network and maintaining a routing table in the ZigBee network. Routing robot can collect own temperature sensor data and transport sensing data to coordination robot to handle. Routing robot can also receive commands from the coordination of the robot and complete the corresponding control action. The system can have multiple routing robots, but considering the cost and other factors, this design only has two routing robots.

SYSTEM HARDWARE DESIGN

Intelligent robot system IOT hardware platform architecture shown in Fig. 2, System hardware consists primarily of coordination for the processor S3C2440 core control module robot to robot CC2430 for the processor core routing control module, camera module, Wi-Fi module, motor drive modules and other components.

This design contains two types of robots, robot coordination and routing robots, robot coordinate system is the core of the wireless network via Wi-Fi and PC, the browser client communication and through the CC2430 wireless module to establish a connection with other routing robots to form a multi-robot information between interconnected. Coordinate robot uses S3C2440 core panel as a master core module, which can reach a maximum operating frequency of 533MHz, can effectively deal with the video image data to complete the design of the system to meet the demand. CC2430 ZigBee communication using high performance as a 2.4G wireless RF transceiver, ZigBee2006 wireless protocol stack can be ported to facilitate communication with other routing robots, it has a rich peripheral interfaces, via USART interface with the host controller communications to facilitate the main control robot control the routing information is processed. Motor drive module using LM298 chip, to achieve the positive DC motor to operate the robot to complete straight forward, straight backward, turn left, turn right, stop, etc. as well as technical action.Routing robot uses CC2430 processor as the master controller. Temperature sensing module directly using CC2430 internal temperature sensor, the measurement range, high precision, responsive and can be used as routing robots ambient temperature, but also saves the cost of design.

Core controller module: The coordination robot and routing robot in IOT intelligent robotic systems with different core controller module, in order to improve the performance of the system, cost savings and implement different functions. Coordinated Robotics core control

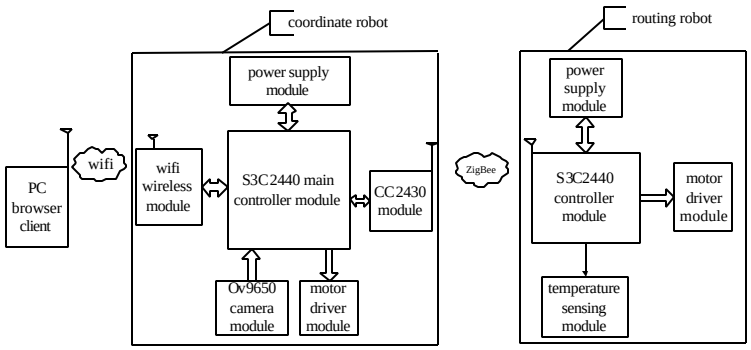

Fig. 2: System hardware platform overall structure

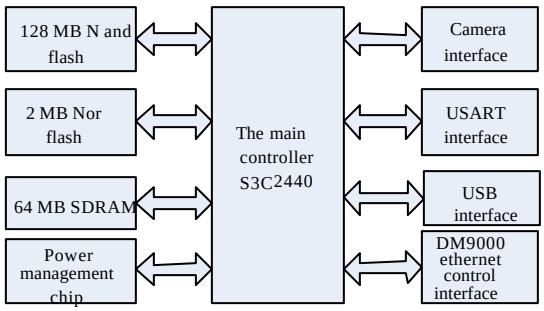

Fig. 3: Coordinate robot core board structure diagram

module uses S2C2440 core controller, shown in Fig. 3 is a block diagram of the core board. Core board by the main controller board and the host controller base plate, master is Samsung's S3C2440 ARM920T core processor chip, S3C2440 is a RISC-based 32-bit instruction set control chip, it has a low cost, low power consumption, performance characteristics, widely used in embedded system development. Backplate with a variety of peripheral interfaces, support for multiple external storage devices, such as Nand Flash equipment, Nor Flash equipment, SDRAM equipment, it is great to meet the development needs of the system, to solve the problem of inadequate storage. Backplane has a rich peripheral hardware devices, such as standard audio equipment, standard USART interface, USB interface, extended GPIO interface, power management devices, CMOS camera equipment, etc, it is mainly to complete the core of the system control function, image data coding. Core board onboard DM9000 ethernet to control the chip, which integrates 10/100 M adaptive transceiver, for sending and receiving data of network provides the hardware conditions. Backplane using low voltage difference on load 1.5 a linear regulator chip AS2815AR 3.3 IC to provide voltage, the controller power supply by the low noise, low dropout linear regulator chip MAX8860EUA, make the system runing in a stable environment.

The core control module of routing robot and coordination robot using TI's CC2430 wireless microcontroller, CC2430 chip system incorporates enhanced industry standard MSC-51 core processor, which is suitable for low-power systems, with a variety of operating modes, The time on switching between modes is shorter, that ensure lower power consumption. It is used to implement embedded system-on-chip ZigBee applications, support for 2.4GHz IEEE 802.15.4/ZigBee protocol, this would resolve the problem of communication among robots, provide hardware condition for system development. CC2430 has extensive hardware peripherals, such as SPI interface, UART interfaces, ADC converter equipment, internal temperature sensor and so on, the design mainly use the internal temperature sensor on the robot to complete the collection of environmental factors. CC2430 has extensive storage capacity, 128KB Flash, 8KB SRAM, such storage device most likely to meet the development needs of the system, to solve the problem that out of memory in the microcontroller development process. CC2430 wireless module circuit diagram is shown in Fig. 4.

Camera module: Camera module is the acquisition of video image system equipment, the system uses cmos ov9650 camera module is shown in Fig. 3-3. ov9650 is OmniVision produced cmos camera, with 1.3 million pixels, the internal provides complete camera and image processing functions, ov9650 camera provides full-frame mode and supports 8/10 bit digital sampling width, uses SCCB (Serial Camera Contorl Bus) data communication protocol, compatible with IIC bus protocol, so the hardware will be designed camera control bus directly attached to the chip IIC bus. Because the controller S3C2440 core board with ov9650 camera bus interface, so you can easily mount the camera module hardware system.

Motor driver module: Motor drive circuit mainly used LM298 chips, LM298 is SGS company's products, the interior chip mainly contains a 4-channel logical drive circuit, is a two-phase motor or a special four-phase motor driver chip and its interior is two full H-bridge bridge driver, you can receive standard TTL logic level signal to drive the motor with different voltage ranges. Its driver module circuit diagram is shown in Fig. 5. Vs is the driving power supply terminal, connected to the voltage 9v, ENA and ENB output are enable the motor termination, connected to the voltage 5v, IN1 and IN2 are TTL control input of the motor, connected to the microcontroller; corresponding to the output terminal OUT1 and OUT2, DC motor connected at both ends. This design uses two LM298 respectively to separate control of four DC motors, increase the car control flexibility.

Usb wireless network card module: Connected by usb wireless network card module in the design of robot and the web server to the client, through Wi-Fi network transmit information between the robot and the web server. System uses Netcore NW336 usb wireless network card, the wireless network card in accordance with the IEEE 802.11 b/g/n protocol standard, maximum transmission rate can reach 150 MBPS and support the

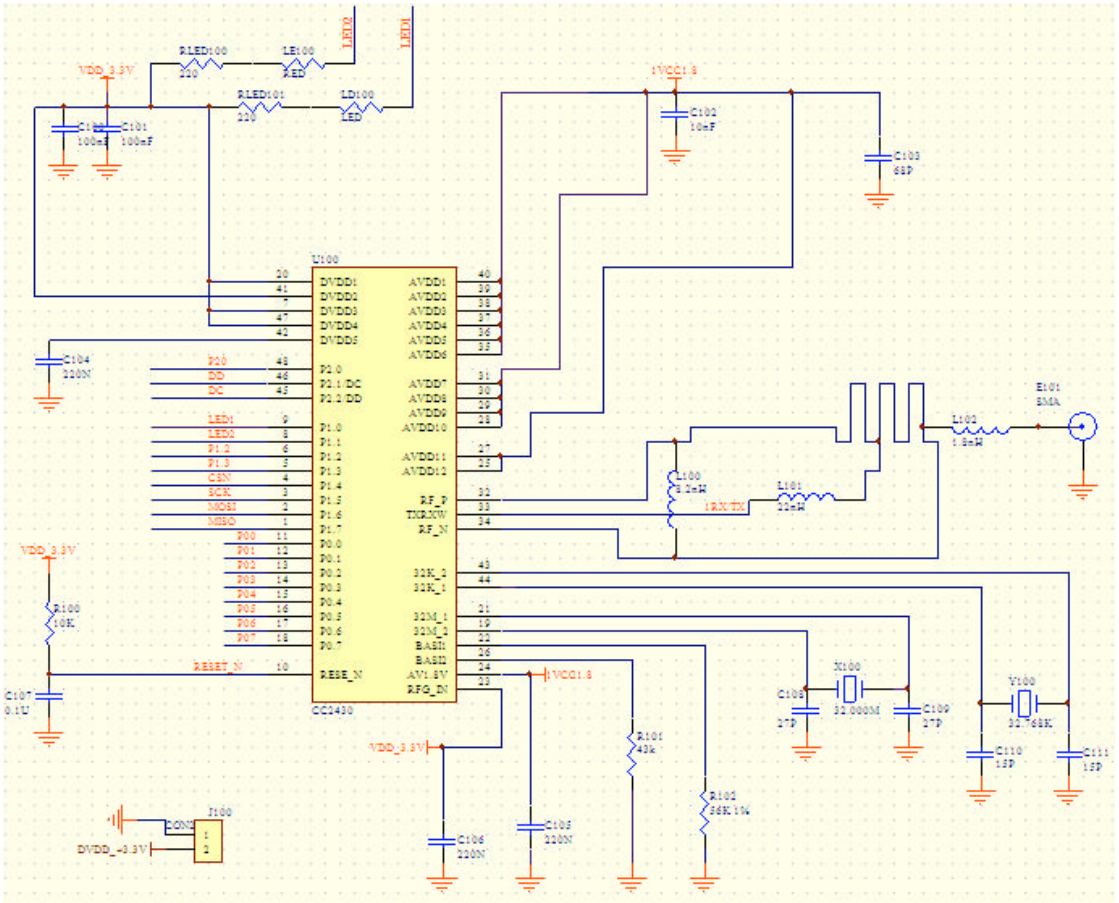

Fig. 4: CC2430 wireless module circuit principle diagram

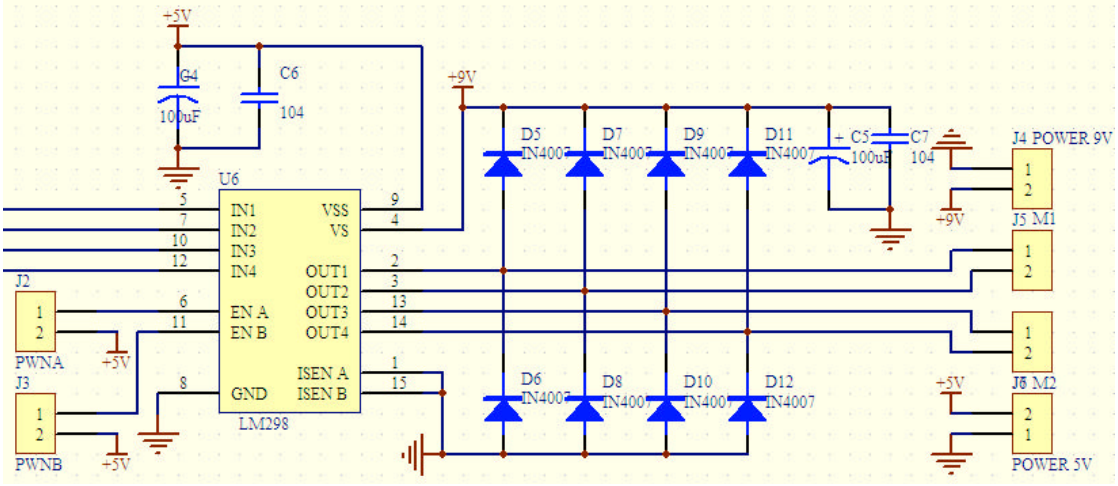

Fig. 5: Principle diagram of the motor drive module

WPS (Wi-Fi Protected Setup) a key encryption. NW336 performance reaches the requirements of image information transmission.

Temperature acquisition module: CC2430 includes an analog temperature sensor and an 8 to 14-bit analog to digital converter ADC. to take advantage of on-chip analog temperature sensors collect temperature, it may need to set the output of the digital precision is 8 to 14. Reference voltage can be set to an external voltage or be set to the internal 1.25 V and set the input of ADC to an on-chip analog temperature sensor, the output of the digital quantity for the corresponding temperature value of the digital quantity. Recycling formula (1) (reference voltage uses internal 1.25 V voltage, bit for the digital Output figures, the Output for the Output digital quantity) convert to temperature value:

$$\text{Temperature} = \frac{\frac{1250}{2^{\text{bit}-1}-1}\text{Output} - 743}{2.45} \quad (1)$$

743 is the data manual of 0 □ when the output voltage (743 mv) in formula (1) , but not every module detected in 0 □ when the output voltage is 743 mv, which requires error compensation:

Offset[mv]=
Measured Voltage at 250C[mv]
¬(Temp.Coeff[mv/?] ×Temp[?]
+Output Voltage at 0?[mv])

Compensation formula is based on the detected temperature at 25 □ case (Temp = 25), the data sheet shows Temp.Coeff = 2.45, Output Voltage at 0 □ = 743, Offset values ??can be calculated. The final actual temperature by equation (2) is calculated:

$$\text{Temperature} = \frac{\frac{1250}{2^{\text{bit}-1}-1}\text{Output} - (743 + \text{Offset})}{2.45} \quad (2)$$

SYSTEM SOFTWARE DESIGN

Design ZigBee wireless data transmission module is mainly used for data transmission between the robot, the wireless module transport data of Different robot and the realization of the function of the different in the system, So ZigBee wireless data transmission module of the software design of the robot coordinate robot software design and routing software design.

Coordination robot zigbee software design: Coordinate robot ZigBee software design process, shown in Fig. 6.

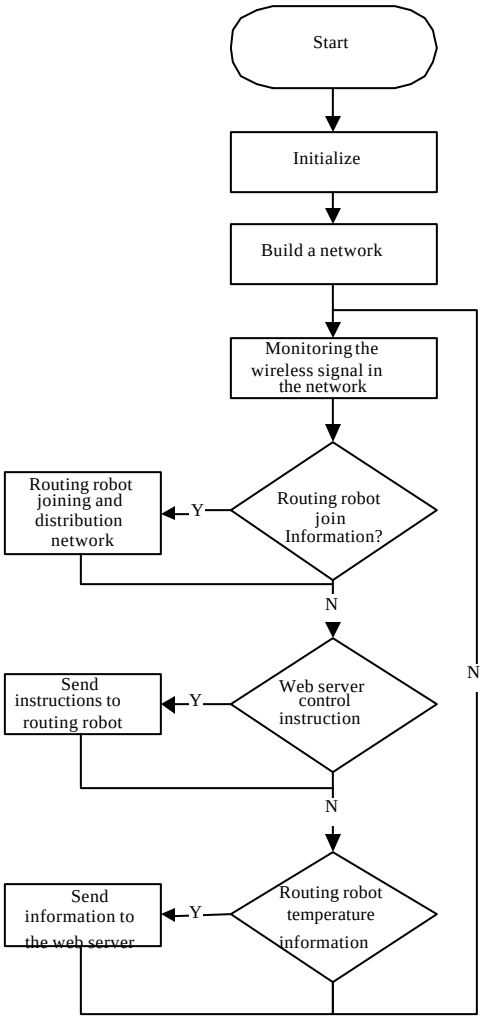

Fig. 6: Coordinate robot Zigbee program flow chart

ZigBee first initialize parameters and configuration option to create ZigBee wireless network, a network, the monitoring network, a wireless signal, if the monitor signal is added to the network to route the robot, the robot was routed distribution network. Robotic hand coordination process control instructions from the web server, the results will be processed and transmitted to the routing robots; while receiving routing robots temperature information, the results will be processed and sent to the web server.

Routing robot ZigBee software design: ZigBee routing robot software design process is shown in Fig. 7. First initialize the ZigBee network parameters and configuration options and then try to join the ZigBee network to establish coordinated robot, if the network does not exist,

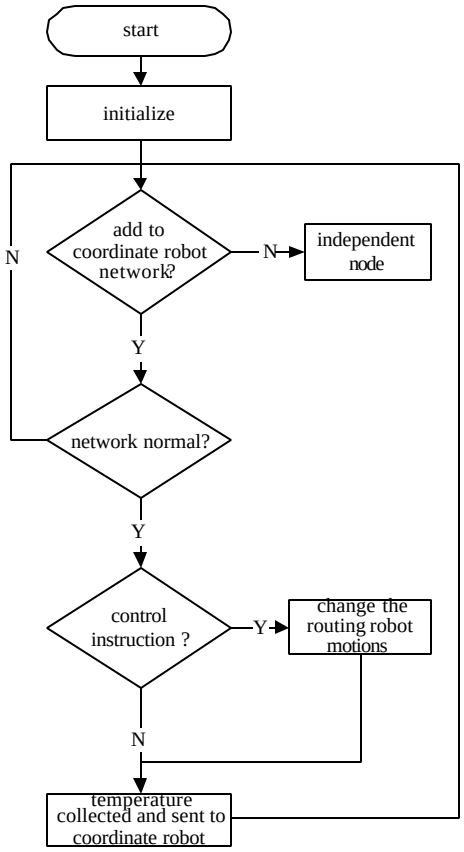

Fig. 7: Routing robot Zigbee program flow chart

the robot will become a separate routing node, if successfully join the network, routing robot mainly deal with two tasks, one is to receive coordinated robots motion control instructions and change their state of motion; another temperature information is collected and sent to the packing process coordinated robots.

SYSTEM TESTING AND RESULTS

As shown in Fig. 8, the intelligent joint robot test platform. Start the hxlt (TP-LINK wireless router router name), the robot will use hxlt network test system. Electric start coordinated robot, waiting for about half a minute, when he saw the development board system on USB wireless network card LED indicator regular flashes, said robot has normal start and added to the hxlt wireless network. Start the routing robot power on, when to see the LED1 indicator on the ZigBee module for about 1 seconds flash once, said routing robot has joined coordinated robot ZigBee network and send the temperature information.

The image acquisition speed and image refresh rate affect the fluency of video, image data using the mjpg-streamer video streaming server and the browser client through web server can receive the image data, fluency, so video capture not only influenced by mjpg-streamer, also affected the performance of web server, such as when the image data of a plurality of a client request, the web server must also respond to them, this time some clients will not image data flow. Between intelligent

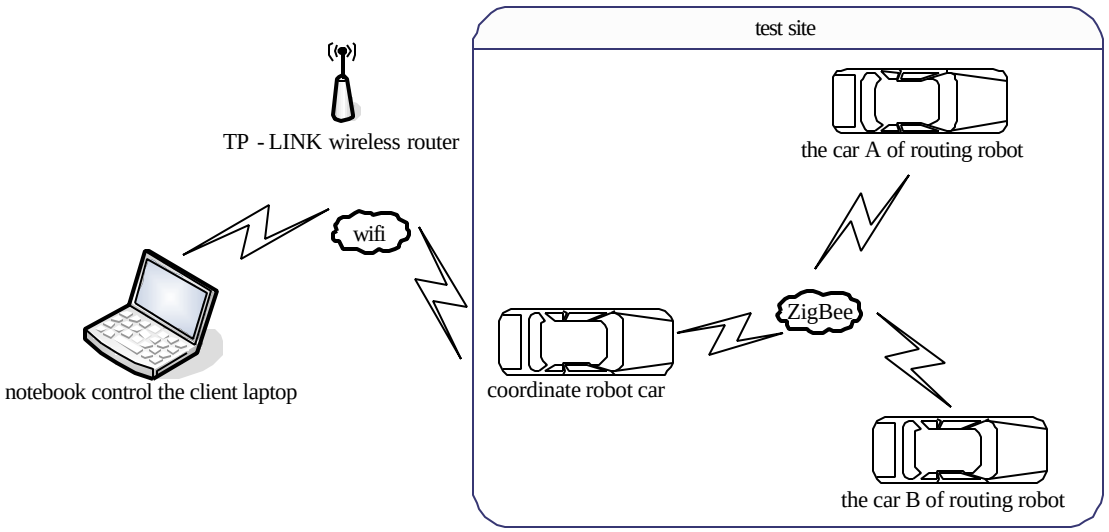

Fig. 8: System test frame

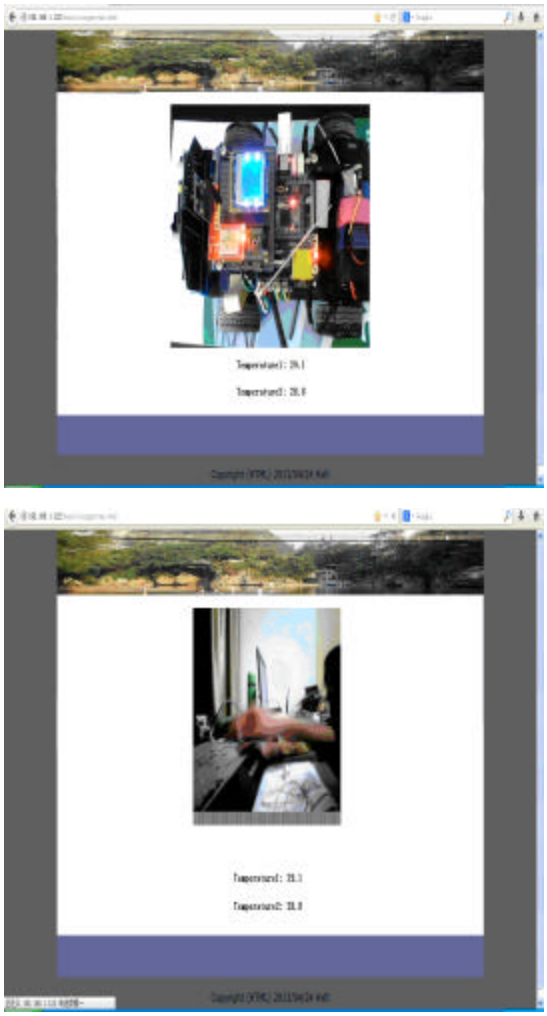

Fig. 9(a-b): System test renderings

complex robot can also communicate between each other and the transfer of information from sensors to the client, the experimental test results as shown in Fig. 9.

CONCLUSION

With the rapidly development of the modern science and technology, the social demand improve constantly, the product what the Internet of things technology combine with robot technology will be constantly updated, Intelligent robot system IOT will be widely applied to people's life. System uses samsung S3C2440 as hardware platform, all meet the requirements on price and the system requirements, using open source embedded Linux operating system as the system software platform foundation, ZigBee as a sensor network system, using HTML web page code. The web server to the client achieves intelligent control of robots, robot temperature information acquisition and the robot surveillance video collection.

ACKNOWLEDGMENTS

The authors are highly thankful for the Guangxi Natural Science Foundation (ID:2013GXNSFBA019282) ,Guangxi university research projects (ID: 2013YB205), Hechi College special projects (2003ZX-N003),Chinese College Students' Innovative Entrepreneurship Training Program (ID:201310605009, 201310605010)and Guangxi Students Projects of Innovation and Entrepreneurship Training Program (ID: 1110,1111).

REFERENCES

Chen, Y.N. and H.L. Hu, 2013. Internet of intelligent things and robot as a service. Simul. Mod. Pract. Theory, 34: 159-171.

Du, M., J. Wang, L. Wang, H. Cao and J. Fang *et al*., 2013. A research on autonomous position method for mobile robot manipulator based on fusion feature. Proceedings of the IEEE International Conference on Mechatronics and Automation, August 4-7, 2013, Takamatsu, pp: 1447-1452.

Gao, L., X.P. Ren and X.B. Li, 2011. Dynamic visual image modeling based on mobile robot self-organizing network in internet of things perception layer. China Commun., 8: 49-55.

Hamblen, J.O. and G.M.E. van Bekkum, 2013. An embedded systems laboratory to support rapid prototyping of robotics and the internet of things. IEEE Trans. Educ., 56: 121-128.

Liu, B., L. Cheng, H.Y. Wu, Y. Chen and F. Wang, 2012. Ubiquitous localization method on mobile robot in the internet of things. Proceedings of the International Conference on Modelling, Identification and Control, June 24-26, 2012, Wuhan, Hubei, China, pp: 537-542.

Peng, J.S., X. Li, Z.Q. Qin and W. Li, 2012. Swarm-Robot system based on wireless sensor network. J. Digital Inform. Manage., 10: 277-283.

Turcu, C. and C. Turcu, 2012. The social internet of things and the RFID-based robots. Proceedings of the 4th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops, October 3-5, 2012, St. Petersburg, pp: 77-83.

Wei, L.S., G. Yuan and X.F. Dai, 2011. Path planning based on warehousing intelligent inspection robot in internet of things. Adv. Mater. Res., 267: 318-321.