THE CARRYING WATER DESIGN OF MOBILE ROBOT BASED ON MC9S12XS128

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***Abstract*—With the development of modern electronic technology, the intelligent robots are researched and developed in many areas. In this paper, the hardware circuit and system software are designed reasonably to achieve the robot carry water from origin to destination. The intelligent robot can carry water along the black guide lines (any shape) forward and backward. A MC9S12XS128 MCU is adopted as the main controller, which is developed by Freescale Semiconductor Company. The tracking, LCD display, water level detection, water storage, water transport and pumping are designed detailedly in the smart water transport system.**

Keywords-MC9S12XS128; automatically carrying water; motor drive; tracking; water level detection

I. DESIGN CONTENT AND REQUIREMENTS

This product is a fully automatic water transport trolley, to carry water from the point of origin to destination, load and unload water automatically. As is shown in Figure 1, the entire process of carrying water is done automatically without any human intervention.

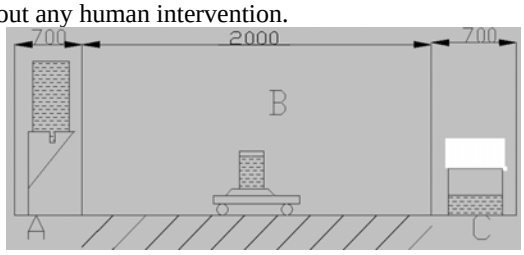

Figure 1. Carrying water smart car

At first, a smart car stops in the initial segment. The car switch is opened to start the car. The car goes forward along the black line and stops at the end of the black line. The car gets water automatically until the water reaches the water lever in the container. Then the car gets back to the starting point along the same route and unloads water automatically. It goes full circle.

II. DESIGN AND PROOF

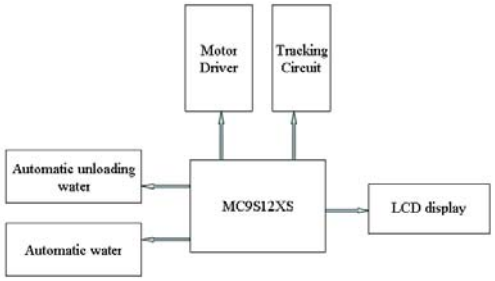

Figure 2. Component Diagram of the System

Total block diagram is shown in Figure 2. When a start command is given, the smart car starts from Area C to Area A along the black guide lines. When it gets to Area A, the smart car emits the 38 KHz frequency infrared rays to the water tower. When the infrared receiver tube on water tower receives the infrared rays, the controller on water tower generates a low level to open the mini-pumps, which injects water into the container. After the car gets water from Zone A, it returns to the Area C along the same path to achieve the water transport.

A. Display module

Option 1: The original display device of LED digital tube is usually selected to obtain the information, which is simple and advantageous to operate. However, the amount of information displayed is too large and there are so many digital tubes in requirement and this way is out of date. So the option is given up.

Option 2: The LCD display module mainly includes the start-up screen, temperature display, date and time display, as well as the quantity of water and water transport time display. This display technology is more advanced, easier to use and better to display. So good this program that it is normally used.

B. The system control unit

Option 1: The 51 MCU has a long history with high integration, processing capabilities, good reliability. It's inexpensive and easy to use. However, in view of the weak,

the functionality of the chip does not have the PWM interface which is commanded in the module of motor, so it requires more actual circuit hardware interface to achieve this function.

Option 2: The STM32 MCU is a 32-bit ARM CORTEX-M3 core, ST production, replacing part of the main IPC 16 and the low-end 32 microcontroller. Stm32's storage capacity is much higher than the 51 MCU. The Enhanced MCU is a high-performance, low-cost and low-power. In view of task time and the degree of mastery of the chip, this option is given up.

Option 3: The Freescale Semiconductor production MC9S12XS128 chip is adopted as the core control unit. High-performance MC9S12XS128 is just a S12X family member. The device includes a large number of on-chip memory and external I / O port. MC9S12XS128 is a 16-bit devices, 16-bit central processing unit (CPU12X), 128KB program Flash (P-Flash), 8KBRAM 8KB data Flash (D-Flash) memory chip. Also it includes two asynchronous serial communications interface (SCI), a serial peripheral interface (SPI) and an 8-channel input capture / output compare (IC / OC) timer module (TIM), 16-channel 12-bit A / D converter (ADC) and an 8-channel pulse width modulation module (PWM). Moreover, the chip also has 91 digital I / O port, some of the digital I / O port have interrupt and wake-up functions. Working at the 3.3 ~ 5.5V in a memory protection unit is used to prevent system errors in the software implementation process.

In view of the experience of MC9S12XS128 chip drives car, as well as the excellent performance of the chip itself and consideration of operation and economic, option 3 is selected.

C. The motor drive module

Option 1: The D/A converter is adopted to changes the voltage applied to the motor. The D/A converter transforms discrete binary digital signals into the analog voltage.

Option 2: In process control, the PID controller has been used widely. The PID algorithm has also been the most popular way in the field of control algorithm so far. It is a feedback control process.

Option 3: The motor speed is controlled by the PWM wave. The different duty cycle pulses are output to the motor to regulate the motor speed.

On the one hand, the MC9S12XS128 MCU don't contains D/A converter, so it's not able to complete the D/A conversion. On the other hand, it becomes a problem that how to regulate the parameters PID. The adjustment is a complex process. So the option 3 is selected, namely the PWM option is selected.

D. Tracking module

The tracking module uses the infrared detection method to track. The infrared rays have the different reflectance properties on the surface of the different color of the object. According to whether receiving the reflected infrared light, the position of the black line is determined. The homemade infrared module are selected in this design. The circuit is shown in Figure 3.

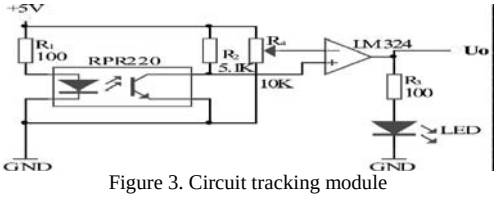

Figure 3. Circuit tracking module

E. Automatic getting water module

Option 1: When a smart car reaches destination, a mechanical arm is designed to get water at the help of MCU program. Then the car returns back along the same path after completing getting water.

Option 2: The micro-pump is selected to extract the water in the water tower, and then inject it into the small car cup.

In option 1, it is hard to design the mechanical arm and it is inconvenient to control it. In option 2, the miniature pump is cheaper and easier to control and operate. Therefore, the second option is selected.

F. Automatic unloading water module

Option 1: Use servo to control cups steering so as to unload water into the storage device. This option is more conducive to unload water.

Option 2: The micro water pump is selected to pump water from the container B to the container C.

Taking into account the existing equipment as well as the complexity of installation, we abandon the option 1. We adopt option 2 to unload water.

III. SYSTEM SOFTWARE DESIGN

The software flow chart is shown in Figure 4.

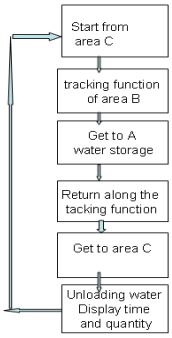

Figure 4.Flow chart of the main program

IV. SYSTEM TESTING

The system is shown in Figure 5. The test results are described below:

(1)A smart car starts from Area C. When it arrives at A zone, it gets water from the water tower. After it gets water, it returns along the same path. Then the car finishes unloading water at area C. The whole process achieves the functions of water transport.

(2) When the smart car gets to Area A, the information exchange between the infrared receiver on the water tower and transmitter on the small car makes the valve of water tower opened to achieve automatic water supply function.

(3) When the car reaches the destination C by tracking, it unloads water through the water pump.

(4) The smart car transports water with an average water supply 400ml in each 8S. The display on LCD is shown in Figure 6. The transported water test table is shown in Table 1.

(5) If a round-trip order is issued, the round-trip carrying water can be realized automatically.

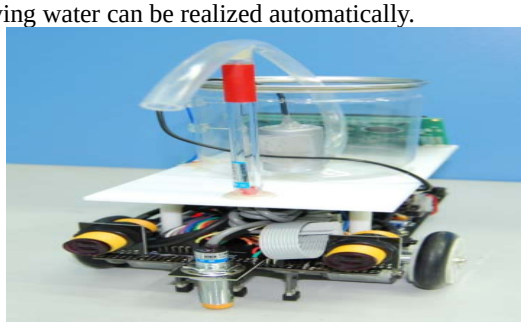

Figure 5. System global view

Figure 6. LCD Test Diagram

TABLE I. Transported water test table

Times(8s)	1	2	3	4	5	6	7	8	averge
Tranported water:(ml)	300	500	500	300	300	500	300	500	400

V. CONCLUSIONS

The paper designs the hardware circuit and software system of the intelligent transport water robot based on MC9S12XS128. The whole system uses the modular design, so that the system has good upgradability and scalability. There are a lot of innovations in the design. For example, in the tracking part, the A/D module isn't used to transform the analog signal which is received by the infrared receiving tube to the digital signal. The resources of MCU are saved because we adopt the infrared detection method. The same method is adopted in the obstacle avoidance part. These methods are adopted so that the design of intelligent transport water robot has advantages in stability, real-time, and cost.

To solve the practical problems in production, the design of the performance is introduced in the robot product development. The project may be applied to a hospital, nursing home, etc. to save manpower, improve the living standards.

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REFERENCES

[1] Zhao Jianxin, Zhang Yali, Zhao Lixin, and Tian sister, "Automatically transported water robot design [J] ".2008, pp.33-35.

[2] Dong Gang. "Intelligent the trolley motion control system developed [D] ". Xi'an: Xi'an University of Science and Technology, 2009.04.29, pp.554-559.

[3] Zhang Yang, Wu Ye, Teng Qing. MC9S12XS Microcontroller Theory and embedded system development [M]. Publishing House of Electronics Industry, 2011, pp.95-98.

[4] Feng Wang and Yangu Zhang, "The Comprehensive Defence against Railway System-wide Disaster by Computer Interlocking System", *Proc. 2nd Int'l Conf. Intelligent Information Management Systems and Technology (IIMST 2007)*, World Academic Press, 2007, pp. 171-174.

[5]Feng Wang, Yangu Zhang, and Chengfeng Ye, "HBACA-based Railway Yard Route Searching", *The 3rd International Symposium on Intelligent Information Technology Application*, 2009.11, pp.496-499.

[6]Feng Wang, Yangu Zhang, and Fangfang Chen, "Research on WangZhai Station Route Optimization", *2009 International Symposium on Image Analysis and Signal Processing*, 2009.04, pp.183-187.

[7]Feng Wang and Xiaoli Zheng, "Simulation of the fixed-point number arithmetic", *Key Engineering Materials*, v467-469, 2011, pp.2097-2102.

[8]Feng Wang, Bo-lin Wang, and Yangu Zhang, "Asymmetry DFT Algorithm and Its Application", *Journal of Chongqing University*, Vol. 31, No. 2, Feb. 2008, pp.162-165.

[9]Xiaoli Zheng, Feng Wang, "Construction of Project-Based Virtual Learning Community", *Lecture Notes in Computer Science*, v 5145 LNCS, 2008, pp. 304-313.

[10]Shi Jie, Lu Guangchang, Zhang Yan, and Li Baofeng,"Easy to transport water robot [J]. Electronic production", 2009, 04, pp.42-45.

[11] Lan Wang, Tiehong Gao, and Feng Gao, "Experimental research on locomotion characters of water strider and movement realization on a water strider robot", 2010 IEEE International Conference on Robotics and Biomimetics, 2010, pp.585-590.

[12] Feng Wang, Xiaoli Zheng, and Haijiang Xia, "The Design of Carrying Water Intelligent Robot Based on C8051F410", 2011 International Conference on Electrical and Control Engineering, 2011, pp.1330-1333.

[13]Yurong Chen, Huijiao Huang, Xiaoli Zheng, and Feng Wang, "The Design and Implementation of Information Transmission Module of Fire Alarm System Based on S3C2440", 2012 International Conference on Mechatronic Systems and Automation Systems, 2012, pp.231-235.