Chapter 6
The Infusion Monitor System Based on Single-Chip Micyoco

Haiyin Qing, Changjun Wu, Yanbao Wu, Haoyu Song, Qiuwen Gong, and Kehan Yu

Abstract This system uses the Single-Chip Micyoco as the main control chip, uses the capacitance sensor of the liquid level measurement as the detecting element, and uses the port wireless receiving and dispatching module (LC12S) as the signal transmission unit, which can realize the information collection of the patients and unified management. When the infusion is over, the alarm signal is transmitted wirelessly to the nurse station. The hospital central control system will realize sound and light alarm according to the test results, and display the specific alarm position for those hospitals with lower condition; for the hospital with best condition, every working nurse could be equipped with an alarm bracelet which can display and alarm need to change droplet bed ID. This system can reduce the medical negligence and improve the efficiency of health care.

6.1 Introduction

With the rapid development of automation equipment in recent years, the progress of intelligent medical equipment will become the focus of people. At present, in clinical medicine, the most commonly used treatment method is intravenous infusion; due to the need for human monitoring, it not only leads to the decline of medical staff's work efficiency, but also causes medical accidents due to human negligence; how to realize the liquid-level monitoring, sound and light alarm and display without affecting the normal infusion of patients? [1–4]. Therefore, it is necessary to improve the existing man-made monitoring mode and study the intelligent infusion monitoring system, so as to reduce the probability of medical accidents and improve the efficiency of medical care.

The concept of portable intelligent infusion monitoring system is introduced: the infusion information of patients in the inpatient building is collected at multiple points and managed in a unified way. When the infusion is about to end, the alarm signal is transmitted to the nurse desk through wireless transmission. The nurse desk

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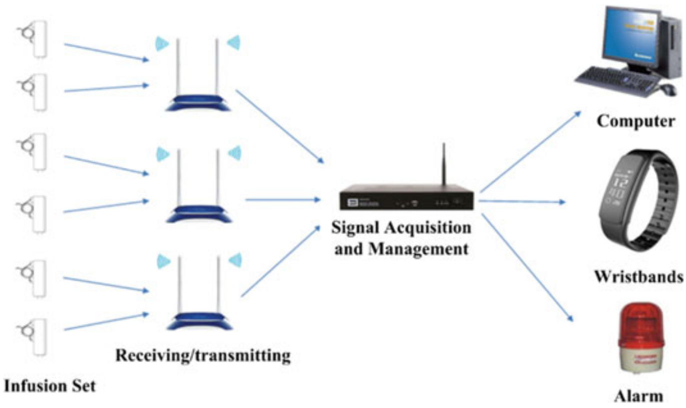

Fig. 6.1 System work flow chart

can clearly see the infusion process of patients through the display screen, and realize the sound and light alarm. If conditions permit, each nurse is equipped with an alarm bracelet, which can realize the real-time monitoring. The workflow of the system is shown in Fig. 6.1.

6.2 Product Design

The software part of the system consists of sending end and receiving end. The transmitter is mainly used to receive the output signal of the liquid-level detection sensor. The signal is analyzed and processed by the single-chip microcomputer to judge the infusion situation. If the infusion is about to end, the transmitter module will send an alarm signal. The receiving end is mainly used to receive the alarm signal sent by the sending end. If the alarm signal is received, the display module will display the bed information and send out the sound and light alarm [5, 6]. The alarm Bracelet processing method is similar.

The hardware part of the system consists of transmitter and receiver. The transmitter is mainly composed of liquid-level detection module and wireless transmission module, and STC89C52 is the main control chip. The receiving end is mainly composed of wireless receiving module, OLED display module, and sound light alarm module. At the same time, STC89C52 MCU is used as the main control chip [7].

6.3 System Composition

Now, SCM is not only a powerful assistant for developers, but also an indispensable tool in practical application, which is widely used in various fields [8]; as an important representative of embedded system, it plays an important role in the development of electronic technology [9]. STC89C52 has a maximum clock frequency of 80 MHz. The chip contains 4 K bytes Rom. The device is compatible with the standard MCS-51 instruction system and 80C51 pin structure. The chip integrates a general 8-bit CPU and ISP flash memory unit. With the PC control program, the program can be downloaded into the MCU. In this way, there is no need to buy a general programmer, and the speed is faster than the editor. The chip pin diagram of STC89C52 is shown in Fig. 6.2.

Sensors are the eyes of the system. In practical application, there are many monitoring points and the environment is more complex, so only manual duty cannot meet the requirements [10]. At present, most of the infusion monitors in the market use photoelectric sensors to detect the flow of liquid. Its disadvantage is that the photoelectric sensor is greatly affected by the light, especially in the strong light environment; the photoelectric sensor almost completely fails. In addition, the transparency of the liquid is very high; sometimes it cannot block the infrared signal from the infrared emitting tube of the photoelectric sensor, resulting in the inaccurate signal transmitted by the sensor; the medical equipment must be of high precision and high stability; in the above situation, we use the capacitive liquid-level sensor based on the change of capacitance, that is, when the liquid flows through, according

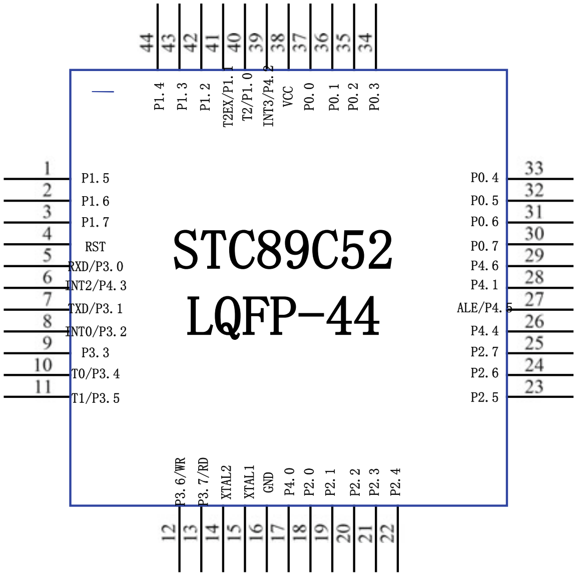

Fig. 6.2 Chip pin diagram of STC89C52 single-chip microcomputer

Table 6.1 Product parameters of xkc-y26a

Index	Parameter
Input volage	DD 5 ~ 24 V
Current consumption	3 ~ 8 mA
Output voltage (high)	Vin
Output volage (low)	0 V
Output current	1 ~ 100 mA
Response time	500mS
Working environment temperature	0 ~ 75 °C
Applicable diameter range	3 ~ 10 mm
Liquid level error	±2 mm
Humidity	5% ~ 100%
Texture of material	ABS
Waterproof performance	IP65

to the difference between the two plates of the capacitor the flow of liquid can be judged by the change of medium [11].

The intelligent non-contact liquid-level sensor uses the inductive capacitance of water to detect whether there is liquid. When there is no liquid approaching the sensor, there is a certain static capacitance between the sensor and the ground due to the distributed capacitance. When the liquid level rises slowly and approaches the sensor, the parasitic capacitance of the liquid will be coupled to the static capacitance to make the final electric resistance of the sensor. When the capacitance value becomes larger, the changed capacitance signal is input to the control IC for signal conversion, which converts the changed capacitance into the change of some electrical signal, and then a certain algorithm is used to detect and judge the degree of the change. When the change exceeds a certain threshold, it is considered that the liquid level reaches the sensing point [12]. The specific indicators are shown in Table 6.1.

At present, most of the infusion monitors on the market use wired transmission alarm signal, and they cannot understand the infusion situation centrally, which not only increases the installation cost, but also does not improve the medical efficiency to the extreme. Our solution is to use MCU to drive wireless module to send real-time data. Because the transmission distance may be far away, in order to ensure stability, we use signal repeater to receive and amplify the signal. Finally, we realize the unified management and distribution of the signal at the nurse end, and make windows-based display software to display the infusion information of each bed.

Lc12s adopts the latest 2.4gsoc technology, which is characterized by free development, sight distance of 120 m, integrated transceiver, no switching, transparent serial port transmission, and communication protocol. It can be quickly debugged successfully. The module is half duplex communication, with strong anti-interference ability, where working frequency can be set, multi-module frequency's complementary interference, small volume MSD package, no antenna, convenient installation,

Table 6.2 Product parameters of lc12s serial wireless transceiver module

Index	Parameter
Working frequency	2.4 Ghz
Receiving sensitivity	95 dBm
Receiving working current	27 mA
Interface	UART Serial port
RF chip	BK2461
Emission working current	40 mA@12 dBm
Working volage	2.89–3.6 V typical 3.3 V
Sight distance	120 m

and medical personnel can monitor each infusion point that carry out the whole process monitoring [13]. The specific index parameters are shown in Table 6.2.

Organic light emitting diode (OLED): organic light emitting diode (OLED) is also known as organic laser display. OLED display technology has the characteristics of self-illumination. It uses very thin organic material coating and glass substrate. When current passes through, these organic materials will emit light. Moreover, OLED display screen has large viewing angle and low power consumption [14]. OLED has the advantages of high contrast, thin thickness, wide viewing angle, fast reaction speed, flexible panel, wide temperature range, simple structure, and process. The first 12,864 screens are LCD, which need backlight and high power consumption, while OLED has low power consumption, which is more suitable for small systems; due to the different light-emitting materials, OLED displays better in different environments. The module power supply can be 3.3 V or 5 V without modifying the module circuit.

6.4 Physical Debugging

According to the hardware design, we use Altium designer software to complete the schematic drawing. The figure below is to draw the wireless sending and receiving module together. The physical schematic diagram is shown in Fig. 6.3.

According to the hardware design, using Altium designer software to complete the drawing of PCB diagram, drawing the wireless sending and receiving module together can save cost; most of the components of PCB adopt chip packaging, pursue small volume and are portable; the specific figure is as follows: the physical PCB diagram is as shown in Fig. 6.4.

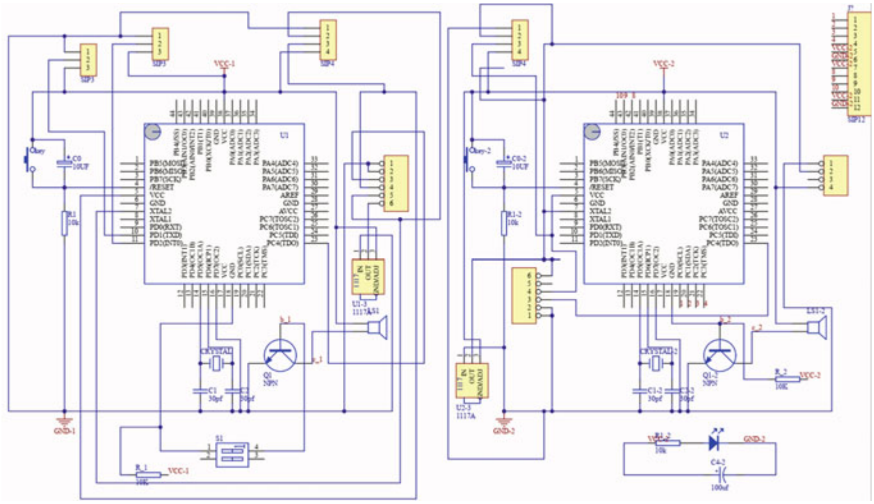

Fig. 6.3 Physical schematic diagram

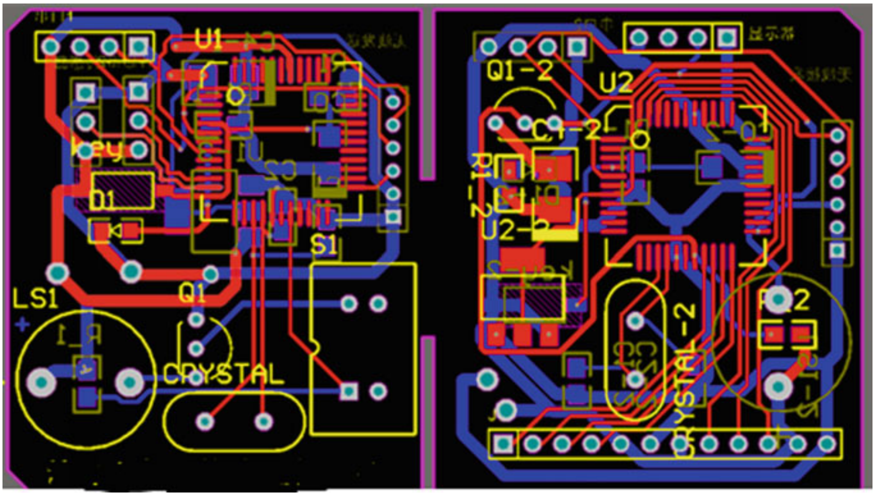

Fig. 6.4 Physical PCB

6.5 Conclusion

At present, the equipment that can realize transfusion monitoring can be seen everywhere on the Internet, but it is rarely used in the market. The reason is that most of the equipment is complex in technology, expensive in cost, and large in volume, or it needs to change the national standard structure of transfusion tube or the original alarm system of the hospital, which greatly reduces the feasibility of the practical application of the product; moreover, the high cost makes small hospitals. It is difficult for target customers such as general clinics to afford.

At present, the system has the reliability and stability to participate in the practical application, which is superior to other similar products in the market in terms of operation difficulty and cost. However, due to the problems of manufacturing technology and medical equipment licensing, it is difficult to be put into the market at present. It is expected that if it can be widely used, it will be an indispensable part of hospitals and animal husbandry. Therefore, the system has a broad market prospect and certain social significance.

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References

1. L. Zhiying, C. Mingxia, L. Hongfu, L. Shunyan, Intelligent infusion monitoring system based on STC89C52. China Sci. Technol. Inform. **10**, 64–66 (2019)
2. Z. Yue, Y. Songli, X. Hui, Y. Tianhao, L. Yifan, Z. Xiaochen, Software design of unattended infusion monitoring system based on MCU. Ind. Technol. Forum **14**, 70–71 (2018)
3. Z. Yingping, Z. hanqiang, Z. Jinpeng, L. Haitian, Design of intelligent liquid droplet monitoring system. J. Jilin Normal Univ. **3**, 69–73 (2017)
4. L. Lei, Y. Ling, L. Ping, L. Fei, W. Yanan, Development of an infusion detection and monitoring device. Med. Health Equip. **7**, 36–38 (2016)
5. W. Zhongwei, H. Xianshan, Y. Tong, Design and research of wireless loss preventer based on 51 single chip microcomputer. Ind. Control Comput. **12**, 154–156 (2018)
6. J. Xizhen, Z. Jiamin, Z. Chengming, L. Zhaolin, C. Mei, Automatic detection, monitoring and alarm device for liquid drops. Electron Technol. **11**, 3–4 (2018)
7. S. Lei, L. Zhentao, G. Ziping, H. Jian, Implementation of transfusion monitoring and management system. Chinese PLA Hosp. Manag. J. **12**, 1155–1157 (2016)
8. S. Hua, application of single chip microcomputer in electronic field. Electr. Technol. Softw. Eng. **24**, 242 (2018)
9. N. Xiaoyan, H. Xu, M. Xuchang, L. Xiwen, S. Lei, Application and development of single chip microcomputer. Hebei Agric. Mach. **12**, 53 (2019)
10. L. Ze, J. Mingshun, L. Shanshan, Z. Youfeng, S. Chenhui, Z. Lei, Z. Faye, S. Qingmei, Design of high precision ultrasonic liquid level measurement system. Automat. Instr. **11**, 56–59 (2018)
11. F. Peiyun, F. Junqing, Realization of remote water level monitoring based on STC89C52. Smart Factory **8**, 57–59 (2018)
12. Q. Zhaoyan, Design of liquid level control system. Technol. Market **12**, 102 (2016)
13. Cairns, OLED will be the next wind outlet, Yingcai, vol. 7, pp. 90 (2016)
14. W. Jinxia, W. Hao, Preliminary design of remote infusion monitoring and automatic alarm. Wireless Internet Technol **5**, 127 (2014)