International Journal of Biology and Life Sciences
ISSN: 2957-9511 | Vol. 6, No. 3, 2024

Medical Intelligent Infusion Management Device Based on STM32

Chao Zhang, Bei Zhao

School of Physics and Electronic Engineering, Taishan University, Tai'an, Shandong, 271021, China

Abstract: The medical intelligent infusion management device designed in this project uses STM32 microcontroller and Internet technology to realize remote one-click bottle changing, and doctors and patients can monitor infusion progress in real time. Compared with traditional infusion, the operation of this device makes infusion intelligent, safe and simple for patients. The device involves the instrument using the power supply to avoid power failure during use, and has the characteristics of low power consumption, small size, low cost, etc. It integrates the work of the whole process of infusion in one, and uses the Internet to achieve the purpose of automatic intravenous infusion. In addition, the use of the instrument is safe and reliable, simple operation, accurate measurement, compared with the intelligent automatic bottle changing infusion device that has been put into application with a complex structure and high cost, it is more suitable for the development of modern medicine, and it is easy to be popular in institutions of different levels.

Keywords: STM32F103 MCU; The Internet; Infusion Automation; Wireless Laser Liquid Level Sensor; Intelligentize.

1. Introduction

With the continuous development of medical technology in China, the application of intelligent medical equipment in the medical industry is more and more extensive. Infusion is one of the common treatment methods in clinical medicine, but the traditional infusion management mode has many defects, such as manual operation is easy to make mistakes, cannot monitor the infusion situation of patients in real time, and has a great impact on the work efficiency and burden of medical staff. Therefore, it is of great practical significance to design a medical intelligent infusion management device based on STM32. This paper aims to discuss the design and implementation of intelligent medical infusion management device based on STM32. STM32 single chip microcomputer and Internet technology can realize remote one-click bottle changing, and doctors and patients can monitor infusion progress in real time. Compared with traditional infusion, the operation of this device makes infusion intelligent, safe and simple for patients. The device involves the instrument using the power supply to avoid power failure during use, and has the characteristics of low power consumption, small size, low cost, etc. It integrates the work of the whole process of infusion in one, and uses the Internet to achieve the purpose of automatic intravenous infusion. In addition, the instrument is safe and reliable in use, simple in operation, accurate in measurement, more suitable for the development of modern medicine, and easy to be popularized in institutions of different levels.

2. Function Introduction of the Device

The device is planned to be composed of a wireless laser liquid level sensor, a central controller (equipped with a full-LCD intelligent Wi-Fi display), a drug solution anti-contamination device, a pipe clamp control module, and a Wi-Fi module, which can allow patients and medical staff to instantly obtain data such as the number of infusion bottles and liquid level, and realize infusion bottle with one click. The reed tube relay is applied to detect the liquid level, the wireless laser liquid level sensor collates the liquid data and sends it to the central controller, which can display and perform related operations on the LCD screen, and send the command to the pipe clamp control unit to control the liquid change. The intelligent device integrates all the work in the whole process of infusion, and uses the Internet to achieve the purpose of automatic intravenous infusion.

2.1. Wireless Laser Level Sensor

Based on the principle of optical detection, the sensor is a non-contact high-precision liquid level sensor with very good performance. The laser beam is very thin, even if the liquid level surface is extremely rough, it can work normally, and the receiving range is very wide [6]. It uses near-infrared light and uses a semi-transmitted mirror to process the laser emitted by the optical flow. Part of the laser is used as a reference signal to input the time transmitter, and the other part of the laser through the semi-transmitted mirror is processed by the optical system to become a certain width of parallel beam irradiated on the object surface. The reflected wave reaches the receiving part of the sensor and is converted into an electrical signal. Because the time from irradiation to reception is very short, the sampling circuit is expanded to the order of nanoseconds to facilitate signal processing and time measurement. Using microcomputer for data processing, into digital display of liquid level value of the analog output signal, using software to detect the signal of reliable parts, if the measurement system failure alarm.

2.2. Central Control Unit

The central controller controls the system's modular devices through protocols, separating the underlying physical network from the applications that are programmed to control the underlying network. When the doctor uses the full LCD intelligent Wi-Fi display to change bottles or check the input of medicine liquid and other operations, the system code program guides the central control to realize the north communication, and the south communication is responsible for programming and controlling the network equipment.

2.3. Liquid Medicine Anti-pollution Device

The whole device is composed of a monitoring tube and a relay device (composed of a normally open reed tube and a manual switch in the control module of the tube clamp, a battery power supply, a light-emitting diode, etc.). The upper part of the monitoring tube is connected to the infusion bottle or infusion bag, and inside is a disposable disinfection float containing a strong magnetic block. The reed tube relay device is installed on the outside bottom of the monitoring tube and is responsible for controlling the opening and closing of the circuit in the control module of the tube clamp, and then controlling the opening of the clamp[10]. With the infusion, the liquid level in the monitoring tube drops to the end of the flow, the float ball drops to the bottom of the monitoring tube with the liquid level to magnetize the normally opened reed tube, the reed tube relay closes, the electromagnetic suction switch opens, and the clamp releases the infusion tube to make the liquid flow smoothly. The device is separated from the liquid medicine to avoid contact, prevent contamination of the liquid medicine, and ensure the safety of infusion.

2.4. Clamp Control Module

The clamp control module consists of a clamp control unit and an infusion clamp. The essence of the infusion tube clamp is an electromagnetic suction switch. The cylindrical iron core in the suction switch and the spring on it are used to clamp the infusion tube in the round hole, and the tube clamp is connected to the infusion tube of each drop bottle. The infusion tube clamp is closed when not in use because of the spring elasticity, and the circuit is connected when in use. When infusion begins, all infusion pipe clamps are closed, and when the first bottle of liquid is finished, the reed tube in the liquid level monitoring device is closed, so that the circuit in the pipe clamp control unit is connected, and the infusion pipe clamp at the second bottle is opened due to magnetic attraction, so as to realize the purpose of automatic liquid change.

3. The Overall Structure of The Device

After research, we determined the basic process of device operation, as shown in Figure 1.

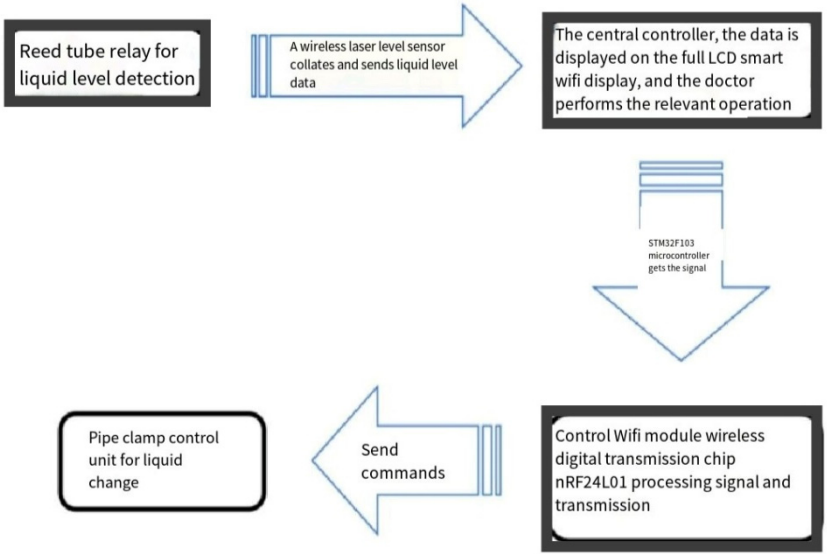

Figure 1. Basic process of device operation

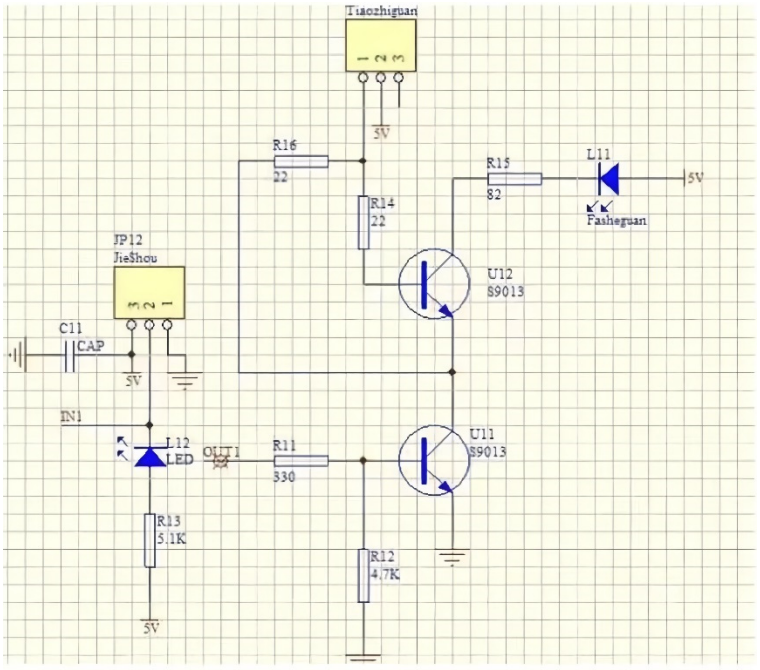

Figure 2. Wi-Fi module circuit composition

Namely: the reed tube relay is used to detect the liquid level [10], the wireless laser liquid level sensor organizes the liquid drug data and sends it to the central controller, which can be displayed and operated on the LCD screen. The STM32F103 MCU obtains and controls the processing signal of wireless digital transmission chip nRF24L01 and the Wi-Fi module transmits the signal to send the command to the pipe clamp control unit to control the liquid change.

The liquid exchange device is shown in Figure 3. At the beginning of infusion, open the circuit master switch at the control module (15) of the tube clamp, connect each infusion tube, close the tube clamp (13, 14) tightly, and only the drip bottle (1) will flow down to make the disposable disinfection float (5) containing a strong magnetic block in the monitoring device (4) float. When the infusion is carried out, the liquid in the drop bottle (1) is finished, so that the float ball (5) is magnetized at the bottom of the monitoring tube with the liquid level, and the circuit at the clamp (13) is opened by electromagnetic principle, so that the liquid in the drop bottle (2) can flow smoothly; The drip bottle (2) makes the drip bottle (3) run down in the same way. When the liquid in the drip bottle (3) is finished, the float ball (11) in the monitoring tube (10) magnetizes the wireless laser level sensor circuit path mediated by the reed tube, and sends an alarm signal to the central controller to notify the completion of infusion.

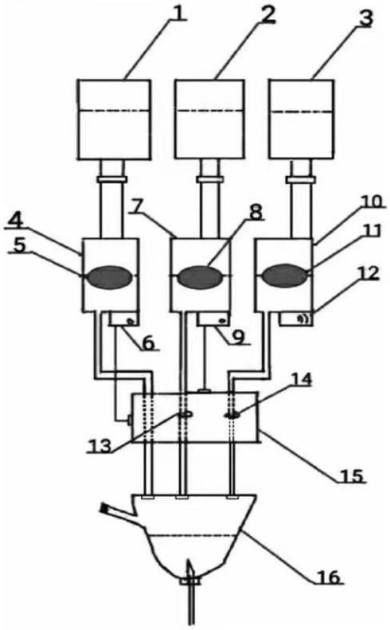

Figure 3. The liquid exchange device

4. Epilogue

We use reed tube relay to detect liquid level, wireless laser liquid level sensor to organize liquid data, MCU STM32F103 to control wireless digital transmission chip nRF24L01 to process signals and Wi-Fi module to transmit signals, and send commands to pipe clamp control unit to control liquid change. Compared with ordinary MCU STM32, we use STM32F103 enhanced series MCU, which has high performance, uses single-cycle multiplication and hardware division, low cost, low power consumption, can be tailored, and can be compatible with all ARM tools and software. Compared with the large medical intelligent infusion device abroad, the device is small in size, and the ordinary infusion device is basically no difference, no excess space occupying pressure. The use of power supply to avoid power failure during use, the patient transfusion safety has been effectively guaranteed. Compared with the ordinary liquid level sensor, the wireless laser liquid level sensor, the laser beam is very thin, the use of near-infrared light, the use of semi-transmitted mirror processing is emitted by the optical flow, partial transmission, high accuracy, wide acceptance range, fast operation speed, and better ensure the efficient infusion process. Use the Internet to monitor the patient's liquid medicine situation in real time, and configure the full LCD intelligent Wi-Fi display for easy operation, to achieve remote one-click bottle changing. Add the anti-contamination device to avoid contact between the device and the liquid, prevent the contamination of the liquid, and ensure the safety of the infusion. The infusion unit can be recycled to reduce costs and does not need to be sterilized before each use.

Although the device solves the problem of automatic bottle changing which cannot be realized by ordinary infusion set, and the intelligent remote one-click bottle changing can reduce the work burden for doctors, there are still some problems to be improved. First, the infusion time is too long, the patient is still inconvenient to go to the toilet, prepare to add a movable stent; Second, when the air temperature is low, many places use the method of warm baby holding the infusion tube, which is extremely inconvenient and has certain safety risks. In the need for proper heating of the liquid medicine, increasing the heating device at the infusion tube or liquid medicine bottle can solve this problem.

References

[1] Yao Liping, Wu Xinshe, Tang Yuanliang, et al. Design of a portable intelligent infusion control device [J]. Internet of Things Technology,2023,13(03):137-139+142.

[2] Liu Guixia, Zhang Hui, Shi Yanqun, et al. Effect of intelligent infusion management on respiratory and critical care patients and their families [J]. Journal of Anhui Medical College, 2019,22(01):19-21+27. (in Chinese)

[3] Yong Jiaxin, Lu Wei. Design of intelligent infusion monitoring device [J]. Digital Technology and Application,2022,40(12):

[4] Wang Hongqun. Application effect of nursing management intervention in patients with intravenous transfusion [J]. Medical Equipment, 2019,01 (11): 172-173.

[5] WEI Jiachang, Li Xianliang, Yan Bo, et al. Automatic fluid change alarm intravenous infusion set [J]. Science and Technology Wind, 20, 19.

[6] Fang Hang. A kind of liquid level Sensor Applied to laser co mplete machine [J]. Technology & Market, 2022, 29 (08): 44-46.

[7] Zhang Xiaochun, Chen Jie, Zhang Qiuhong, et al. Design of a safe fixed infusion set [J]. China Medical Equipment, 2018,33 (01): 82-85. (in Chinese)

[8] Gong Xiao Shan, Tang Hao, Zhang Hehua, et al. Discussion on standardized management of the use of hospital medical equipment [J]. Medical and Health Equipment, 2018,39 (12): 82-84. (in Chinese)

[9] Zhu Menglin. Automatic infusion device and Automatic infusion method [M]. China Patent CN108653857A, 2018-10-16.

[10] Cai Pengfei, Deng Jing, Xu Shun, et al. Design of External Automatic cutoff infusion Device [J]. Industry and Technology Forum, 2018,17 (11) : 77-78.