Advances in Engineering Research, volume 197
Proceedings of the 2020 9th International Conference on Applied Science, Engineering and Technology (ICASET 2020)

The Design of Infusion Monitoring System Based on AT89C51

Jianjun Zhang

Intelligent Manufacturing Institute, Jianghan University, Wuhan, Hubei 430056, China
**Corresponding author. Email:tozhangjianjun@qq.com*

ABSTRACT
Intravenous fluid infusion is an effective treatment for patients, but it requires monitoring by nurses or family members. We design a monitoring system based on AT89C51 to solve monitoring problems and avoid medical accidents. We use infrared sensors to monitor the infusion drip rate, buzzers and light-emitting diodes(LED) to achieve abnormal alarms, and liquid crystal display(LCD) liquid crystals to display the information. Through this design, medical staff can treat abnormal situations such as too fast or too slow infusion. This system has comprehensive functions, low price and high performance.
Keywords: *fluid infusion, infrared sensors, AT89C51， buzzer,LCD, nRF24L01.*

1. INTRODUCTION

Intravenous fluid infusion is so reliable in the patient's healing process. Every year, there are a large number of medical accidents due to infusions. Using an infusion monitoring system can avoid these medical accidents. Many scientists have done researches in this area to reduce medical accidents. Setiawan, Agung W. et al.[1] designed and developed a low-cost wireless remote infusion monitoring system which can report the important information to the nurses' station for the monitoring system in the patient room and nurses' station. A infusion monitoring system was designed based on the STM32 microcontroller and one pair of infrared emitting and receiving diode by Xu, Zhi Hui et al.[2]. Amano, Hikaru et al.[3] developed the infusion monitoring device employing a Bluetooth module which could detect the drip infusion rate and an empty infusion solution bag and send the data to the central monitor. A new drip infusion solution monitoring system was developed for hospital and care facility use by Ogawa, Hidekuni et al.[4] which could detect and count the fall of each drip chamber drop of fluid. Sifa Fauziyyah, Auliya et al.[5] designed the automatic infusion monitoring system based on Arduino. An infusion monitoring system, aiming to reduce potential safety hazard of manually-controlled infusion was introduced by Wang, Jifeng et al.[6]. Zhang, Le et al.[7] proposed an infusion monitoring system based on OneNET platform, with Arduino as the core control device, infrared tube to detect the drop rate and number of drops of infusion, non-contact liquid level sensor to detect residual liquid level, load cell detection drug. Wang, Hua Sheng et al.[8] introduced the intelligent medical infusion monitoring system.

In this research, an infusion monitoring system based on ST89C51 is designed. Infrared sensor is used to monitor infusion drop speed. Buzzer is used to generate audible alarm, and light-emitting diode is used to generate light alarm. LCD module is used for the real-time display of drop speed and infusion residual quantity. When an accident occurs, doctors and nurses can detect and deal with it in time to avoid medical accidents.

2. HARDWARE DESIGN

2.1. Emission Port

The block diagrams are very important in the design of the research. The emission port of the infusion monitoring system block diagram is show in Figure1.

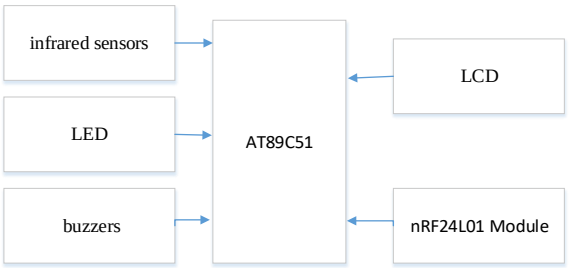

Figure 1 Emission port system block diagram

2.1.1. Droplet detection

The drip rate detection circuit is the most critical part of this design. If the drip rate is not accurately measured, the calculation of the infusion time will be inaccurate, and then the sound and light alarm will be inaccurate, so that the medical staff cannot handle it correctly in time and lose the monitoring effect.

The detection circuit is shown in Figure 2. It consists of two parts: the measurement of the infusion speed and the shaping circuit. The two ends of the infrared tube are placed on the dropper to measure the infusion rate. The shaping circuit amplifies the infrared conversion signal and sends it to the computer.

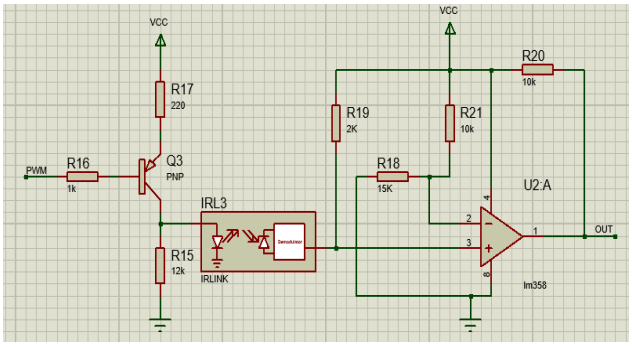

Figure 2 Detection circuit

The drip rate detection is the use of infrared detection technology to measure the infusion rate at the dropper. The principle of droplet detection is shown in Figure 3. The infrared pair tube transmitter emits infrared light, and the light penetrates the dropper and irradiates the phototransistor. The phototransistor turns the light irradiated on it into a current signal. If a droplet falls and blocks the light, part of the light is scattered and absorbed by the droplet, so that the light signal received by the phototransistor is weakened. As a result, the current signal output by the phototransistor of the LED is converted into a voltage signal and the voltage signal is weakened. By detecting the strength of the output voltage signal, it is judged whether there is a droplet, and then the single-chip microcomputer is used to calculate the dropping speed.

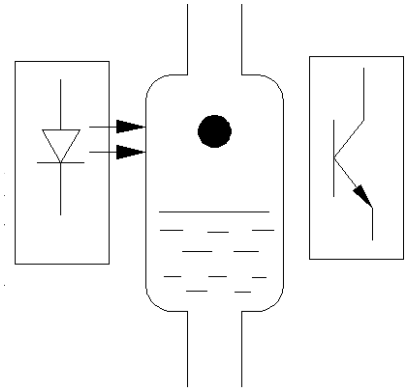

Figure 3 Principle of droplet detection

2.1.2. Sound and light alarm module

Buzzer and light-emitting diode are used to realize sound and light alarm. The alarm circuit diagram is shown in Figure 4

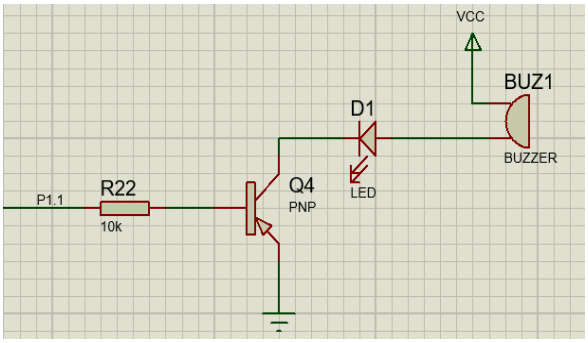

Figure 4 Alarm circuit

Sound and light alarms are mainly used in the following two situations.One is that when the liquid in the infusion tube is about to drip, the sensor does not detect the dripping of the liquid for a period of time. Then Alarm signal is generated and notified to medical staff. They will remove the needle or change the dressing as soon as possible to avoid blood backflow and cause harm to the patient's health. The other is that during the infusion process, the drip rate of the infusion is unstable and the situation is too fast or too slow. The buzzer will sound, and the LED will light up to remind medical staff that something is happening.

2.1.3. Wireless transmission module

NRF24L01 Module is used for wireless transmission. It is shown in Figure 5.The patient's infusion-related status information is sent to the PC at the nurse station through

wireless sensors. Medical staff can detect abnormal conditions of patients through monitoring, and deal with them in time to avoid medical accidents

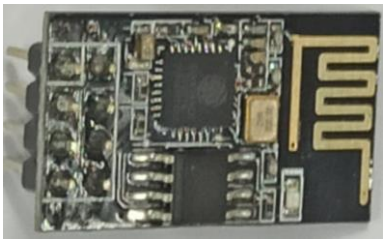

Figure 5 NRF24L01 Module

2.2. Receiving Port

Receiving port block diagram is shown in Figure 6.

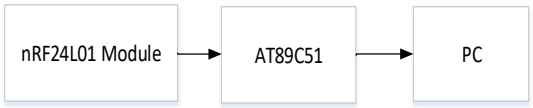

Figure 6 Receiving port block diagram

The receiving part is mainly placed at the medical staff, and the information sent from the patient is received through the wireless transmission module.After receiving the data, it is transmitted to the single-chip microcomputer, and then transmitted to the PC through the USB interface line. Medical staff can grasp the patient's condition in time through the PC and give corresponding treatment.

3. SOFTWARE DESIGN

Software design is a design created using software Keil uVision.The flowchart of system software is shown in the Figure 7.

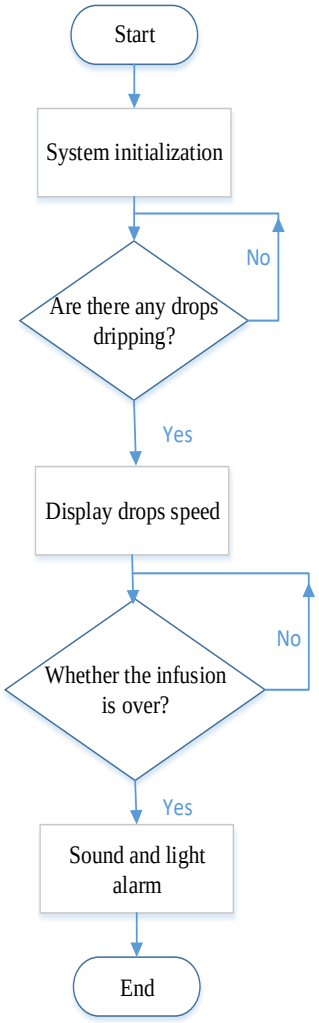

Figure 7. Software flowchart

When the power supply is turned on, the system will enter into initial state. If the infusion drop speed is set, the system will calculate the error between current drop speed and the setting drop speed. If the speed error is allowable, the system continues to work normally, otherwise the system will send voice and light alarm to the nurse station. The nurse will check in time to see if the injection is finished or other abnormalities have occurred. It can avoid accidental medical accidents.

4. CONCLUSION

The infusion monitoring system is designed on ST89C51 microcomputer. The infrared pair tube transmitter is used as the drops speed sensor. Buzzers and light-emitting diodes are used to provide warning information. Data and information are sent to the nurse station through wireless sensors. The experiment is done based on this system, and the result shows that this designed monitoring system can reach high accuracy, high reliability.

ACKNOWLEDGMENT

This work was supported by Teaching Research Project of Wuhan Education Bureau(2004003).

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