Research and Development of Intelligent Ward Patient Information Management System Based on PLC

Deng Baoqing, Xu Haixia, Liang Junhao, and Wang Yushu

***Abstract*—With the development of modern science and technology, the hospital ward management will be standardized, intelligent, modern ward information management system development. Based on PLC(Programmable Logic Controller) intelligent hospital information management system of research and development, is based on Siemens S7-1200 PLC as the control core, through a personal computer, PLC control software, 5 g of WICC man-machine interface and advanced communication technology, research and development accord with patients and medical personnel to use, the advanced hospital information management system, intelligent management of ward, patient, equipment and medical staff information, create a perfect intelligent control room information management platform. The topic is mainly used in the hospital doctors and nurses and patients through the management system of information input, query and ward automatic allocation management, at the same time, the system can accomplish the hospital ward bed number, equipment, number of digital management, the patient has a detection unit within the function such as environmental indicators and alarm information. The ward management system can improve the ward management mode, speed up the information inquiry speed, reduce the pressure of doctors and medical staff in the hospital, facilitate the real-time treatment of the ward situation by medical staff, so as to realize the intelligent management of ward information.**

***Index Terms*—Intelligent ward, PLC, ward information management, man-machine interface.**

I. Introduction

In modern society, information management has become an independent discipline, all kinds of human information is gradually realizing the whole network, and the hospital intelligent ward information management system needs to keep up with the pace of the information age.

Hospital patients every day countless, rescue patients is the job of a race with time and the number of staff and energy is limited, the ward patients more need to update the information, the management of paper cases patients is a very tedious work, medical staff a lot of time, so to realize electronic information management cases patients can reduce the medical staff a lot of work, make more energy to take care of patients. With the implementation of the new electronic medical records in hospitals, doctors no longer need to carry a large amount of paper patient information when they go toward rounds, so as to avoid the phenomenon that patients often take the wrong medical records, and realize the sharing of patient information, which greatly reduces the working pressure of medical care. Similarly, the management of ward beds is also an important part of the hospital information management system. Only with good bed management, can the hospital make reasonable treatment plans and arrange corresponding nurse care for patients through these.

Hospital ward information management system is an information management system that covers communication technology, electronic technology and medical technology. The intelligent ward management system can speed up the inquiry speed through the feedback information displayed on the screen, so that doctors and patients can understand the patient's situation in a timely and convenient way, and facilitate the real-time treatment of the ward situation by medical personnel, so as to accelerate the pace of hospital informatization and make the hospital ward management more convenient and standardized.

Hospital information management system embodies a hospital operation efficiency, it is the foundation of a hospital facilities, let patients, ward, medical personnel to implement systematic management information is to use more effective, more advanced information technology to strengthen hospital management, improve the work efficiency of the staff at the same time ease the pressure on medical staff. Intensifying hospital ward information management system is the inevitable direction of hospital development in the future.

II. Schematic Design

Through the analysis and control system function of intelligent ward patient management system, based on the research and development of PLC (Programmable Logic Controller) intelligent ward information management roller, and WICC configuration software dt system, Siemens S7-1200PLC is selected as the coesigner unit interface is selected as the monitoring system.

A. Research Objectives and Contents

Research Objectives: The intelligent ward information management system mainly manages patients and beds in different wards. The purpose is to better protect the health of patients.

Research content: This research is mainly about the management of the number of beds and wards, realizing the automatic statistics of the number of beds and patients in wards. Because different types of wards have different environmental requirements, there are different limits on the number of people in different wards at the same time. The

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designed system has two kinds of wards, the common ward and the ICU ward. The common ward has 4 beds, the ICU ward has 2 beds, and the limited number of people in the common ward is 12, and the limited number of people in ICU is 6. The basic structure of ward information management system. This is shown in Fig. 1.

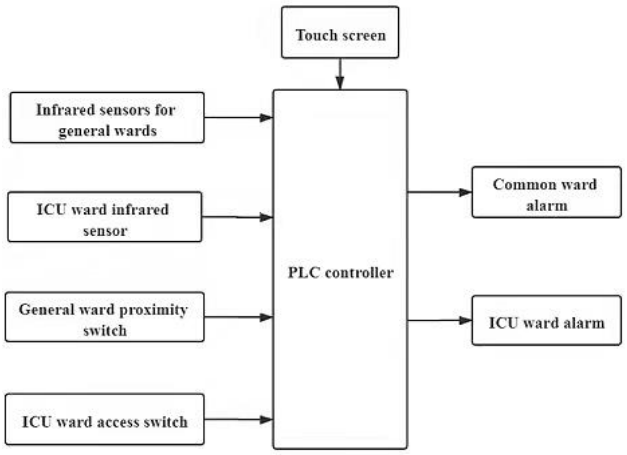

Fig. 1. Basic system structure diagram.

B. Main Function Realization

With Siemens S7-1200 PLC as control core, through a personal computer, PLC control software, 5 g of WICC man-machine interface and advanced communication technology, research and development accord with patients and medical personnel to use, the advanced hospital information management system, intelligent management of ward, patient, equipment and medical staff information, create a perfect intelligent control room information management platform [1].

The main functions are as follows:

1) Statistics the number of empty beds in the ward, the corresponding bed number and the number of patients;

2) The number of people in different types of wards was counted;

3) Alarm treatment can be carried out after the number of people in different wards reaches the limit;

4) The number of patients in the ward and the number of people in the ward can be monitored remotely through the touch screen;

5) Realize network interconnection and data sharing through communication module;

6) Usage of testing instruments and equipment;

7) Air quality indicators such as ambient temperature and humidity in the ward were detected.

III. Hardware, Software and Configuration Interface Design

The research and development of intelligent ward information management system based on PLC is based on Siemens S7-1200PLC as the control core. Through personal computer, PLC control software, WICC man-machine interface and advanced 5G communication technology, it intelligently manages ward, patient, equipment and medical staff information, and creates a perfect intelligent control ward information management platform.

A. Hardware Design

By comparing different types of hardware, select the components suitable for this system and draw the PLC wiring diagram.

1) Device selection and circuit design

The PLC model selected for the control device is Siemens S7-1200 series, which is simple in programming and stable in operation, and can meet the control requirements of this system. S7-1200 series PLC can be based on the control requirements of different systems for the corresponding input and output expansion, for some more output points of the system can expand the output module, for some more input points of the system can expand the input module [2]-[4].

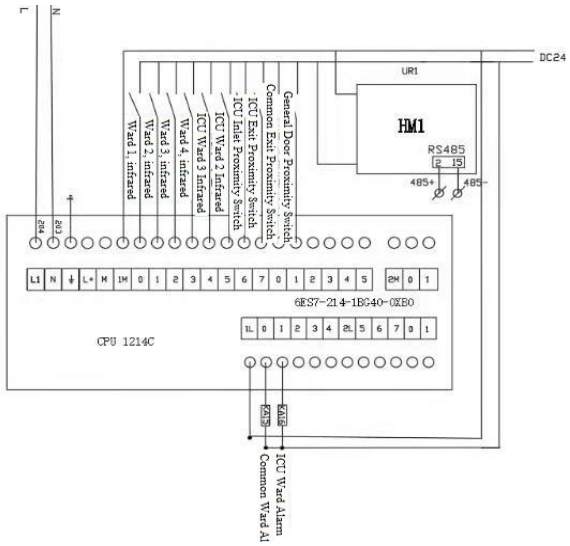

Fig. 2. PLC wiring diagram.

In terms of hardware wiring, the wiring is carried out according to Fig. 2. The output of the alarm lamp is output through the relay for better security. For the PLC wiring needs to be wired in accordance with the requirements, not more lines cross, negative and positive electrode reverse connection and other incorrect wiring. PLC power supply needs 220V AC, 24V DC power supply is needed for the output module [5].

The pyroelectric infrared sensor detection device can accurately detect the presence of moving human body within a distance of 6 ~ 15 meters, as shown in Fig. 3(b). The low-power light-emitting diode with model IN4007SOT-23 is selected as the alarm indicator light, which will not disturb the patient's rest but also save energy, as shown in Fig. 3(c). For some data that is difficult to measure, the proximity switch can be used to obtain the desired data without close contact as shown in Fig. 3(d).

(a) (b) (c) (d)

Fig. 3. Diagram of S7-1200, infrared sensor, alarm indicator light and proximity switch.

2) System I/O table

The system input is composed of an infrared sensor and a proximity switch. Some state display and start and stop of the system are controlled by a touch screen. There are only two

kinds of alarms when the number of patients in wards exceeds the limit. At the same time, the number of patients and the empty beds are also displayed in the touch screen, and the alarm information will also be displayed in the touch screen [6], [7].

TABLE I: SYSTEM I/O TABLE

Input		Output	
I0.0	Common No. 1 Infrared	Q0.0	Common Ward Alarm
I0.1	Common No. 2 Infrared	Q0.1	ICU Ward Alarm
I0.2	Common No. 3 Infrared		
I0.3	Common No. 4 Infrared		
I0.4	ICU1 infrared		
I0.5	ICU2 infrared		
I0.6	IC entrance proximity switch		
I0.7	IC door access switch		
I1.0	General entrance proximity switch		
I1.1	General door approach switch		

B. Software Design

TIA Portal software is the industry's first automation program that integrates design and design project environments and can be applied to most automated tasks.

1) System flowchart

The flow chart of ward information management system is shown in Fig. 4. The system comes in two main forms after startup, one for the general ward and one for the intensive care unit. After the general ward procedure is started, the system will automatically detect the vacant beds in the ward and mark the number of the vacant beds. The total number of people in the ward will be measured and displayed on a touch screen. When the total number of people in the ward reaches the limit value, the alarm in the ward will act to produce an alarm. In the same way, ICU ward procedures are also run. First of all, the available beds and total number of patients in the ward will be detected, which will be displayed on the touch screen. When the total number of patients reaches the limit value, an alarm will be generated.

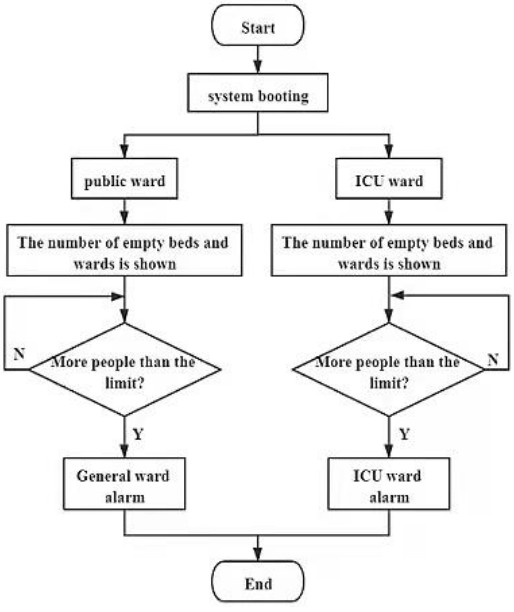

Fig. 4. Flow chart of ward information management system.

2) Programming - ladder diagram

The ladder diagram is very suitable for switching logic control. The input current of switching quantity is 24V DC voltage, and the output of switching quantity is relay output.

The system is programmed in the interface of the ladder diagram of TIA Portal V15 software. An example is given to illustrate the procedure of general ward bed detection [8], as shown in Fig. 5.

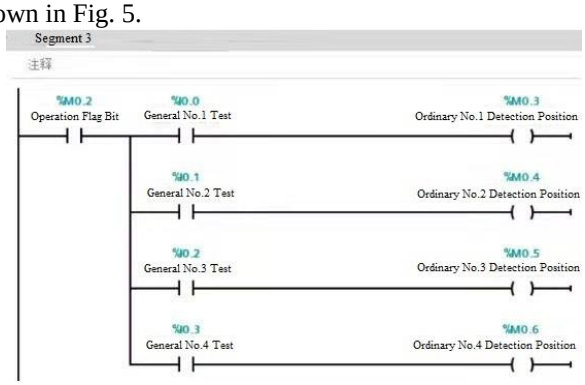

Fig. 5. Test procedure for the number of spare beds in general wards.

This procedure is the bed detection procedure of the general ward,

I0.0-I0.3 is the infrared detection signal input of four beds, M0.3-M0.6 is the status bit of four beds. When I0.0 gets power and M0.3 gets power, it means that there are patients in Bed 1. The same goes for the other three beds [9].

C. Configuration Interface Design

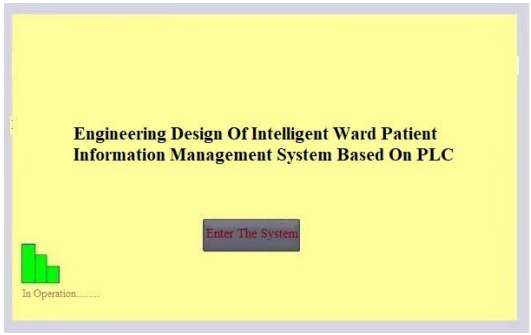

Fig. 6. Start-up interface

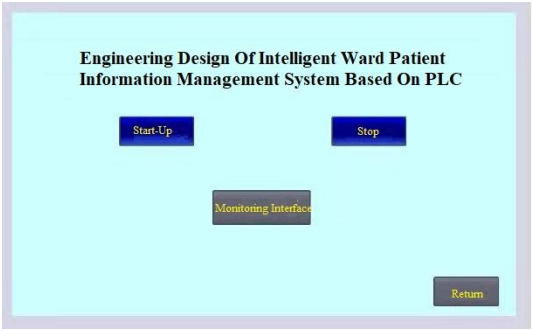

Fig. 7. Control interface.

The configuration interface of the ward information management system, namely the touch screen interface, consists of three parts, the boot interface, the control interface and the monitoring interface, as shown in Fig. 6 and Fig. 7. The boot interface displays the corresponding information of the system. In the lower left corner of the interface, there is a status symbol of the system. When the system starts to run, the symbol is displayed. In the middle of the interface there is a button to enter the system, click the button, the

configuration interface will automatically switch to the control interface. There are start and stop buttons in the control interface [10]. Click the start button to start the system. Click the stop button and the system stops running. At the same time, in the control of the entrance with the monitoring interface, click into the system, the configuration interface will automatically switch to the monitoring interface. On the monitoring interface, there are two kinds of information display and status display of wards. On the left side of the interface is the general ward, and on the right side is the ICU ward. The display information types of the two wards are the same, including the display of the vacant beds and the total number of patients in the wards, as well as the sign signal of the beds. There is an alarm message at the bottom of the interface. When the alarm signal appears, the alarm message will be displayed, but it will not be displayed under normal circumstances [11], [12].

IV. Simulation and Debugging

After the system design is completed, the design of the information platform is verified by simulation. Then, link the object, verify the function of the system.

A. System Simulation

The simulation software used in this paper is S7-PLCSIM V15, and the system is simulated in S7-PLCSIM V15 through WinCC and STEP7 connection [8]. The system simulation table is shown in Fig. 8.

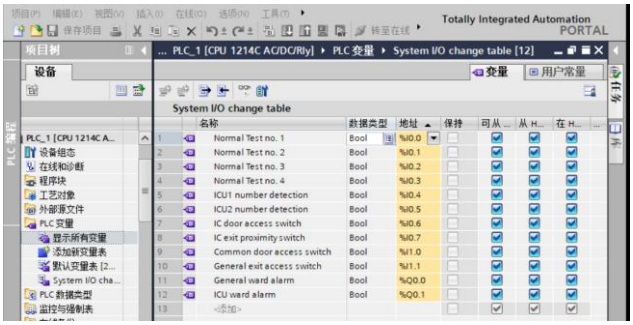

Fig. 8. System simulation table.

Through the simulation of the system designed by the software, we can check whether the designed system is available and reasonable. Due to the simulation, there is no signal input, the need to manually simulate the input signal in the simulation table. In the configuration interface to control system according to the real situation, such as simulation general wards, click the start button in the control interface, the system to start, and then in the heart of the simulation Table I beds of infrared input signal is set to "true", at this time will be displayed in the empty bed number display box no. 3, 1 bed logo goes on, in the heart of the simulation table of ICU in proximity switch set to "1", there is someone that is coming, said the ICU ward number dialog will be displayed in the 1, continue to the same operation, after the number 6 will generate alarm information. At this time, it is necessary to set the exit approach switch to "1", indicating that someone has gone out, and the alarm signal will disappear automatically. The correctness of the system is verified by simulation, which shows that the system is correct and reliable and meets the design requirements. The simulation monitoring interface is shown in Fig. 9 [13].

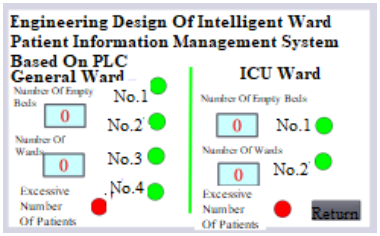

Fig. 9. Simulation monitoring interface.

B. System Function Debugging

After the success of the simulation experiment, it is necessary to connect the design control system module with various equipment in the hospital ward in the field according to the connection diagram, and further improve the function of the system through experiments and debugging [14].

V. Conclusion

Based on Siemens S7-1200PLC intelligent ward information management system, mainly used for hospital staff through the management system for patient information input, query and automatic ward allocation management. Input the name of the patient in the system interface to query the corresponding sickroom beds and conditions, the use of equipment by the patient; Input the name of the doctor to query the information of the patient in charge of the doctor, such as the patient confirmed illness and need to be hospitalized, can be input through the system and automatically find, can be allocated to the corresponding ward type of empty beds.

To sum up, the main work of this project is as follows:

1) Use Siemens S7-1200PLC control module and Kingview software;

2) Create the interface of the information management system through the configuration interface;

3) Design the main flow diagram, ladder diagram (or sentence instruction);

4) Classify patients, wards, doctors and other information in the system management interface;

5) Adding, deleting and modifying patient and ward related information as well as multi-condition combined query;

6) Automatic classification and allocation of different types of patients and ward types;

7) debugging function, using PLC programming and Kingview simulation;

8) Linking physical objects and verifying system functions.

VI. Prospects

The use of intelligent ward information management system to ward management, has unprecedented advantages. Integrating computer, PLC control software, WICC man-machine interface and 5G communication technology into one information management system, compared with the traditional hospital ward management, high security, convenient and fast, large storage capacity, small risk, low

cost. The experimental results show that the application of the system in the hospital ward information management system has greatly improved the efficiency of hospital management, increased the economic benefits of the hospital and medical staff, and has been highly praised by doctors, nurses, patients and patients' families, as well as the medical professionals.

In addition, the subject can be developed with more powerful features. On this basis, to expand the functions of PLC, man-machine interface and other functional modules, make full use of 5G communication, embedded technology, etc., to improve the functions of the system, expand the scale of hospital management, can make the hospital management system to achieve information, structured, hierarchical and standardized. Therefore, the market development prospect of this topic is broad and has high development value.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Professor Deng Baoqing is in charge of the project. She is responsible for design scheme formulation, software and hardware function research and development, technical supervision, sample making; Dr. Xu Haixia participated in the project design and contributed some useful theoretical research suggestions to this work; Engineer Liang Junhao is responsible for software design and platform construction, and provides the software programming data and simulation support for this thesis; As the main participant, Assistant Engineer Wang Yushu was responsible for project planning, PLC simulation and sample production. All the authors approved the final version of the research paper.

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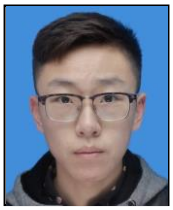

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