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Ward Calling System Based on PLC

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Abstract: In order to accurately and timely transmit help-seeking signals from inpatients to medical staff, this system aims to improve the efficiency of hospital medical services and patient satisfaction. It is controlled by Siemens S7-1200 PLC and monitored in real time through the HMI touch screen in TIAPortalv17. Simulation and experimental results demonstrate that the system exhibits high stability and ease of operation, enhancing the efficiency of hospital work and the quality of medical services. Additionally, it boasts convenient operation, stable performance, a simple program, and ease of expansion.

Keywords: PLC; Bed Call System; Digital Display.

1. Foreword

The purpose of this study is to create a simple, stable, reliable and easy to expand ward call system by using PLC control technology. Our research focuses on addressing the issues of cumbersome operation, difficult expansion, and high cost in existing systems, thereby enhancing the efficiency of medical services and patient satisfaction. In the related research at home and abroad, the ward call system is mostly based on single-chip microcomputer technology, but this kind of system often has weak anti-interference ability, insufficient stability, and the man-machine interface is not friendly enough. After comprehensive comparison, this study selects PLC as the core controller and integrates touch screen technology to optimize the human-machine interface. This technical solution aims to improve the stability and reliability of the system and greatly improve the user experience. The significance of this study lies not only in providing theoretical support for the intelligent upgrade of the ward call system, but also in its practical value, which is anticipated to propel hospital management to a new level of modernity. [1]

2. The Overall Design Scheme and Function Introduction of the System

2.1. Whole Design Scheme

The overall design of the system focuses on the two core functional modules of ward call and ordering call. The ward call system introduces PLC technology, as shown in Figure 1, the ward call design flow chart, patients can call through the bedside call button, the touch screen in the ward or the mobile application. The call information is transmitted to the nursing station or the central control room in real time to display the patient 's location and demand type. After the medical staff confirms the call, the system records the response time and prompts the patient through the screen or voice that the call has been received. The call history is saved to facilitate the analysis of response time and service quality, and optimize the allocation of resources.

The hospital independently arranges a variety of nutritional meal packages. The daily package is changed by the canteen according to the situation. The total name of the specific package is unchanged. Each ward has three cuisine buttons. The canteen prepares the nutritional meal package. The patient can choose the package he wants to press the corresponding button, press a few buttons to display several meals, and the staff receives the call signal to view the specific ward to prepare the corresponding package. After the distribution is completed, the reset button system is reset. The whole system uses TIA Portalv17 software for PLC programming and HMI touch screen simulation to realize the simplicity of operation and the intuition of monitoring. So as to significantly improve the quality of hospital nursing services and the patient 's medical experience.

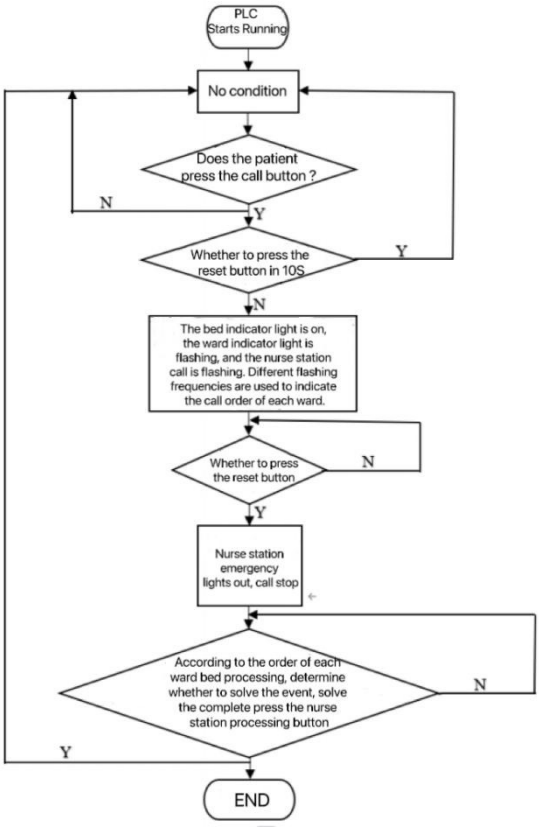

Fig 1. The overall design scheme of the system

According to the design requirements, the call system of each bed is controlled, covering the two functions of ward bed call and ordering call. There are three wards, each with four beds, all equipped with bed call and reset buttons. If the patient does not reset within 10 seconds after pressing the call button, the bedside light is turned on, the ward door indicator changes according to the frequency, and the specific ward is displayed in the monitoring interface of the nurse station. The

nurse can cancel the indicator light through the touch screen and process the event according to the call order, and reset the indicator light after completion. The control system takes PLC controller and I / O module as the core, and realizes the emergency call control of the ward through the line connection. The monitoring system is based on the HMI touch screen technology of TIA Portalv17 to monitor the patient 's call in real time. The ward call system design requires 25 input points and 17 output points. CPU1214 C and DI16 / DO16 expansion module SM1223 are selected. [2]

2.2. System Hardware Selection Design

A nurse station typically controls 20 beds in a hospital. The PLC selected for this application offers higher stability and reliability compared to traditional relay controllers, and also saves space within the control cabinet. Its main functions include logic control, timing and counting control, data processing, step control, motion control, etc. In addition, PLC also has the monitoring function, which can monitor the working condition of the whole control unit in real time, and give an alarm or stop the operation when it is abnormal. When selecting PLC, the control scale, the working ability and action speed of the actuator, the number of input and output points and other factors are considered. Siemens S7-1200 CPU 1214DC / DC / DCPLC is selected in this system design. It is a modular and compact product with powerful functions. The PLC is suitable for a variety of different occasions, particularly for small-scale standalone automatic control systems.

3. System Software Design

3.1. Work Flow Chart

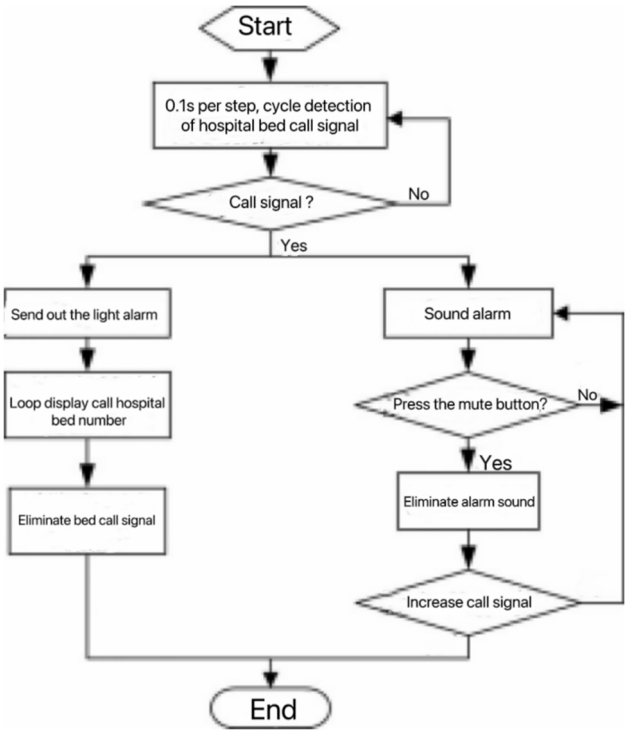

Fig 2. Work flow chart

When the system begins to work, a 0.1 s pulse is generated by PLC 's M8012, and the pulse signal is used to scan and detect the call signal of each bed step by step. If a hospital bed or multiple beds send out a call signal, the number of the call bed is immediately displayed on the call bed indication system of the nurse station and the HML of the doctor 's duty room, and the sound and light alarm signal is sent out ; all the bed numbers that send call signals are displayed circularly in the digital tube of the corridor ; press the mute button to eliminate the sound alarm signal. When there is a new call signal, the sound alarm signal is issued again. Eliminate all bed call signal, eliminate the light alarm signal, so cycle work, work flow chart as shown in Figure 3. [3]

3.2. Program Design

When designing the system program, the program is first divided into program modules with basic functions. For example, the system program design is divided into bed call signal storage circuit, cyclic scanning detection bed call signal circuit, call bed display circuit, sound and light alarm circuit, etc., order call circuit, and then these basic functional modules are combined to make it a complete program.

3.3. Call Signal Processing

In order to realize the one-click call function, simplify the programming, and facilitate the use of patients and medical staff, the call system adopts a call button with self-locking function. It can be seen from the input circuit that when the call button is pressed, the corresponding LED lights will light up to provide visual cues in the hospital bed and nurse station. When the button is released, the LED lights will be turned off. In the reference program shown in Figure 4, the address of the PLC input relay is octal coded, where K5X1 represents 20 input signal bit strings from X1 to X24. Through the double word transmission instruction DMOV, the input signal is stored in the auxiliary relay K5M1, as the corresponding hospital bed number call flag bit.

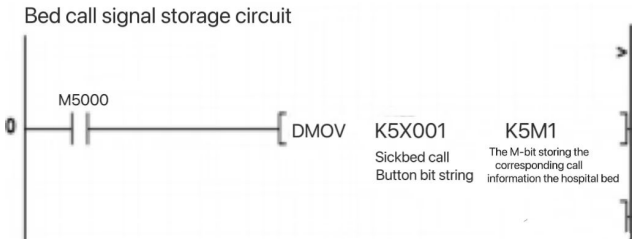

Fig 3. Call signal processing program

3.4. Cycle Scanning Detection Call Signal

M0V0 is used as the number identification of the hospital bed, and the rising edge of M8012 is used as a timing pulse of 0.1 seconds. The continuous increase of bed number is realized by INC V0 instruction. In the absence of the bed call signal, the bed call signal flag M50 is maintained at 0, and the value of V0 is automatically increased by 1 per 0.1 second, which means that the system detects the bed call signal every 0.1 second. Once the bed call signal is detected, the bed call signal flag M50 becomes 1, and the normally closed contact of M50 is disconnected, thereby interrupting the timing pulse of 0.1 seconds, and displaying the bed number of the call signal. T0 is used to control the display time of the call number of the hospital bed. Once the display time is over, the system will begin to detect the next hospital bed. When the value of V0 reaches or exceeds 21, the value of V0 will automatically return to zero, thus starting a new round of cyclic scanning detection. Fig.5 shows the program flow of cyclic scanning call signal detection.

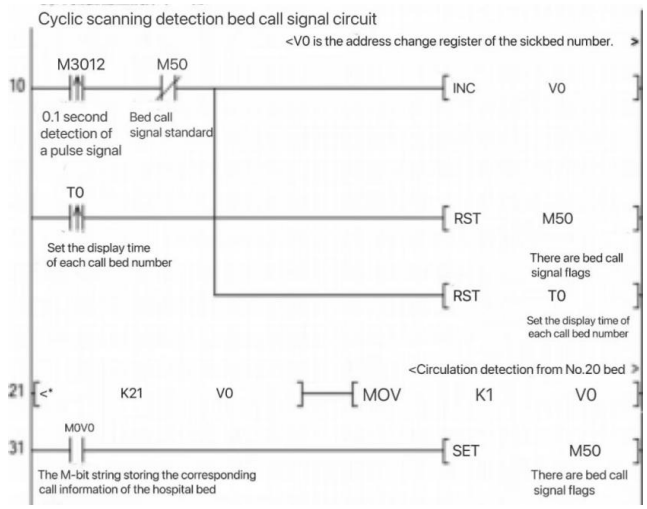

Fig 4. Loop scanning detection call signal program

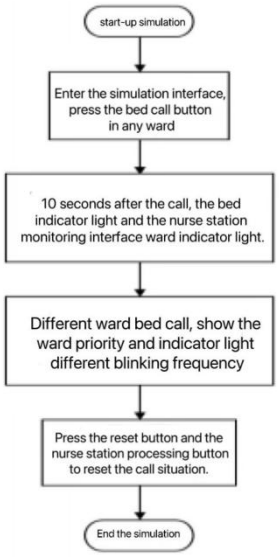

Fig 5. Ward call simulation demonstration flow chart

4. Simulation Verification

Enter the TIA Portal v17 interface, create a PLC program block and HMI panel, and connect the PLC to the panel. After completing the design and preparation of the PLC main program, compile and simulate to check errors, and establish the simulation of the HMI screen. Select the root screen in the screen under the HMI touch screen. It can be seen from the picture that various basic objects, elements and controls can be used in the drawing process of the root screen. According to the system design requirements, complete the configuration simulation required by different parts of the program. The flow chart of simulation demonstration is shown in Fig.6.

The specific simulation interface is shown in Figure 7. It is necessary to design 12 call input points corresponding to the bed and the input points corresponding to the bed reset button, display the specific bed number in each ward, and each bed corresponds to the output of a bed emergency indicator, and design the call timing element display. A call indicator light is designed outside each ward and the specific ward room number is displayed. The nurse station should have a reset button that can reset the emergency call indicator lights in all nurses ' stations. The call input of the hospital bed needs to pass the ability of timing priority discrimination. The ward priority processing order is indicated by the flashing frequency of the ward indicator lights in three different nurse stations, and the priority levels 1, 2 and 3 are displayed below.

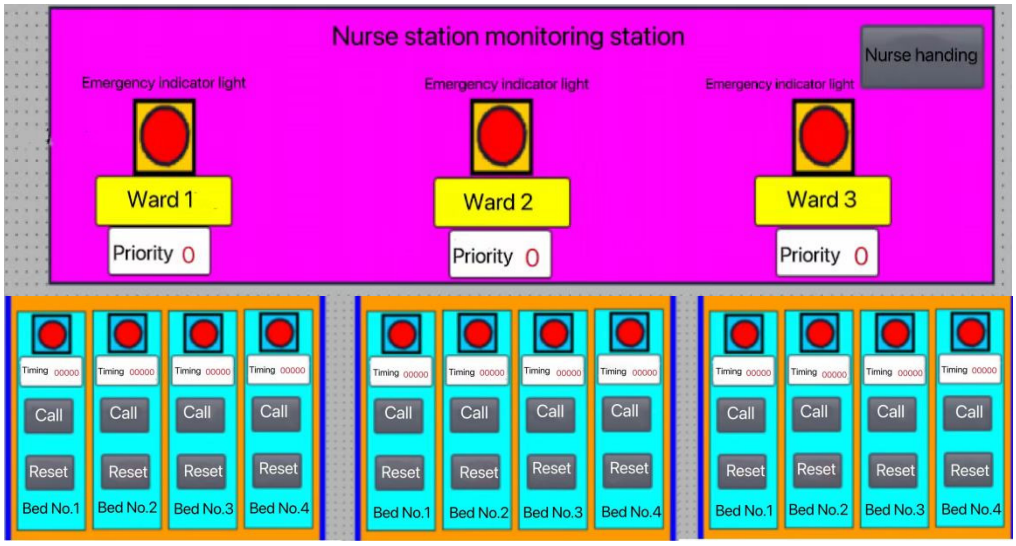

Fig 6. Bed call design

As shown in Figure 8, first of all, after pressing the call button of the No.1 hospital bed, the monitoring interface starts timing immediately. After 10 seconds, the indicator light of the No. 1 hospital bed will be lit, and the indicator light outside the No. 1 ward will also be lit. At this time, the call indicator light of the nurse station will start flashing at a specific frequency and display the corresponding call priority. According to the call order of the ward and the hospital bed, the corresponding indicator will be lit. If the patient presses the reset button, the timing will be cleared and the indicator light will be extinguished, so as to show the call situation of each bed and the flicker frequency of the monitor indicator light under different call priorities.

After entering the ordering call monitoring interface, the simulation demonstration process is shown in Figure 9. It consists of 9 indicator lights for system operation, ward display, and meal type display, and 14 buttons for start, stop, call, and reset. The interface displays the system operation

and ordering details. After starting the simulation, press the system start button system to run, the patient presses any call button, the simulation shows the type and number of copies, and displays the specific ward, presses the reset button to indicate that the light is off and the number of meals is cleared.

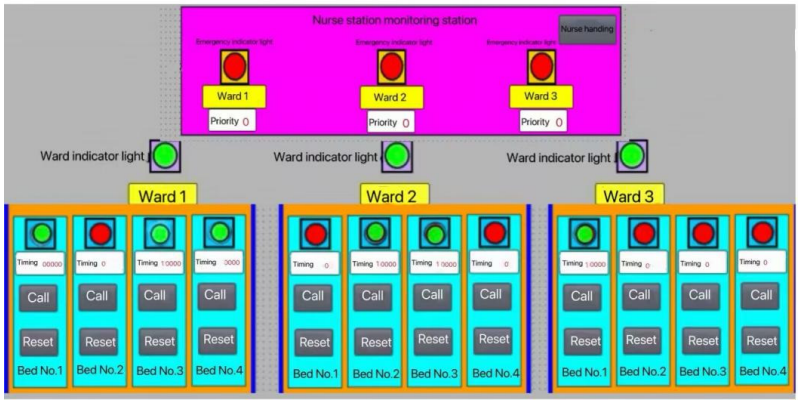

Fig 7. specific simulation demonstration

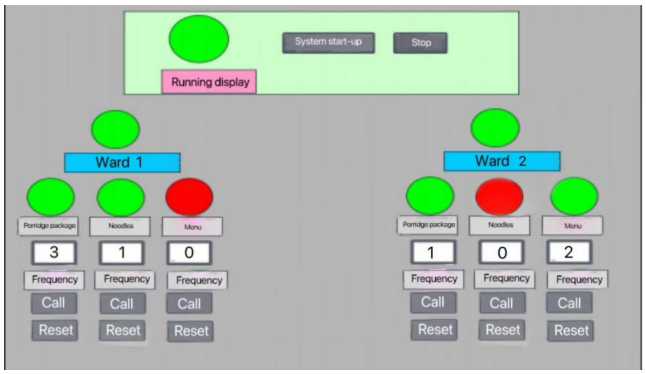

Fig 8. Simulation of ordering system

5. Summary

The ward call system realizes intelligence by using network and communication technology. With the development of microelectronics and computer technology, PLC uses very large scale integrated circuits and high-performance microprocessors to enhance functions, reduce costs, and improve cost performance. PLC products are updated every 3 to 5 years. The integration, speed, function, reliability and product series are continuously improved, and the user 's choice and use are more convenient. This design uses Botu v17 software, through PLC programming and HMI simulation control and monitoring call system, the operation is simple and intuitive. The modular method is used to control the program, which is easy to expand and modify. The comparison between the system simulation results and the actual operation shows that the system has excellent stability, practicability, economy and humanized design, and effectively saves medical resources. PLC has good expansibility, HMI touch screen operation interface is simple and intuitive, the system is easy to understand and operate by patients, showing the advantages of humanization. With the continuous emergence of new products, it is necessary to continue to explore and practice in the future to improve system efficiency.

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