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A Remote Controlling and Monitoring System for Laboratory Animal Feeding Environment

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***Abstract*—The manual operation is major in environmental regulation. During experiment, the keepers have to wait for a long time in the laboratory, this brought animal keepers heavy workloads, and manual operation is lack of accuracy, easy to produce wrong operation. In recent years, with the development of computer hardware and software technology, embedded system and Internet technology, effectively improve the flexibility of embedded system, and widely used in all aspects of life. According to the specific requirements of the rearing space, this paper designs a remote monitoring system to provide their keepers friendly space with conveying pattern configuration interface and animals of the real-time monitoring of the picture. It makes the researchers be away from the animal laboratory for a long time, but keep environmental monitoring and real-time adjustment anytime and anywhere from the network login system.**

Keywords—environmental monitoring; animal; animal laboratory; remote control

I. INTRODUCTION

With the development of biology and medicine, more and more animal experiments have been carried out [1]. By observing and analyzing the physiological reactions of experimental animals under different living conditions, the latest theoretical achievements in medicine, biology and pharmacy can be effectively verified and the transformation of medical scientific research achievements can be accelerated. There are a series of environmental indicators in the animal feeding space, including temperature, maximum daily temperature difference, relative humidity, minimum air changes, airflow velocity at the animal cage, air cleanliness, ammonia concentration, etc [2]. An indicator used to compare living conditions is the concentration of various gases in the container [3]. In animal experiments, often need to breed animals provide special setup to complete the specific living environment study, so often need to adjust the feeding gas, liquid concentration in space, will continue for various kinds of gas, liquid fluid according to certain cycle, order into the animal's space, and requires controllable fluid conveying mode.

II. DESIGN OF HARDWARE SYSTEM

The embedded control system structure designed in this paper is shown that the upper PC system transmits the fluid conveying mode information to the lower single-chip system through serial communication, and the single-chip controls the multi-way solenoid valve through the input and output ports. The system isolates the user from the complex underlying hardware equipment [4]. Only by modifying the fluid transport mode information stored in the upper PC, the required fluid on-off control can be achieved, and the operation is very simple [5]. Because of the use of the upper computer-lower computer hierarchical control structure, so that the underlying embedded control system is more independent than the upper PC, as long as the PC control mode data passed down through the serial port, SCM software can be based on the data received to achieve the control of the solenoid valve on off [6].

III. EQUIPMENT SELECTION AND CONTROL SCHEME

Wide angle lenses should be used when selecting a camera, as there is generally less space in a feeding room or laboratory in a barrier environment. Cameras with variable focal length or night vision are better, but they are expensive [7]. In order to reduce the system cost, the mode of single monitor plus video switcher plus multichannel camera is adopted. The price of manual control switcher is low, but it can't satisfy the automatic linkage control with the auxiliary lighting system, while the price of program-controlled switcher with interface is high, and the communication program is more complicated. The ordinary manual switcher can be modified and connected with the intelligent industrial control module to achieve the switch control by the industrial PC through the bus, to achieve the purpose of coordination with the auxiliary lighting system control. And the system can be seamlessly connected with the environmental quality monitoring system [8]. Auxiliary lighting can use brightness control of thyristor ac voltage regulator module, the control voltage on the voltage regulator module can come from intelligent industrial control module or programmable controller, but want to consider with environmental quality monitoring and control system to choose the next bit machine communication protocol compatible, so as to control signal transmission and centralized control of the bus. Lamps and lanterns can use incandescent lamp already, which can choose to adjust fluorescent lamp [9].

IV. LIGHTING AND BACKGROUND MUSIC

A. Lighting Setting and Control Mode

The working illumination in the barrier environment must be set according to the requirement of working illumination in the national standard [10]. The animal lighting system needs to use the ordinary incandescent lamp according to the

requirements of the national standard for animal illumination and light and shade, and the automatic control and timing switch. Moreover, in order not to affect the normal physiological behavior of experimental animals in the barrier environment, the switch is set with automatic slow control, so that the light can be slowly and smoothly switched between light and shade within the adjustable range [11].

Concrete research content analysis of animal welfare in animal breeding, animal experiments procurement before, during and after the requirement of animal welfare management present situation and existing problems, and then according to the above problems, combining the actual requirement of animal welfare management, using methods and technologies of SOA, puts forward the experimental animal data exchange and sharing in the system: the determination of demand analysis and design, experimental animals animal experimental data analysis and sharing, provide foreign security and access control based on the experimental data and animal information access services, improve the utilization rate of the data and reduce the cost, provide support for distributed data. Resources will be provided for data exchange in a manner consistent with international standards, including possible future integration and exchange of data generated from comparative medical experiments, as well as experimental management information [12].

B. Setting and Control Mode of Background Music

Environmental control should not only meet the needs of normal physiological activities of experimental animals, but also consider their psychological needs, which is an important embodiment of the importance of animal welfare. Background music can be set in the barrier environment. According to the average noise in the non-working period, several pieces of light music are selected to simulate the appropriate natural environment, the volume is set, and the music is played automatically on a regular basis, which can form a benign stimulus for the experimental animals to grow up healthily. It was sent to the power amplifier circuit to operate the corresponding solenoid valve to control the flow on and off. The local monitoring server is located in the animal laboratory and has two main functions: reading the information of the fluid transport mode in the database and sending it to the lower computer [13]. In addition, it also undertakes the function of running Web server, supporting remote modification of fluid transport mode information and remote video monitoring. The remote client can be any computer that can be connected to the Internet. By accessing the designated URL, feeders can modify the feeding space fluid delivery mode and monitor the experimental site at any time and anywhere [14].

C. Software Design of Lower Computer

Single chip microcomputer software after the main program is the single chip microcomputer system, the main program first in a series of initialization, build appropriate resources for subsequent operation conditions, including the output port initialization, serial port initialization, timer is initialized, stack initialization, and then open system interruption, into the circulation wait state [15]. Once the PC terminal resets the fluid on-off mode of the animal feeding environment, the port number of the MCU corresponding to a certain solenoid valve that needs to change the state will be sent to the MCU through the serial port in the form of ASCII code, causing the serial port interrupt, and sending out the corresponding solenoid valve control signal in the serial port interrupt service program.

D. Software Design of Upper Computer

Through the form of Web site, the upper computer provides remote fluid entry adjustment function and real-time monitoring function of animal experiment feeding space for animal experiment researchers, which enables animal experiment personnel to regulate and monitor the feeding conditions in the animal feeding space through the Internet anytime and anywhere [16]. The fluid transfer mode data is stored in the upper computer database. After the upper computer program reads the data of the fluid flow mode in the database, it interacts with the embedded system by means of serial communication, so that the embedded system can control the opening and closing of the solenoid valve according to the fluid flow mode data set in the database. At the same time, the upper computer USES JavaWeb technology to read the server database, and presents the data of fluid flow into the mode to the animal keeper in the form of Web page, which is convenient for remote adjustment.

V. LIGHTING AND BACKGROUND MUSIC

A. The Management Program of Database

The database management program is the core of the whole monitoring software. The data transmitted from the lower computer is generally processed and then loaded into the database. By means of the database management program, the environmental monitoring data obtained from the database can be counted, analyzed and reprocessed, so as to obtain the evaluation results of environmental quality in the barrier environment in a period of time [17]. In addition, the data in the database can also be used for statistical and correlation analysis between the traits and quality indicators of experimental animals and environmental parameters, so as to obtain the best environmental parameters suitable for experimental animal breeding or animal experiments in the barrier environment. Another function of the database manager is to manage the configuration parameters of the software system, namely the configuration database, which defines the attributes of the system hardware.

B. Monitoring Configuration Interface

This is the interface between man and machine, through which monitoring software can be configured. For example, select the communication interface, communication rate, give the hardware address or channel number and the corresponding relationship between monitoring parameters and so on. In addition, through this man-machine interface, you can achieve the operation of the system control, such as access to the relevant real-time data or historical data, control equipment start and stop and so on [18]. In addition, the monitoring software should provide the upper and lower alarm functions of monitoring data, and the software should provide the corresponding setting window. When the monitoring data to reach or exceed the alarm limits set by the user, should be able to automatically start the corresponding alarm device, such as alarm lamp or buzzer, can make a prompt to the user, and

artificial regulation of environmental parameters, also can undertake collaborative control, and air conditioning purification system history of alarm events should be automatically stored in the alarm database, for query and analysis [19].

VI. CONCLUSION

The rapid development of life science, the experiment of zoology is the basis and prerequisite for life science, multiple research field have a significant impact on life science, become an important part of modern science has brought to the attention of the governments around the world and the scientific research institutions, and even become to measure a national science and technology level of important symbol. In animal experiments, for the purpose of scientific research is the study of animal experimental model, experimental techniques, choice of animal species, and in the experiment of animal reaction observation and analogy, to study and to reveal the essence of human life phenomenon and disease mechanism, recognize the related law of disease mechanism, and create disease cure according to the rule of medical technology, to provide services for human health. In the field of life science, laboratory animals have made great contributions to human health. However, human beings ignore the welfare of experimental animals for the sake of scientific and technological progress. With the continuous progress of human civilization and the gradual development of science and technology, the welfare of experimental animals has gradually been paid attention to. The welfare of experimental animals is embodied in the purchase, feeding and design of experimental animals. The ethical and moral issues of animal experiments have been controversial from all walks of life. The focus of the debate is mainly on how to design the methods of animal experiments, which should refer to the principles of animal welfare and how to choose animal species.

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