Design of Intelligent Fermentation Mixer Based on PLC

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Abstract. Aiming at different types of organic fermentation environments, an intelligent fermentation mixer that can be controlled and monitored at multiple points is designed. The system is mainly composed of PLC, inverter, servo motor, touch screen, temperature and humidity detection module, STM32 acquisition module, HMI, cloud server and other units. After completing the electrical design, software design and mechanical structure design of the system, the whole system was debugged. The results showed that the system was operating normally and its functions basically met the original design requirements. The system adjusted the feedback network and algorithm to improve the organic fermentation environment. The control has better stability.

Keywords: Servo; Frequency converter; Information interaction; Fermentation technology.

1. Introduction
Fermentation engineering is the basis of biochemical engineering and modern biotechnology and its industrialization. The biological fermentation process has a complex mechanism, highly nonlinear and time-varying. The biological parameters in the fermentation process are important process parameters, especially for the organic fermentation process. The scientific regulation of parameters such as temperature, humidity and oxygen concentration is an important link in modern smart agriculture. At present, most of the organic fermentation equipment on the market is a specific model designed for the fermentation of specific varieties of organic matter. The fermentation process of other varieties of organic matter is mostly incompatible, and there are also certain problems in the use of equipment. The characteristics of limitations and poor applicability. Therefore, in order to achieve precise regulation and control in the fermentation process of organic substances, a fermentation process measurement and control system with an intelligent detection unit is urgently needed. Based on the above considerations, based on the existing technology and achievements, this paper proposes a PLC-based intelligent fermentation mixer, and establishes an intelligent detection unit based on the biomass soft-sensing model, which has become an effective means to realize the optimization and regulation of the fermentation process.

2. System Composition and Functional Principle
The intelligent fermentation mixer is a device based on PLC and Internet + technology. It is mainly composed of PLC, inverter, servo motor, touch screen, temperature and humidity acquisition module and other units. The system control process is mainly composed of industrial control board STM32 receiving environmental acquisition parameters and passing I/O port sends, PLC receives the feedback data of temperature and humidity module in different operation modes, and compares it with the temperature and humidity interval set by the system. When the temperature and humidity do not meet the fermentation environment, the system uses DC brushless drive, inverter, heating the wire controls the blower and water pump to control the temperature, humidity and oxygen content of the organic...
fermentation environment. At the same time, it records the monitoring data of the fermentation environment and uploads it to the network layer for download by the client, so as to realize the real-time detection and regulation of the fermentation environment parameters. Share with data to realize the information interaction of clients in multiple places. The principle block diagram of the system is shown in Figure 1.

![Figure 1. The principle block diagram of the system.](image)

3. System Design

3.1. Electrical Component Configuration and Mechanical Structure

The electrical part of the system is mainly composed of PLC, STM32 industrial control board, host computer configuration interface, DC brushless mechanism, communication cable, etc. The DC brushless drive and DC brushless motor are used as actuators. The system hardware configuration is shown in Table 1. The main design of the mechanical structure is shown in Figure 2.

| Product                  | Model           | Quantity |
|--------------------------|-----------------|----------|
| PLC                      | FX3U-32MT       | 1        |
| RS-485ADP Communication  | RS-485ADP-MB    | 2        |
| server Driver            | MR-J4-10A       | 1        |
| servo motor              | HG KR 13J       | 1        |
| touch screen             | GS2110-wrbd     | 1        |
| Frequency converter      | FR-E720-0.4K    | 1        |

![Table 1. System hardware configuration.](image)

![Figure 2. System mechanical main structure.](image)
3.2. Electrical Component Configuration and Mechanical Structure

Use RS-485ADO-MB and temperature and humidity acquisition module for MODBUS communication, real-time detection of temperature and humidity changes during organic fermentation, a touch screen and host computer system are set up on the fermentation site, and on-site personnel can detect data and equipment management through the touch screen, and the host computer will detect the data is uploaded to the Internet in real time. Two PCs and a mobile interface are set up for R&D data monitoring ports, customer data monitoring ports, and mobile management ports to receive data. PLC communicates with the temperature and humidity acquisition module through the RS485 interface and the MODBUS protocol, and the PLC passes through the dedicated communication protocol uploads the data to the on-site upper computer, and the upper computer uploads the data to the Internet for the other ports to download The system detection process is shown in Figure 3, and the data protocol is shown in Figure 4. The specific program design includes: PLC control program design; host computer software Kingview C++ and PLC communication program design, network communication program design, interface display program design, Access database writing and reading program design, network communication protocol TCP/IP program design.

![Figure 3. System detection process.](image1)

![Figure 4. Data flow.](image2)

3.3. System Configuration Design

The man-machine interface is the bridge between the user and the machine system for data interaction and information processing and display. Various types of information can be displayed on the graphic operation terminal, including various indicators, buttons, report information, clock data and freely set by the user. Graphics and other display functions. Human-computer interaction refers to the hard and soft touches between humans and machines. This combined surface includes not only the direct contact between points, lines and surfaces, but also the space for remote information transmission and control. In this design, the Kingview software of Asia Control Technology carried by the desktop computer is used as the man-machine interface. Connect the programmable controller through the programming cable, and connect to the Internet through the WIFI module. Kingview software is used as the main human-computer interaction for user feedback.

The main interface for user operation consists of title, date, time, start, stop, and manual blowing. It is composed of functions such as manual water spraying. Real-time temperature change curve and historical temperature change curve are the main methods for the device to feedback temperature and humidity information. The reset function is to use the soft element as a button to feed back to the PLC,
which is regarded as a jog function. When the reset is successful, the indicator light will turn from red to green, indicating that the device has been reset and can start working.

4. Experiment and Analysis

In order to obtain a good fermentation environment, this paper uses PLC and related electrical equipment to control the temperature and humidity of the organic fermentation environment, and through the man-machine interface constructed by Kingview software, the fermentation environment parameters are monitored, regulated and shared in real time, the changes of the temperature and humidity status and real-time data are shown in Figure 6 and Figure 7. The experimental results show that the system can detect the temperature and humidity of the fermentation environment in real time, and can send real-time data to multiple remote ports for real-time monitoring, so as to realize the information exchange of clients in multiple places. This system has the following characteristics.

- The detection control mode of this system has been improved from the traditional single upper and lower limit control mode in the past to multi-sensor PID algorithm control under different environmental modes. It has high adaptability to applications in different occasions. At the same time, the mode switching is easy to operate. The system is simple and convenient, convenient for non-professionals to use.
- The detection devices of this system mostly use non-contact sensors, which respond quickly, reduce the time consumed by detection and feedback, and are more sensitive to the control of organic matter in tropical monsoon climate, subtropical monsoon climate, and temperate monsoon climate.
- PID algorithm is used to control the fermentation environment, keep the organic matter in the most suitable environment for fermentation, the product fermentation cycle is shortened, and the production efficiency is improved.

5. Conclusion

Experiments show that the structure and implementation method of the intelligent stirring system for the fermentation process constructed in this paper are correct and feasible. The technology is applied to the organic fermentation work, and can realize the online detection and optimization control of temperature, humidity and oxygen content during the fermentation process, and has obtained a good result. The application effect can provide reference value for the actual promotion and use. On the existing basis, the system can also expand the functions according to user needs. The upper computer software part opens different permissions for different customer groups. The equipment sends data to the management terminal and the client through the upper computer software, and the production and fermentation cycle can be queried in different places. Temperature and humidity data, through the Internet of Things technology to achieve remote control and detection, can effectively reduce labor costs, and facilitate users to accurately control the fermentation environment and obtain real-time data.
Acknowledgments
The authors wish to thank Nanjing Xiaozhuang University and Sino-German Institute of Intelligent Technology Application. This work was supported in part by a grant from Nanjing Xiaozhuang University Key discipline “Electrical Engineering” Foundation (4119007&4112128).

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