Control and realization of intelligent fishing system based on PLC and fuzzy PID algorithm

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Abstract. In this paper, based on the frequency conversion constant speed control principle theory, to control the stability of the number of fish pipe to fish for the technical means, to control the number of fish to ensure catch efficiency and damage rate as the main purpose, research and design based on the fuzzy PID controller of intelligent pump suction fishing control system, determine the system platform, sucking fish overall frame structure of the control system is given, A complete electrical control system is designed. The purpose of this paper is to obtain a fully functional fish suction equipment control system, specifically realize the intelligent catch count, control fish suction switch, lossless fish transfer speed control system switch and automatic cycle control.

1. Introduction

In recent years, with the increasing demand for aquatic products, fishery development has been steadily advancing, and catching has gradually become a link that cannot be ignored [1]. Traditional fishing methods have the disadvantages of high labor intensity, low work efficiency and high fish mortality, which seriously affect the economic benefits [2]. The live fish catching equipment is the key to solve this problem, so the mechanization of live fish fishing operation is becoming more and more prominent. As an important mechanical equipment in fishery production, non-destructive fish suction pumping system has the advantages of simple operation, high efficiency and low damage rate of fish body [3]. In particular, the use of fish suction pump can greatly improve the mechanization and automation level, effectively reduce labor intensity, improve the quality of fish caught, improve fishing efficiency [4].

In this paper, design of the intelligent fish fishing system based on the analysis on existing fish pump absorption at home and abroad [5], with independent intellectual property rights in this team sucking fish machine prototype based on the research on intelligent control, by decomposing the fish absorption device of main component, analyses its working principle, combined with PLC technology designed for use in shore-based and sea fish absorption pump automatic control circuit to achieve lossless automatic fishing and improve the current level of productivity.

As shown in Figure 1, the automatic start and stop system of vacuum pump and fish suction pump is designed based on the monitoring of high water level sensor. According to the signal of high water level sensor combined with the judgment of fish and water mixture amount of fish tank water level sensor, the intelligent control platform automatically completes the whole fish suction work, including the suction time, suction speed and suction quantity. Tube average flow velocity decreases with the
increasing of proportion of fish, the real-time fish uptake by count data to calculate, according to the size of the density of fish and fish, combined with the best sex transmission ratio is calculated, automatically adjust the fish absorption device speed system design, control fish pump absorption to reduce friction, improve the efficiency of absorption of fish.

![Monitoring system of upper computer](image)

**Figure 1 Smart catch capture design.**

2. **Fuzzy PID controller design**

Fuzzy controller mainly compares the actual output value of the system with the preset value of the system to calculate the error $e$ and error change rate $ec$ [6]. Then carry out theoretical analysis to find the corresponding theory domain to make it fuzzy, establish the fuzzy control rule table, through the analysis of membership function and anti-fuzzy derivation to get $\Delta K_p$, $\Delta K_i$, $\Delta K_d$. Put these three variables into the PID controller, and then continuously modify the PID controller system parameters, finally get the parameters $K_p$, $K_i$, $K_d$ and adjust the control quantity accordingly [8].

$$K_p = K_{p0} + \Delta K_p$$
$$K_i = K_{i0} + \Delta K_i$$
$$K_d = K_{d0} + \Delta K_d$$

The control process of fuzzy PID controller is shown in the figure below:

![Figure 2 Fuzzy PID control flow char.](image)

The function of fuzzy control is to constantly set PID parameters, PID control is to control the output. Take the current sampling value, that is, the current fish suction speed, get the deviation value between the set fish suction speed and the actual fish suction speed, fuzzy, assign the value, get the change value of the deviation, fuzzy setting, calculate the current parameters, and finally PID output. In the fuzzy PID control system, the setting part of PID parameters is actually a two-input and three-output fuzzy controller [8]. The difference $e$ between the actual sucking speed and the target value and the rate of change of the deviation $ec$ are selected as the fuzzy input, and the fuzzy output is the modified value of PID three parameters.

The PID parameter setting must take into account the function and relationship of the three parameters at different times, and the system stability, overshoot, response speed, steady-state accuracy and other requirements should be taken into account in the control process.
Discrete PID expression:

\[ u(k) = K_p e(k) + K_i \sum_{j=0}^{k} e(k) + K_d [e(k) - e(k-1)] \]  

Among them: \( u(k) \) is the controller output sampled for the \( k \)th time. \( e(k) \) is the deviation of the \( k \)th sample. \( e(k-1) \) is the deviation of the \( k-1 \)st sample.

Fish suction pump through the front-end optical counting device, fish suction speed will be sent to the PID controller and fuzzy logic stick inference device, after processing to get the inverter control quantity, finally control the motor speed to achieve the speed of fish suction pump adjustment [9].

Its schematic diagram is shown below:

![Fuzzy PID controller structure diagram.](image)

According to the design of fuzzy PID controller, the characteristic surface of three parameters \( \Delta K_p \), \( \Delta K_i \), \( \Delta K_d \) is obtained, as shown below:

![Fuzzy rule observation window.](image)  
![\( \Delta K_p \) characteristics of surface.](image)  
![\( \Delta K_i \) characteristics of surface.](image)  
![\( \Delta K_d \) characteristics of surface.](image)
3. **Hardware design of frequency conversion speed control system**

Research and design of the hardware of the system, including the design of the lower computer, the design of the program block diagram, the selection of hardware, etc.

According to the control scheme of fish suction pump, the general block diagram of electrical control system designed is shown in figure:

![Figure 8 Control general block diagram](image)

The main hardware components of the system: programmable logic controller PLC, frequency converter, vacuum pump, fish pump, pressure sensor, grating sensor, etc. PLC isolation transformer, low voltage electrical appliances and control cabinet, etc. The control system takes PLC controller as the core, which can not only adjust the brightness of fish collecting lamp but also adjust the speed of fish sucking. The pressure sensor is used to detect the pressure signal of the vacuum tank and convert it into 4-20 mA current signal as the feedback signal of the system control [10]. The communication module can communicate with the upper computer and monitor the system in real time.

First, power on the system for program initialization to ensure that the inverter, grating sensor, AD module and other hardware equipment and the lower computer (PLC) can carry out normal data transmission work through the indicator [11]. The system is mainly divided into two kinds of manual control and automatic control mode, when the system fails, manual control and in monitoring interface through the alarm lights flashing and voice alarm output, and then call the fault processing subroutine, to manually set at this time, to meet the automatic operation of the system condition, then switch to automatic control mode [11]. The specific process is shown in the figure below:

![Figure 9 Main program flow chart](image)
4. **Experiment and Simulation**

In order to verify the automatic regulation function of the intelligent fishing system, the self-developed prototype was used to conduct experiments in a pool with a depth of 1.5m, a length of 5m and a width of 2.5m. Fig.10 is the field experiment photo. At the same time, the head curve is obtained as shown in the figure. As can be seen from the figure, with the increase of the flow, the head of the fish suction pump gradually decreases, which is similar to the external characteristic curve of the general centrifugal pump, in line with the flow characteristics of the fish suction pump.

![Figure 10 Picture of fish suction pump test.](image1)

![Figure 11 Flow and head curves.](image2)

In the tank test, the fish suction pump has good stability and dynamic performance in setting the fish suction speed control, and the system using fuzzy PID controller has good steady-state performance, and the system overshoot control is very good.

5. **Conclusion**

In this paper, the intelligent fish fishing system fuzzy PID controller are analyzed theoretically, and the absorption of fish pump control system has carried on the detailed introduction, change system on the control method using PLC controller based on the control of frequency converter, drive motor frequency conversion movement, on the control algorithm by fuzzy PID algorithm to make fish speed closer to the absorption and the set value. Thus, the steady-state performance of the system is improved, the overshoot is reduced, and a more scientific control method is provided for the control of fish suction pump.

In the process of research and design of intelligent fishing control system, there are still some deficiencies in theory and practice that need to be further improved and perfected. As for the design itself, it focuses on the algorithm of its controller and the design of software and hardware. This set of equipment may be more suitable for the fish with smooth shape and line, such as autumn knife fish.

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