CHEMICAL ENGINEERING TRANSACTIONS
VOL. 71, 2018
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet
Guest Editors: Xiantang Zhang, Songrong Qian, Jianmin Xu

ISBN 978-88-95608-68-6; **ISSN** 2283-9216
DOI: 10.3303/CET1871217

Design and Experimental Research of Chemical Chemical Granular Material Automatic Dispensing Device Based on PLC

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The design and test of automatic granular material dispensing device based on PLC are discussed. By using the design mode of PLC automatic feeding device and combining with the experimental results, the advantages of the device compared with manual feeding are judged, and the possible technical defects are analysed comprehensively in order to improve the efficiency of particle feeding. The results show that the automatic feeding device based on PLC can improve the efficiency of feeding, reduce the rate of artificial participation, and meet the need of feeding in intensive aquaculture. Therefore, the automatic dispensing device of granular material based on PLC can be applied on a large scale and has a high development prospect.

1. Introduction

The overseas market demand for aquatic products is constantly increasing, during the farming process, we should also pay close attention to the overall benefits and technical methods. Under the technical conditions of PLC, it can exert the technical advantages of refined farming with advantages of flexibility and non-destructive. Therefore, this paper will analyze the design mode of the automatic feeding device, combining with the experimental analysis results to judge its benefits compared with the manual feeding, it also integrates possible technical defects, so as to carry out more in-depth research work in the future.

2．Literature review

Among the advanced feeding methods in the field of aquaculture abroad, six to eight layers of layered cages are mostly used for terrestrial livestock. In the feed delivery phase, automated feeding is used (Fantoni et al., 2014). Therefore, the stocking density and scale are constantly increasing. The efficiency of feeding and labor saving are remarkable. At present, there are few studies on the automatic feeding of aquatic products in China. For feeds for aquatic products, automatic placement devices are difficult to apply directly to aquatic fish (Wagner et al., 2018). Therefore, it is particularly important to design an automatic pellet delivery device for aquatic applications (Fekir et al., 2017).

With the vigorous development of China's aquaculture industry, marine fishing capacity, compound fisheries and fishery population have been vigorously developed, which has promoted the development of various economies to a certain extent (Wójcik et al., 2018). According to incomplete statistics, in 2005, China's aquaculture industry accounted for 71% of the world. To a large extent, it directly affects the development of the global aquaculture industry and directly drives the development of China's fisheries (Foppoli et al., 2017).

When feeding on a large water surface, it is better to use mechanical feeding. At the same time, the principle of "three look" and "four decisions" should be adhered to when feeding. Weather, water quality and fish watching should be observed. Qualitative, quantitative, timing, and positioning are followed. When using mixed feed to raise fish, the quality of the compound feed, the amount of feed, the water environment, the number of feeds, and the feeding method are comprehensively considered. In this way, feed utilization is increased, the cost of farming is reduced, and economic benefits are improved.

Please cite this article as: Deng D., Xie X., Deng X., Yan H., 2018, Design and experimental research of chemical chemical granular material automatic dispensing device based on plc, Chemical Engineering Transactions, 71, 1297-1302 DOI:10.3303/CET1871217

After long term aquaculture, the feed feeding pattern has been thoroughly recognized. The feeding frequency of the compound feed should be based on the feeding habits of the fish, and the carnivorous fish have a higher storage capacity for the food. When the food in the stomach is gradually digested, the fish will actively consume the food. Therefore, it is advisable to feed the carnivorous fish 2 to 3 times per day (Ji et al., 2018).
Programmable controllers (PLCs) are specialized in operational control systems in industrial control environments (Nagy et al., 2018). It is essentially a computer for professional control. A programmable memory is applied. Internally, instructions for operations such as logic operations, sequence control, timing, counting, and arithmetic operations are executed. Various types of mechanical equipment or production processes are controlled through digital or analog input and output. The basic components include a power supply, a central processing unit (CPU), a memory, an input unit, and an output unit (Piergrossi et al., 2018). The open-loop control of the switching quantity, the closed-loop control of the analog quantity, the digital intelligent control and the data acquisition and monitoring are realized. It has the characteristics of fast running speed, high reliability, convenient programming, flexible configuration and complete input/output function modules (Yang et al., 2018). PLC technology is used in aquaculture feeding. In order to minimize the structural cost of the feeding device and improve the operational reliability of the feeding system, an aquafeeding device with a lower structural complexity of the blanking component was designed (Ramos et al., 2016).
In summary, in order to achieve automated precision feeding in aquaculture, a PLC-based automatic feeding device for pellet feed was designed. The device uses PLC as the control core. The proximity switch is a position detecting element. The electromagnet is used to drive the action of the blanking member. Through the touch screen, the blanking time is set and automatic quantitative dispensing of the feed is achieved. The feed delivery test was based on raw grain mixed pellet feed. The test results show that the average weight of the blanking material and the blanking time show a linear relationship when the opening area of the blanking opening is constant. This provides a theoretical basis for further research on automatic variable feeding devices for aquatic products.

3. Method

Memory includes ROM and RAM memory. ROM memory contains operating systems, drivers, and applications, while RAM stores user-written programs and working data. In some modular PLCS, a bus or rack is provided in the back of the circuit where the CPU and other I/O modules and all other modules are inserted into the corresponding slots. The bus enables communication between the CPU and I/O modules to send or receive data. This communication is established by addressing I/O modules based on the location of CPU modules on the bus. Assume that if the input module is in the second slot, the address must be i2:1.0 (only the first channel for the second slot). Some buses provide the necessary power for I/O module circuits, but they do not provide any power for sensors and actuators connected to I/O modules. PLC USES a holding memory to store user programs and data in the event of power supply interruption or failure, and to restore the execution of user programs. As a result, these PLCS don't need to reprogram the processor every time they use a keyboard or monitor. It can be realized by long life battery, EEPROM module and flash memory.

3.1 Design scheme of the device

The following aspects are mainly considered when designing the automatic feeding system of the floating bait.
(1) Because the background in the floating bait identifying process is water surface, the environment is quite complicated, there are interference factors such as reflect light and fish school, and the floating bait will fluctuate with the water surface, so it is difficult to accurately identify the number of floating bait on the water surface using embedded machine vision.
(2) To solve the problem of indeterminable feeding amount of floating bait due to the changes in the appetite of the fish school caused by external environment changes such as farming pond water temperature and dissolved oxygen, it is necessary to quantify the feeding ability of the fish school and collect and analyze real-time conditions of the remaining floating bait on the water surface, and we also have to solve the problem that the amount of bait thrown by the feeding machine needs to meet the requirements of feeding precision.
(3) To ensure normal running of floating bait image recognition program on the embedded system, first, an embedded development environment needs to be built; second, cross-platform cross-compilation of the software program is required; at last, due to the speed limit of the platform, the program needs to be optimized.
(4) When feeding, the bait thrown in the air will block the floating bait on the water surface, and the spray caused by the floating bait falling on the water surface will seriously affect the image recognition result of the floating bait, which will result in the true situation of the remaining floating bait on water surface not being

collected. In order to solve this problem, it is necessary to arrange the collection timing of the automatic feeder and the timing of the floating bait feeding reasonably.
The overall structure can be as shown in Figure 1.

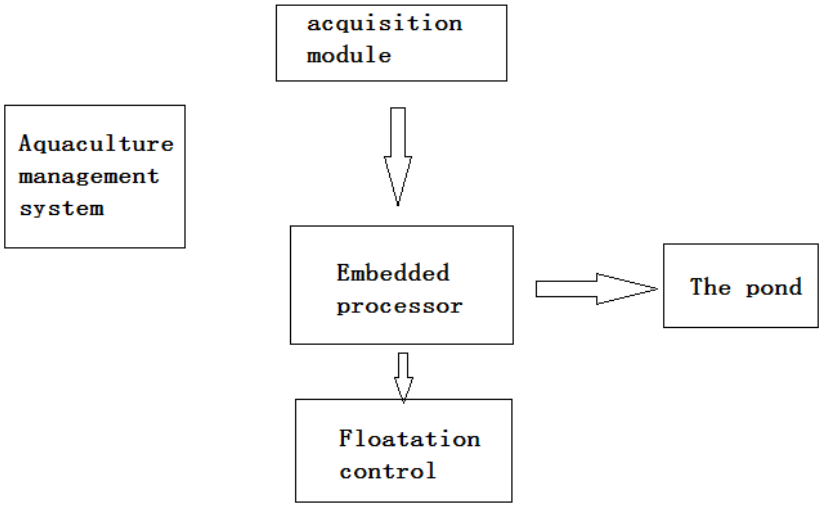

Figure 1: Overall system block diagram

The main process of automatic feeding is: firstly, the image acquisition module of the floating bait information collecting part periodically collects pictures of remaining floating bait within the fence of multiple farming pond, then the collected image data is uploaded to the embedded processor through the USB transmission protocol, the processor recognizes all floating bait in the captured image through image processing algorithm, and calculates and counts the number of floating bait and the feeding ability of the fish school by formula, and then the embedded processor sends instructions according to this information to control the feeding machine to supplement or terminate feeding of corresponding ponds, and to form a closed loop floating bait automatic feeding system.

3.2 Research on feeding technology based on fuzzy control method

The basic principle can be as shown in Figure 2.

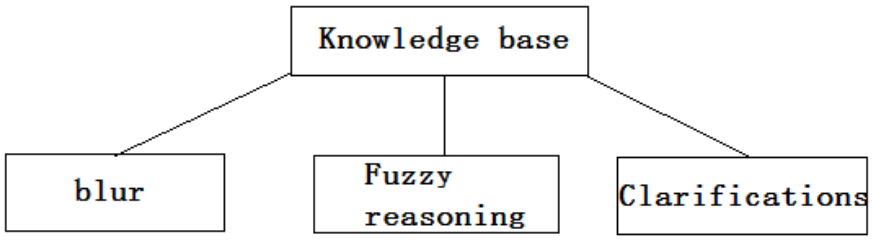

Figure 2: Fuzzy control scheme

The fuzzy control system is shown in Figure 3.

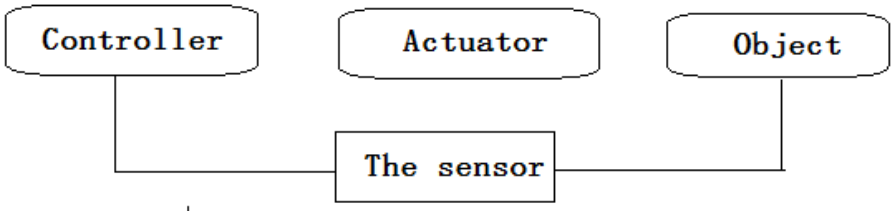

Figure 3: Fuzzy control system framework

Under the guidance of experienced breeders, this project completes the analysis of the refined feeding control process. The main steps of the refined feeding process are: after the automatic feeding system is turned on, it starts feeding to induce food in-take, then images of remaining floating bait are collected and automatically recognized, bait-thrown of next feeding cycle will be proceeded according to recognition results. The above-mentioned steps are repeated continuously until a feeding finish point is found and the feeding is terminated, so far, a complete feeding process is finished. Because bait in-take amount of the fish school not only relates closely to the number of remaining floating bait on the water surface, it also relates closely to the feeding ability of the fish school itself, it is not unilaterally determined. Figure 4 shows the structure of the fuzzy controller, feeding time is the output variable, which needs to be fuzzified or de-fuzzified. The number of remaining floating bait on the water surface and the ECVFAI can be obtained through real-time image acquisition and the processing of images of remaining floating bait on the water surface. The feeding time is the working time of the feeding machine performing continuous feeding, which is used to control the bait amount of the feeding. As shown in Figure 4.

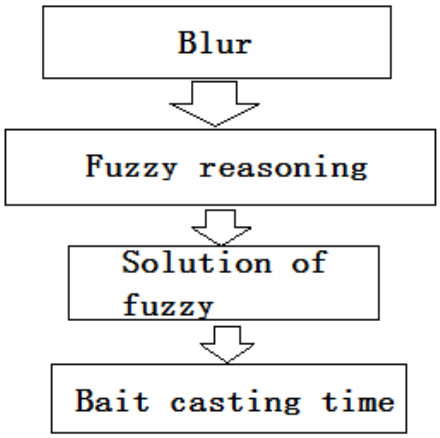

Figure 4: Fuzzy controller structure

The fuzzy control rules are established based on the experience of breeders and experiments. The principles of the fuzzy control rule table are as follows: if the feeding ability of the fish school is very weak, it indicates the need for floating bait is low, and feeding should no longer be continued or only a small amount of bait should be fed at this time; if the feeding ability of the fish school is strong, the amount of floating bait needs to be fed also depends on the number of remaining floating bait on the water surface, if there are few remaining float bait, then feed more; if there are many remaining floating bait on the water surface, then feed less.

3.3 Automatic feeding system

The system design is shown in Figure 5.

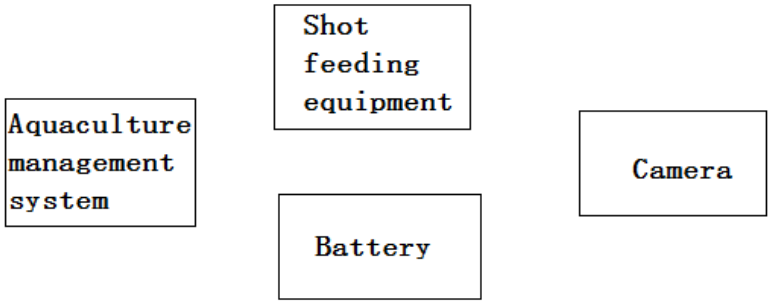

Figure 5: The system design

The software part of the feeding system is mainly based on the Linux platform. Before programming the software for floating bait image acquisition, display, transmission and recognition, a development environment

for software programming should be constructed. This project uses the Qt image interface system to develop the visual interface and operability of the enhanced feeding system. In addition, the image processing library Open CV is also cross-platform. If the cross-platform development environment is not well established, the developed software will encounter compatibility issues during transplantation and result in running failure, following passages would focus on the construction of the development environment. The development environment is shown in Figure 6.

TCP/IP data transfer mainly relies on the programming of socket, which actually provides a communication endpoint. Before communication, both parties must create an endpoint and set the same port number in the properties of the endpoint, so that connection between two different devices can be established, otherwise they cannot communicate with each other. There are three types of sockets: stream socket, datagram socket, and raw socket, among which, the stream socket provides connection-oriented and reliable data transmission services, sending data without errors or duplication, socket of this type is implemented based on the TCP protocol.

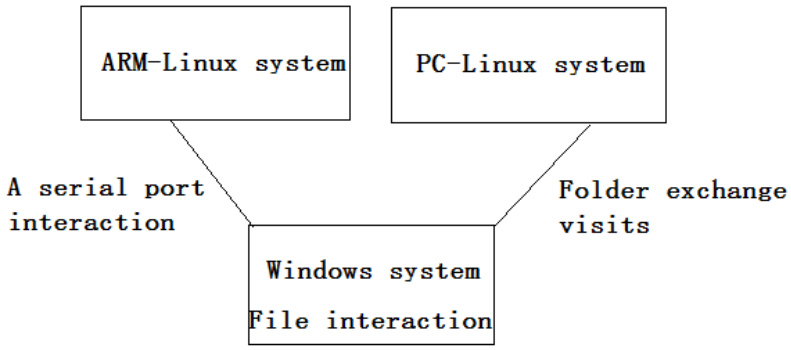

Figure 6: Development environment construction

4. Results and analysis

From the perspective of the market, the situation of various products produced by different countries will be broken with the intensification of international competition. A few brands will monopolize the international market. From the point of view of the development of network, the development direction of programmable controller technology is that programmable controller and other industrial control computers form a large control system by networking. Currently, a large number of programmable controllers (programmable controllers) have been Distributed in DCS (Distributed Control System). With the development of computer network, programmable controller, as an important part of automation control network and international general network, will play a more and more important role in industry and many other fields.

In the feeding process, there are many factors affecting the accuracy of on-site detection of floating bait data, and the detected data tends to be biased. Therefore, the floating bait recognition system needs to be compared with the manual identification count to discuss the accuracy of data obtained by image processing. During the experiment, in the beginning, the fish school didn't consume the bait thrown by the feeding machine at once, the reason is that the sound of the electromagnetic oscillator and the motor of the feeding machine made the fishes uncomfortable so that the they didn't dare to eat. Therefore, before the feeding machine experiment, the fish school needs to be domesticated according to the principle of biological conditioned response. The specific method is to give a certain sound signal (the sound of the feeding machine) to the fish school while each feeding, so as to establish a conditioned response of the sound signal and the feeding. After a week of domestication, the fish school is no longer afraid of the sound of the feeding machine. This design is carried out after the domestication of the fish school, after turning on the automatic feeding system, the main work is to feed and induce food in-take, and the remaining floating bait images are collected and automatically identified; then, according to the identified number of remaining floating bait, the feeding ability of the fish school and the fuzzy control rules, carry out the corresponding feeding control and planning of the current feeding cycle. Under the same farming conditions, automatic feeding can give more suitable amount of floating bait than manual feeding, so that the fish population grows faster, and the bait coefficient of automatic feeding is lower than that of manual feeding. The bait coefficient is the amount of floating bait required for the fish school to gain unit weight.

From the technical point of view, the new achievements of computer technology will be more applied to the design and manufacture of programmable controller, there will be faster computing speed, greater storage capacity, more intelligent varieties appear; From the perspective of product scale, it will further develop towards the direction of ultra-small and ultra-large; From the perspective of product compatibility, the product variety will be richer and the specifications more complete. Perfect man-machine interface and complete communication equipment will better adapt to the needs of various industrial control occasions.

5. Conclusion

This project aims to design a PLC-based automatic feeding system for floating bait, which can judge the feeding activity of the fish school, and at the same time, it can throw an appropriate amount of floating bait for fish. The specific implementation process of this method is to take the floating bait as the medium, use machine to identify the number of remaining floating bait on the water surface and use image acquisition module to shoot pictures of the floating bait, then by image processing, identify and count the floating bait in the images. The automatic feeding system has high precision in floating bait recognition, and the bait amount it throws is more reasonable than the manual feeding method. Finally, the bait is supplemented by fuzzy control rules, the fish population would not be in a semistarvation state or stop growing due to insufficient feeding amount, low feed utilization rate would not be resulted due to excessive feeding and the water quality would not be compromised, which greatly improves the efficiency of farming.

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