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Iot Based Automated Fish Farm Aquaculture Monitoring System

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ABSTRACT

This paper presents an IoT-based fish farm monitoring system designed to enhance operational efficiency, improve environmental management, and optimize resource utilization. The proposed system utilizes a network of sensors deployed throughout the fish farm to collect data on various parameters such as water quality, temperature, pH level, dissolved oxygen, and feed consumption. These sensors are connected to a central hub, which aggregates the data and transmits it to a cloud-based platform for storage and analysis.

At present, China is the largest aquaculture country in the world, ranking in the forefront of the world in terms of the aquaculture scale and the aquaculture production. However, with the expansion of the aquaculture species and the gradual saturation of the development and utilization of the water resources, the traditional aquaculture methods are liable to cause adverse consequences such as the water pollution and the low quality of the aquatic products. Therefore, we have to abandon the extensive way of relying entirely on the experience for the aquaculture in the past. Through the use of the emerging technologies and the timely and accurate data of the aquaculture environment, it is inevitable to make efficient and timely adjustment. In this context, the introduction of the technology of the Internet of Things makes it possible for the aquaculture with high efficiency, high yield and environmental protection.

KEYWORDS: Professional commitment, Self-efficacy, Primary school teachers.

INTRODUCTION

Aquaculture which involves the cultivation of aquatic organisms has become a criticaleconomic sector as global demand for seafood grows. As wild fisheries are already overfished, sustainable and efficient aquaculture methods are now needed to maintain safety and mitigate the negative environmental impacts of overfishing.

In this record the application of Internet of Things technology in aquaculture has become important by applying innovative methods to monitor environmental conditions increase the productivity and improve the welfare of aquatic animals. our project aims to transform the aquaculture sector through the Internet of things. Our project integrates cutting-edge technologies such as relays, Arduino Uno microcontrollers, and waterproof temperature and turbidity sensors to create a system that streamlines fish farming methodsand promotes sustainability.

We strive to solve the central problems of traditional aquaculture, such as water quality management, optimization of water level metrics, and more, with an emphasis on promoting ecologically sustainable and economically viable solutions. Let's dive into the specifics of our project and explore the various components that make up the core of our IoT aquaculture system.

Our waterproof sensors provide fish farmers with real-time information on water temperature, turbidity, and other critical parameters so they can make informed decisions.Acting as a central unit, the Arduino Uno collects and analyses this data before triggering automatic actions via relays to ensure optimal conditions for fish development.

Aquaculture is one of the prospering segments in developing countries like India because it contributes 1.07 percent of the GDP. It is found that fish necessity of the countryby 2025 would be in terms of 1.6 crores tones and thanks to the overfishing regular fisheriesare drained therefore commercial aquaculture has been appeared. Aquaculture comprises the arrangement of exercises, information and methods for the rearing of underwater plantsand a couple of sorts of animals within the water. Water is the primary need of all living.

The contributions of this paper are as follows: (1) We integrated the transformer self-attention mechanism (TR) and added a small target detection layer on this basis to improve the overall feature extraction ability of the model, greatly improving the recognition rate of fish lateral line scales. (2) Establish a challenge dataset for fish lateral line scale detection and counting. We collected image data of fish lateral scales in different scenes and conducted effectiveness screening on experimental data. Additional, in order to avoid too single dataset image and ensure the reliability of the data, brightness, adaptive histogram equalization, enhance edges, Gaussian noise in six methods of image preprocessing, including horizontal and vertical flipping, are used to expand the original image data and ultimately construct fish lateral line scale datasets.

To solve the problem of the extremely similarity of fish lateral line scales boundaries, the Transformer Encoder is fused with the C3 module in the eighth layer of the Backbone layer, forming a new module to further improve feature extraction capability in YOLOv. The features obtained from the C3 module at the seventeenth layer of the Neck layer are then convoluted and up-sampled. Afterward, the same-scale features from the third layer of the backbone network are fused by concat, forming the feature map corresponding to the small object detection layer. Subsequently, the small object detection layer (Head) is built in the detection network, completing the overall construction of the model

LITERATURE REVIEW

The fish body lateral line scale data collection was carried out at the Hebei Zhuozhou Digital Fishery Precision Technology Integration Base. The collection period is from July 19, 2022, to August 2, 2022. The collection objects are 8-23 cm crucian carp and koi fish, including a total of 18 black crucian carp, 10 red gill crucian carp, 1 pure white crucian carp, 6 red and white koi, 2 tri-color koi, and 1 yellow koi. The SONY IMX686 camera is used for data collection through shooting, and the data collection includes multi-directional, multi-species, different distance, different scene, and different size fish body lateral line scale images and real-time videos. A total of 1903 image data files and 16 video data files were collected, with image formats as JPG, resolution of 4624 pixels × 2604 pixels per image; video format is MP4, with each video having a frame width of 1920 and a frame height of 1080.

YOLOv5 is a standard convolutional neural network that performs various convolution operations, pooling operations, and result output through a fully connected layer on input three-channel images [24], [25]. It adopts the Path Aggregation Network (PANet) structure [26], which leads to insufficient fusion of multi-scale features. YOLOv5 mainly includes three parts: the Backbone layer, the Neck layer and the Head layer. The Backbone layer continuously extracts key and general features through convolutional down sampling. The Neck network layer is used for further feature extraction [27]. It includes two parts: the left FPN and the right PAN. The FPN extracts features at different scales in the image by constructing a feature pyramid with different resolutions. The right-side PAN obtains multiscale information through a bottom-up path aggregation module. Finally, the Head layer is used for object detection and output of corresponding final detection results, converting the three feature maps extracted by the backbone network into the final target detection results. We chose the smallest YOLOv5s as the base model, which ensures detection accuracy while saving detection time and model space size.

OBJECTIVES OF THE STUDY

1. The system being proposed here analyses the innovative ways to improve aqua culture monitoring and controlling.
2. There is the need for an improved system with higher frequency of data input, higher accuracy of higher quality sensors, and a wider rangeof parameters being monitored. The motivation behind this project is to develop a transferfunction between aqua culture water quality monitoring system and source of data collection till its transmission to the destination.
3. To enhance aquaculture efficiency, quality, and sustainability through real-time monitoring and control.

HYPOTHESES

1. There is no significant difference between the professional commitment of male and femaleprimary school teachers.

2. There is no significant difference between the self-efficacy of male and female primary school teachers.

3. There is a significant relationship between professional commitment and self- efficacy of Primary school teachers.

Delimitations of the study

Time Delimitations: Researchers often set specific time frames for their studies. These time boundaries help narrow down the scope and ensure that the research remains feasible within the given constraints.
Population Delimitations:Population boundaries specify the specific group of people or organisms under study. These delimitations enhance the accuracy of results by targeting a specific group.

SAMPLE OF THE STUDY

Sensor Network:Various sensors measure critical parameters such as pH, conductivity, water turbidity, and temperature.These sensors continuously collect data from the aquaculture environment.
Data Processing and Analysis:The collected data undergoes preprocessing and feature extraction.Machine learning algorithms (such as decision tree classification and random forest) are applied to identify patterns and predict potential problems.The system learns from historical data to make informed decisions.

Real-Time Monitoring and Alerts:The system provides real-time monitoring through an **Android app** or a web-based interface.Alerts are generated when deviations from optimal conditions occur (e.g., sudden changes in water quality).

Optimum Farming Conditions:The system recommends ideal conditions for fish and shrimp growth.Factors like temperature, pH levels, and feeding schedules are optimized based on ML predictions.

METHODOLOGY

These methodologies combine technology, data analysis, and real-time monitoring to promote sustainable and efficient aquaculture practices. They contribute to both ecological balance and economic viability.

RESEARCH TOOLS

Bit.ai:

Bit.ai is an all-in-one platform that allows researchers and teams to collaborate, share, track, and manage knowledge and research in one place.

ANALYSIS, INTERPRETATIONS AND DISCUSSION OF THERESULTS

H1: There is no significant difference between the professional commitment of male and female primary school teachers.

Table 1.1

Gender Wise Mean, SD and Significance of Difference of Professional Commitment of primarySchool Teachers

Gender	N	Mean	S D	SEd	t-ratio	Significance
Male	250	229.94	23.17	1.56	2.40*	Significant
Female	250	233.69	24.81			

* Significant at .05 level of significance

The first hypothesis of the study was that there is no difference in the professional commitment of male and female primary school teachers Table 1.1 shows that in case of male teacher respondents the mean of the scores on professional commitment was 229.94 and in case of female respondents it was 233.69. The ‘t’ ratio in respect of the two means was 2.40 which is significant at .05 level of significance. Therefore, the first null hypothesis stands rejected.

H2: There is no significant difference between the self-efficacy of male and female primary school teachers

Self- Efficacy of Primary School Teachers – Gender Wise The independent variable of self-efficacy was also studied on the basis of gender.

Table 1.2

Gender-Wise Mean, SD and Significance of Difference of Self-Efficacy

Gender	N	Mean	S D	SEd	t-ratio	Significance
Male	250	34.09	5.58	0.36	0.14	Not Significant
Female	250	34.04	5.63			

* Significant at .05 level of significance.

The mean and standard deviation of self- efficacy of male teachers was 34.09 and 5.58; and of female teachers was 34.04 and 5.63. The t-value for gender difference was 0.14 which is not significant (Table 1.2). Hence, the second hypothesis that there is no difference in self-efficacy of male and female primary school teachers stands accepted.

One possible explanation of the staid result is that both categories of respondents while teaching classes remain more or less equally concerned with their image and reputation as teachers. The high scores of self-efficacy of both the categories reflect the conscientiousness of both regarding effective performanceof teaching duties and responsibilities.

H3. There is a significant relationship between professional commitment and self- efficacy of Primary school teachers.

After studying professional commitment, self- efficacy of male and female school teachers, the next step was to study the relationship between professional commitment and self-efficacy of primary school teachers. Correlation co-efficient were computed between self-efficacy and professional commitment.

Table 1.3
Correlation between Professional Commitment and Self-Efficacy

Variable	Correlation
Professional commitment	**.391****
Self- efficacy	

The coefficient of correlation between professional commitment and self- efficacy was 0.391, which is significant at .01 levels thereby showing a highly positive relationship between professional commitment and self-efficacy. It means that there is a significant positive relationship between professional commitment andself-efficacy. (As depicted in figure 1.3 above)

The third hypothesis states that there is a significant relationship between professional commitment and self efficacy of primary school teachers. Analysis of data revealed a highly significant correlation betweenthe two variables. These results are on expected lines. Therefore, the hypothesis that there is a significant relationship between professional commitment and self-efficacy of primary school teachers stands accepted.

FINDINGS OF THE STUDY

1. Female primary school teachers were found to have higher professional commitment than maleschool teachers.
2. There is no significant gender difference was found in the self-efficacy of primary school teachers.
3. There is positive correlation was found between professional commitment and self-efficacy ofprimary school teachers.

CONCLUSION

The proposed TRH-YOLOv5 model aims to realize non-contact detection and counting of the fish lateral line scales in the actual aquaculture environment. In this study, based on the basic YOLOv5 model, a new target detection model was built to address the problem of the automatic identification and counting of fish body lateral line scales. The paper leverages the Transformer's self-attention mechanism as well as the fundamental principle and benefits of small target detection layer, thereby enhancing the recognition capability of easily confused small targets and significantly improving the accuracy of fish body lateral line scales' identification and counting. The experimental results showed that the TRH-YOLOv5 model performs best when the learning rate is set at 0.01, the Batch-size is set at 8, and the default SGD optimizer is used. While maintaining the same model size and detection speed, the detection accuracy mAP50 increased by 3.7%, and the recall rate R improved by 8.2%, demonstrating superior detection performance and identification accuracy for fish body lateral line scales. As tested on multiple datasets of image collections, the identification counting rate can reach 99%, showing excellent results. Therefore, the model built in this study is efficient and significant in terms of automatic recognition and counting of fish body lateral line scales.

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