Image recognition based on water hyacinth controlled breeding monitoring equipment

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Abstract. The use of image recognition, designed a kind of intelligent monitoring of water hyacinth growth monitoring device, this device realizes the automatic identification of water hyacinth growth status and scope, through image recognition of collecting water hyacinth images into water hyacinth growth related data, after the data through the Internet of things push to the terminal, to achieve the objective of the auxiliary water hyacinth controlling farming work. The water hyacinth controlled planting and breeding monitoring equipment designed in this project has good practicability and promotion value. It can be applied to water hyacinth controlled planting and breeding and water control project, which can effectively solve the problem of large workload and untimely supervision of water hyacinth, and is conducive to promoting water hyacinth to water control work.

1. Introduction

The current controlled breeding of water hyacinth depends on the two aspects of fence control and manual management, both of which are indispensable. The analysis shows that the current controlled breeding of water hyacinth mainly has the following two problems in manual management:

(1) In the current controlled breeding work of water hyacinth, the inspection record of water hyacinth growth mainly depends on manual inspection, and can not be carried out spot check. As the water hyacinth is planted on the water surface, for large areas of cultivation and cultivation, manual inspection is time-consuming and labor-intensive, which is not conducive to the large-scale promotion of water hyacinth controlled cultivation and water control project.

(2) Water hyacinth has a strong reproductive capacity, so it requires high control breeding of water hyacinth. The inspection times stipulated are relatively frequent, and it is difficult to carry out manual inspection in bad weather to ensure that water hyacinth does not overflow.

Based on the above background, this project proposed a control fence that conforms to the above water hyacinth breeding scheme, which can provide users with the growth information of water hyacinth during the control and breeding process and reduce the human resource input during the implementation of the scheme.
2. Systematic research content and research objectives:

2.1. The system design

The main design idea of the device is as follows: a camera is used to collect the image information of the water hyacinth growing inside the fence, and the MCU sends the image information and sensor information to the top server through the wireless communication module, so as to avoid the MCU processing too much data and reduce the power consumption of the MCU. The server will be treated as data analysis. Image information through the built-in image recognition script to extract the information they need, then, together with the sensor information in the database, and pushed to the client, the server detects the water hyacinth, abnormal production will be the first time control and data acquisition terminal open warning guiding light to online client push alarm information.

The separation of data acquisition and data analysis is adopted to reduce the power consumption of the data acquisition end as much as possible. Meanwhile, the real-time connection of the client end to the device can also be ensured to facilitate users to query information. The wireless transmission module at the data acquisition end can be changed according to different needs to ensure smooth data channel.

Figure 1. Overall system link diagram
2.2. Module design

2.2.1. Design of data acquisition end

The whole system includes photovoltaic panel, battery, power management module, MCU, wireless communication module, water temperature sensor, temperature and humidity sensor, and full-color camera, as shown in Figure 2. During the breeding process of water hyacinth, the cost of manual supervision is high. Therefore, an automatic supervision system is needed to monitor the growth of water hyacinth in real time. In order to obtain the growth density information of water hyacinth, a variety of sensing schemes were comprehensively considered, and finally the machine vision scheme was selected. Therefore, a full-color camera was added to collect the image information of water hyacinth in the fence; 3, the temperature sensor DS18B20, low cost, high precision, and digital sensor, less affected by the external environment; 4. DHT11 sensor is selected for the temperature and humidity sensor, which can simultaneously control the vehicle gas temperature and humidity, and is the same digital sensor as DS18B20; 5. Add water quality sensors according to the requirements of daily management of water hyacinth breeding; 6. Environmental information and image information are transmitted to the background server through wireless transmission to achieve remote monitoring. Considering that many domestic manufacturers have launched Zigbee modules with different features and functions, this scheme plans to use Zigbee wireless networking scheme in advance; 7. The MCU can receive the alarm information returned by the background server through wireless communication. When the growth density of water hyacinth does not meet the preset threshold, the warning signal light will be lit to provide guidance for the staff coming to deal with it. 8. Since there is no power supply on the surface, photovoltaic power generation is added to provide energy, while the battery is added as buffer, so that the control system can get stable power supply. Meanwhile, the wireless communication with high power consumption is added with automatic sleep function.

2.2.2. Background service design. The background server mainly has two functions: data analysis and processing and client data. The wireless module is connected to the core of the background server through a serial port. The background server chooses Linux platform, supports python natively, is easy to develop back-end, the front end use HTML5 development, the server provides web services for
customers. The following figure shows the back-end workflow of the server, which runs repeatedly. The front end of the web page provides data visualization service for users by retrieving data in the database. At the same time, the HTML5 web page can be encapsulated to form a mobile client of mobile phone, which makes it convenient for users to view data and receive alarm information.

![Image processing design](https://example.com/image.png)

**Figure 3.** Background server data processing flow chart

Data processing part is mainly used for classifying the data, and invoke the image recognition script processing image information, and record data classification to the database, the use of the database on the one hand is convenient for user to check the growth of water hyacinth information, on the other hand is to record the entire process of growth of water hyacinth, provide data for the growth of water hyacinth related research.

Considering the high maintenance cost of the server, this project split the back-end service part of the client to the cloud server to avoid the influence of network access on the data analysis records of the back-end server.

2.2.3. **Image processing design.** Because image recognition requires more computing resources, the background server has reserved more resources to complete image processing. After the image is received by the server, the processing steps for the image are roughly as follows. Opencv is used to identify and record the location data of the identification anchor point reserved at the corner of the fence. Based on the identified position data, the image was clipped and trapezoid corrected to form a complete overhead view of the fence. Opencv made color statistics on the processed image and binarized the image. The water surface was white and the covered area of water hyacinth was black. Then, the number of the two kinds of pixel points was counted. The number of white pixels was recorded as X, and the number of black pixels was recorded as Y, so the coverage rate of water hyacinth a was
a = \frac{Y}{X + Y} \times 100\%

Limited by the installation conditions, so the camera to collect images will produce perspective distortion, so in order to extract information, must first after correction, the project provided by the use of opencv perspective transformation function correct to face up to the point of view of the picture about the process is as follows, is obtained by grey, fuzzy and binarization hierarchical graph, then the outsourcing rectangular silhouette images, and find the angular point, obtain the coordinates of the four corners of fence by trapezoidal four corners and outsourcing rectangular vertex transformation matrix, projection transform, finally get the fence figure in the face.

Since the color of water surface and water hyacinth leaves are different, the area can be calculated by color screening and statistics, mainly to make statistical records of the corrected image pixels. This gives the water hyacinth density and saves it to the database. According to this method, the growth of cyanobacteria and other aquatic plants in the fence can also be measured to meet the needs of daily management.

3. Application and benefit analysis
This project in the experimental stages the MCU using ESP32 as data collection and used directly with WIFI module as a wireless communication module, data are formed by interaction among various modules networking communication channels, image processing and data analysis program using a backend server run debian system raspberries pie 3 b +, maximum limit reduce the cost of equipment condition, ensure the stability of the system. The project deployed EMQ container in aliyun, provided MQTT, cloud database and client API, and formed data channel between client and background server. During the actual experiment, the stable operation of the equipment can be guaranteed for a long time.

The main purpose of this project is to reduce the human resource investment in the controlled planting and breeding of water hyacinth, reduce the economic investment in the process of planting and breeding, and improve the management reliability of the controlled planting and breeding of water hyacinth.

Planting experiment data in taihu lake area as an example, its economic investment mainly divided into facilities cost, specified seedling cost, raising the salvage of transportation cost, project indirect cost recycling, and includes the management of the water hyacinth in planting and raising salvage transportation resource costs, responsible for the cost of 20% ~ 30%, planting and raising salvage transportation resource costs of total economic input weight of 0.28. This equipment can reduce about 70% of the manual management cost, can reduce about 6% of the economic cost of water hyacinth controlled planting.

4. Conclusion
The project provides a monitoring device with controlled breeding of water hyacinth to reduce labor costs. Based on the existing functions of the control breeding fence installed in the existing fence, it can provide users with breeding environment information, water hyacinth coverage information, threshold alarm, auxiliary fishing and other functions, so as to simplify the work of the two steps of breeding and daily management of water hyacinth. This project has great significance in the application of water hyacinth to water pollution control, which is conducive to the large-scale promotion of water hyacinth control planting, breeding and water control project. In addition, in other biological treatment projects, the monitoring equipment developed by this project also has high application value, practical value and promotion potential.

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