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Research Article

Design of Intelligent Fish Box Based on Machine Vision and Internet of Things Technology

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ABSTRACT

The rapid economic development has fueled the demand for enhancing lifestyle and home aesthetics, leading to the growing popularity of leisure activities and home decoration. As a response, the ornamental fish industry has flourished, prompting fish enthusiasts to seek efficient ways to care for their fish. Smart fish box has emerged as popular solutions, offering features such as remote control and monitoring. Smart fish box incorporates machine vision and Internet of Things technologies, allowing users to remotely control lighting, water changing, feeding, and oxygen pump operations. Temperature sensors transmit data to a mobile app, enabling users to monitor and adjust water temperature. These boxes also features built-in cameras for real-time monitoring and send notifications when fish food is running low. This innovative design addresses several challenges in ornamental fish care. This paper presents the mechanical structure, control circuitry, and vision algorithm of the smart fish box. By utilizing collected data, a neural network is trained on the Raspberry Pi platform, successfully recognizing fish health status.

1. Introduction

According to the Ministry of Industry and Information Technology of China, the application of new technologies and products is being accelerated across the country to cultivate new economic growth points and explore new models. There is a growing demand for intelligent fish farming equipment and manufacturers around the world are developing and manufacturing various types of intelligent fish box controllers. A number of controllers with simple circuitry, stable operation and automatic intermittent operation have been introduced. However, due to the independent operation of different devices and their unique environmental parameters, aquariums require the installation of multiple independent controllers, increasing costs. The development of multifunctional fish box controllers is therefore becoming increasingly important [1].

The subsequent sections of this paper are organized as follows.

II. The analysis of smart vision fish box functions.
III. The design of the controller for the intelligent visual fish box.
IV. The design of the sensor system for the smart vision fish box, comprising peripheral sensors and actuators.
V. The software design of the smart fish box includes control algorithms and a neural network vision algorithm for fish health identification.
VI. System testing, including debugging and preparation of each component.
VII. Summary of the main contents of the paper.

2. Functional Analysis of the Intelligent Visual Fish Boxes

2.1. *System Scheme Design Overview*

The intelligent visual fish box controller is composed of several essential components, including the primary control board Arduino development board, visual

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recognition module Raspberry Pi and camera, and various peripheral circuits. These components work together to enable the functionality of the system. Additionally, the system incorporates crucial elements such as the mechanical structure, switches, relays, temperature sensor, WIFI module, voice control system, and a range of motors. To control the system, signals are sent from the network of the mobile app on the cell phone side to the microcontroller. Serial communication is established between the voice control part, the main control board, and the cell phone. The mechanical part incorporates an electric control box for the automatic feeding mechanism, which is directly connected to the box.

The system operates on 5V control electricity and can function by connecting to a standard 220V household socket. After powering on, the fish box can automatically connect to the Internet. Through the cell phone, users can toggle the water pump, the oxygen pump, and lights on and off. The temperature sensor collects data, which can be transmitted to the cell phone, allowing users to view the historical water temperature change curve on their mobile device. Furthermore, The voice control module of the fish box operates by capturing audio signals through a radio device. These signals are then processed and converted into corresponding hexadecimal data. This data is subsequently transmitted to the main control board, enabling voice control functionality. Additionally, the fish box is equipped with a fish food bin that has a capacity to store food for up to 4 days, allowing users to remotely feed the fish using the mobile app. When the fish food bin is empty, a signal is sent to the user as a reminder to refill the food bin and reset it to zero positions. Additionally, the camera provides real-time monitoring of fish health and sends notifications to the user in the event of fish death, enabling timely clean-up to prevent further water pollution [2].

2.2. *External Structure Introduction*

To ensure durability, the electric control box body is fabricated from high-quality PVC foam board, known for its strength and resilience. This material provides a sturdy and reliable structure for the box. Inside the box, the circuit wiring is meticulously organized and arranged to optimize functionality and efficiency. The neat wiring layout helps prevent any interference or malfunction, ensuring the smooth operation of the entire system. The schematic diagram of the electric control box design is illustrated in Fig1.

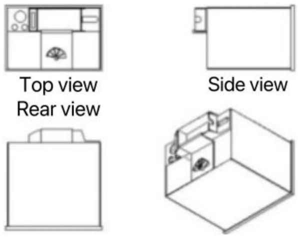

Fig.1 electric control box

The feeding mechanism is created using 3D printing tech nology instead. Fig2 showcases the design of the 3D print ed feeding mechanism.

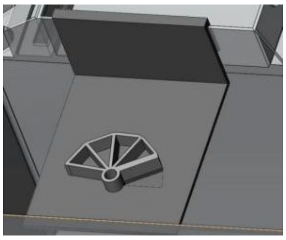
Fig.2 printing feeding mechanism

The practical realization and effectiveness of the intellige nt functionalities in the assembled fish box are showcased in Fig3.


Fig.3 The smart fish box effect

3. Smart Visual Fish Box Controller Design

3.1. *Central Processing Unit (CPU) Board*

The Arduino UNO utilizes the Atmel Atmega328 chip, which offers ease and speed in project development. As an open-source controller, it can be programmed, compiled, and burned using the IDE and a USB cable, eliminating the need for additional programming tools. The main control board provides a total of 0 to 13 digital inputs/outputs and 0 to 5 analog inputs/outputs. The main control board, powered by either USB or an external power supply (5V to 9V), supports Internet service provider downloads. It provides stability and high efficiency, meeting the control requirements of the smart fish box. By utilizing this board, the use of Arduino UNO as the main control board can reduce system design costs and improve program development efficiency. The PCB design is accomplished using specialized software. Fig4 illustrates the schematic diagram of the Arduino design, which was created using Altium Designer.

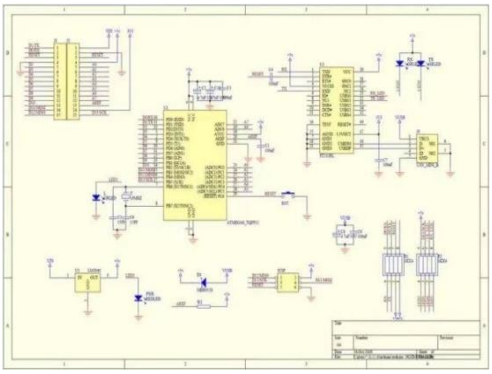

Fig.4 The arduino schematic diagram completed using Altium Designer

3.2. *Visual Component and Camera*

(1) Raspberry Pi 4B

This design incorporates the Raspberry Pi 4B, an ARM-based microcomputer motherboard, to handle the vision component of the smart fish box algorithm. The Raspberry Pi 4B is capable of connecting to devices such as a mouse, network cable, and keyboard for programming and other operations. It can also output high-definition video through its HDMI interface. The Raspberry Pi 4B utilizes a MicroSD/SD card as its memory storage. Additionally, the motherboard features an Ethernet port and multiple USB ports for peripheral connectivity.

The selection of Raspberry Pi 4B is based on its outstanding performance. With a 64-bit quad-core processor running at 1.5GHz, the Raspberry Pi 4B delivers high processing speed and offers ample memory capacity. It also provides an excellent desktop system experience. The original camera integrated with the Raspberry Pi satisfies the requirements of this design for accurately identifying the survival or non-survival of ornamental fish. The schematic diagram of the Raspberry Pi 4B motherboard is illustrated in Fig5.

Fig.5 Raspberry Pi4B motherboard

(2) Camera

The camera used in this design is the original Raspberry Pi camera with a resolution of five megapixel. It is connected to the CSI interface on the Raspberry Pi motherboard, enabling real-time video streaming. The camera captures the live video feed, which is then processed by the Raspberry Pi's neural network to detect and determine the survival status of the fish in the box.The schematic diagram of the Raspberry Pi camera module is displayed in Fig6.

Fig.6 Raspberry Pi supporting camera

(3) The network connectivity component

To establish a network connection in the smart fish box sy stem, the ESP8266 is employed as the wireless network M CU. This module is specifically chosen for its affordabilit y, seamless integration, and its suitability for Io product d evelopment. The ESP8266 demonstrates consistent and re liable performance, even in challenging conditions and ex treme temperatures. It boasts a built-in 32-bit Tensilica pr ocessor and standard digital peripherals, enabling versatil e functionality in diverse operational environments.

In terms of hardware, only a few peripheral circuits such as interfaces, RF BLUN, and a power management module are required, which helps reduce the PCB size and complexity.

The ESP8266's 32-bit Tensilica processor contributes to low power consumption. It incorporates patented technologies that enable extremely efficient power usage, making it suitable for a wide range of low-power applications.

Furthermore, the ESP8266 features a built-in ultra-low po wer Tensilica L106 32-bit RISC processor, operating at a CPU clock rate of 160 MHz. It supports a Real-Time Ope rating System and the Wi-Fi protocol. This provides 80% of the processing power required for program design and development, ensuring efficient and effective operation of the smart fish boxes system. Fig7. illustrates the schematic diagram of the ESP8266-12E minimum system design.

Fig.7 ESP8266-12E minimum system

4. Smart Vision Fish Box Sensor Design

4.1. *Voice module*

The Su-03T is a compact, low-power, and cost-effective speech recognition chip. It is specifically designed for easy integration into various smart products that require voice control, including smart homes and other applications. Despite its small size, the Su-03T chip offers efficient speech recognition capabilities, enabling seamless voice control functionality in the targeted smart devices. Its low power consumption ensures the energy efficiency, while its affordability makes it an attractive option for manufacturers seeking to incorporate voice control features into their products.The schematic diagram of the SU-03T application circuit design is presented Fig8.

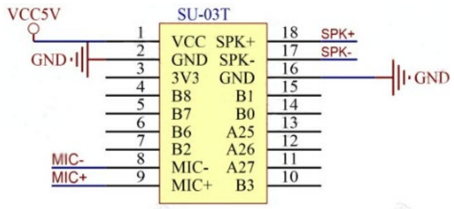

Fig.8 Design of SU-03T Application Circuit Diagram

The voice module utilizes an on-board electret capacitor with dimensions of 4.0*1.2mm as the audio input device. The microphone operates within a voltage range of 1.1V to 10V and has a sensitivity of 42dB. This microphone configuration enables the voice module to capture audio signals effectively for further processing and voice recognition. The built-in microphone design is illustrated in Fig.9.

Fig.9 The built-in microphone

The module operates by utilizing its built-in microphone to capture voice input. It processes the recorded audio by analyzing its spectrum and extracting key features. These features are then compared against a pre-defined library of commands. The module's on-board processor performs further processing of the recognition results, which may include tasks like serial transmission. This enables seamless integration with other components of the system and allows for efficient execution of commands based on voice input.

By leveraging the capabilities of online development platforms, the SU-03T module can be optimized to achieve higher accuracy and faster voice recognition. Its low power consumption and streamlined development process make it an ideal choice for fulfilling the requirements of the voice control component in this design. The system function block diagram is depicted in Fig10.

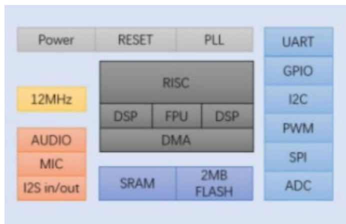

Fig.10 System function block diagram

4.2. *Temperature sensor*

The temperature sensing element employed in the design is the DS18B20 digital temperature sensor. The probe's water temperature detection line is sealed with waterproof measures, such as stainless steel. The DS18B20 sensor utilizes one-wire bus transmission method to transmit temperature data, ensuring high sensitivity and minimal delay. Each DS18B20 sensor has a unique identifier number, allowing for individual sensor identification based on these numbers. The length of the sensor wires can be adjusted according to user requirements. In this design, a waterproof DS18B20 probe is utilized for water temperature detectio n in the fish box [3]. The circuit schematic for the DS18B20 temperature sensor is depicted in Fig.11.

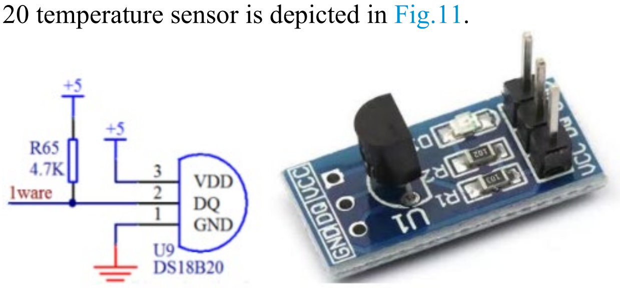

Fig.11 DS18B20 temperature sensor circuit schematic

4.3. *Rudder*

The design incorporates the use of a DS3235 digital rudder for controlling the rudder mechanism. This rudder is equipped with a rudder control panel that is controlled by a microcontroller unit. It provides a single PWM pulse width to set and lock the desired angle of rotation. The DS3235 rudder offers high control accuracy, good linearity, and seamless integration with the control protocol, allowing for precise control with a minimum control angle of 0.9°or less.

The rudder is equipped with a digital circuit board, robust metal gears, a CNC aluminum mid-case, and double ball bearings. These components work together to ensure efficient heat dissipation and enhance the overall durability of the system. In the context of this design, the rudder is directly linked to the feeding mechanism. Whenever the main control board receives a feeding command, the rudder promptly responds to carry out the desired action, the rudder rotates by 36°. With a power supply of 7.4V, the rudder can generate a torque of 35 kg*cm and complete a 60° rotation in just 0.11 seconds. This rudder's precise angle control, fast heat dissipation, and long lifespan make it suitable for the automatic feeding function of the fish box. The rudder Interface design is depicted in Fig.12.

Fig.12 rudder Interface

4.4. *Motor Control Relay*

The JQC-3FF-S-Z relay is utilized as the motor control relay in this design. It is responsible for controlling the connection between the live wire and the motor. The relay configuration includes a common terminal and a normally open contact, which are used as the connection points. The neutral wire is directly connected to the motor. To control the relay, the control end is connected to a 5V power source, GND, and an IO pin of the microcontroller. This configuration enables the microcontroller to effectively control the operation of the motor by activating or deactivating the relay.

When a command is received, and the corresponding pin on the microcontroller becomes low voltage, the normally open contact of the relay will be closed. This action allows current to flow through the relay, thereby turning on the appliance connected to the relay. Essentially, the relay acts as a switch that can be controlled by the microcontroller to turn the appliance on or off based on the received commands. The design of the JQC-3FF-S-Z relay is shown in Fig.13.

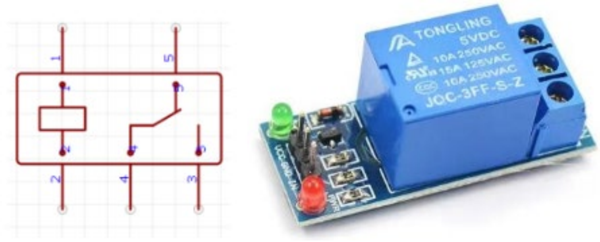

Fig.13 JQC-3FF-S-Z relay

4.5. *Buzzer*

In this design, a 5V buzzer with the model number 12065 is used as an acoustic signaling device. The negative terminal of the buzzer is connected to the common ground shared with the microcontroller, while the positive terminal is connected to an IO pin on the main control board. When the microcontroller detects that the fish food bin is empty, it drives the corresponding pin to a high level, activating the buzzer and producing an audible alert for the user to indicate the empty bin condition.

By controlling the IO pin connected to the buzzer, the microcontroller can activate or deactivate the buzzer as needed. The buzzer serves as an audible indicator to notify the user when the fish food needs to be refilled, ensuring the timely care and well-being of the fish in the box. The design of the Buzzer is shown in Fig14.

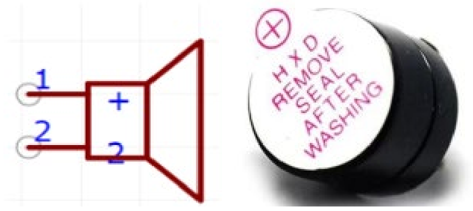

Fig.14 Buzzer

5. Software Design

5.1. *Control algorithm for each component of the fish box*

(1) Regular section

Arduino IDE is used for developing code for the main control board, which offers convenience and speed in development and programming, thereby reducing the complexity of development. The overall idea of the code is as follows:

Initial setup: Configure the GPIO pins and serial port baud rate, initialize variables required for the program, and ensure that all data structures are in their initial state.

The main loop: Read the data from the serial port and enter a nesting structure for condition judgment. If there datum received on the serial port, the system remains in standby mode. When data is received on the serial port, it proceeds to the next level of condition judgment. If the conditions are met, the corresponding operation will be executed.

The code follows a sequential flow where it constantly checks for data on the serial port and performs specific actions based on the received signals from the voice module and ESP8266. The Arduino IDE provides an intuitive platform for coding, compiling, and uploading the code to the main control board, allowing for efficient development and execution of the desired functions. The Control Flow Diagram of the Main Control Board is depicted in Fig.15.

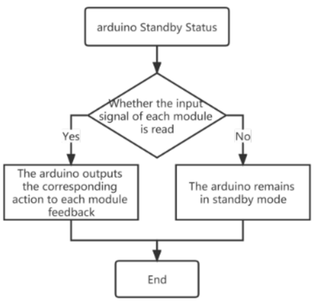

Fig.15 Control flow diagram of main control board

The intelligent control system of this design utilizes relays to manage various components, including lighting, oxygen pump, pumping pump, and heating rod. Upon receiving the relevant command or when specific conditions are met, the microcontroller triggers the activation of the corresponding relays by setting the associated output pins to a low level. This enables effective control over the respective devices, ensuring their proper functioning as per the desired commands or conditions.

However, the automatic feeding mechanism operates slightly differently. The feeding mechanism is controlled by a rudder motor. Each time a feeding command is received, the rudder motor turns by 36°, which is equivalent to one-tenth of a full revolution. Once the fish food bin reaches its final frame, indicating the depletion of fish food, it undergoes a reset process to return to its initial position. Simultaneously, the attitude variable is reset to its original value. In conjunction with this, the microcontroller sets the designated pin connected to the buzzer to a high level, activating the buzzer to audibly notify the user about the empty bin.

This approach ensures that the feeding mechanism operates reliably and accurately. The rudder motor provides precise control over the angle of rotation, allowing for controlled dispensing of fish food. The detection of an empty bin and the subsequent reset and alert mechanism help ensure that the fish in the box is properly fed and taken care of.

(2) ESP8266 Networking Component Design

1. Temperature Sensor Data Processing Design

The DS18B20 temperature sensor stores temperature valu es using complement notation, where the low 8 bits are in verted and then incremented by 1 to obtain the original co de. The temperature data, in hexadecimal format, is stored in RAM and converted to BCD format for further storag e. By using the commands sensors.requestTemperatures() and sensors.getTempCByIndex(0), the temperature can b e obtained from the sensor. The ESP8266 module commu nicates with a cell phone app via WiFi and displays the te mperature data using the Temp component. This allows u sers to conveniently monitor the water temperature of the fish box on their mobile devices. The design of the mobil e phone application showcasing the numerical component s and historical temperature effect is depicted in Fig.16.

Fig.16 Mobile phone APP in the numerical components and historical temperature effect

2.Mobile App Interface Design

Using the Blinker platform for secondary development, a mobile app interface is created for operation and control. The app connects to a third-party server to enable network control. Users can toggle the device on/off, set the desired temperature for the fish box, and monitor real-time and historical temperature data through a temperature curve. Additionally, users can monitor the water temperature and track the remaining days of fish food effortlessly through the intuitive app interface.. This provides a convenient way for users to remotely control and monitor their fish box. The design of the mobile phone app interface is depicted in Fig.17.

Fig.17 Mobile phone APP interface

Upon pressing the interface button, ESP8266 transmits control commands to Arduino based on the status of the switches. Each component on the mobile phone interface is associated with a specific function, When a specific component is pressed, the corresponding code associated with it is executed. In addition, numerical values are displayed using the numerical component, similar to the Temp usage described in the previous section [4].

(3) Voice recognition module

The voice control component is implemented in C programming language. During development, specific keywords are defined, and the voice chip extracts features from the voice input and compares them against these keywords. When a corresponding command is recognized, Once the code is executed, the relevant data is transmitted through the serial port to the main control board, enabling the system to respond to voice commands. Additionally, the SU-03T module can undergo intelligent training on other platforms to further improve the accuracy of voice recognition.

The voice recognition chip is seamlessly integrated with a n MCU (Microcontroller Unit) and establishes communic ation using the jeon format. Upon receiving the data, the s erial port carefully analyzes it to extract the recognition c ode corresponding to the current command. Based on this code, the system executes the appropriate operation, ensu ring seamless functionality and accurate response to user commands.

5.2. *Advanced neural network vision algorithm for fish health identification.*

(1) Data collection and processing

To gather images of healthy and dead goldfish from the web, a crawler was employed. However, during the crawling process, it was observed that a significant portion of the collected dataset was inaccurate due to various reasons, such as complex backgrounds. To address this issue, a data filtering step was implemented to reduce the dataset size and select images that was relatively pure and aligned with the requirements of the design. These selected images were considered suitable data for further analysis and utilization in the project. The design of the data set portion is displayed Fig.18. While the 3D diagram illustrating the data features is presented in Fig.19.

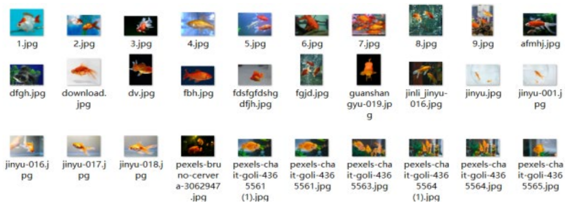

Fig.18 Data set part of the data

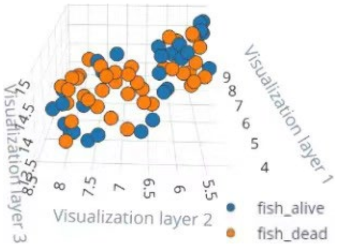

Fig.19 3D diagram of data features

The images were initially represented in RGB format. To prepare the images for training, a normalization operation was applied to each pixel channel, converting the values to floating-point numbers ranging from 0 to 1. Before training, all images were resized to a uniform size of 320x320 pixels using the shortest axis fit method, ensuring consistency in the dataset.

Once the data processing steps were completed, the dataset was divided into a test set and a training set according to a certain ratio, typically two to eight. Each image in the dataset was labeled with the appropriate class label, indicating whether the goldfish in the image was healthy or dead. Finally, relevant features were extracted from the images for further analysis.

It is worth noting that after the data filtering and processing, most of the surviving data features were found to be located in the upper right region of the coordinate space, while the majority of the features from the dead fish data were concentrated in the lower right region. These spatial distributions of features could potentially serve as discriminative factors for distinguishing between healthy and dead goldfish.

(2) Utilizing the MobileNetV2 architecture, an object detection model is employed in this design to achieve accurate detection of fish survival. The Raspberry Pi executes the object detection algorithm, capturing images and providing detailed information about the detected objects such as their class, quantity, and precise locations within the images. This approach ensures effective monitoring and analysis of the fish population in the system.

Building a functional computer vision model from scratch requires significant effort, as it necessitates a diverse range of input data to ensure robust generalization. Consequently, training such a model can be time-consuming, often spanning several days. To alleviate this process and expedite it, the fish box design incorporates transfer learning. By leveraging pre-trained models and retraining only the upper layers of the neural network, the process becomes more manageable and faster. This approach yields more reliable models that can be trained within a short timeframe and using smaller datasets.

To achieve robust object detection in this design, the MobileNetV2 SSD FPN-Lite pre-trained model is utilized. This model has been trained on the COCO 2017 dataset, which consists of images scaled to 320x320 pixels. The architecture of MobileNetV2 SSD FPN-Lite consists of three main components: the base network (MobileNetV2), the detection network, and the feature extractor (FPN-Lite). This combination of components enables accurate and efficient object detection, making it well-suited for the detection of fish survival in the system.

The base networks, including MobileNet, VGG-Net, LeNet, AlexNet, and others, serve as the foundation for neural networks. These base networks offer advanced capabilities for tasks such as classification or detection. By incorporating fully connected layers and softmax layers at the end of these networks, a classification network can be created [5]. Alternatively, the fully connected layers and softmax layers can be eliminated and replaced with detection networks such as SSD, Faster R-CNN, and other similar architectures to enable object detection capabilities. The classification network schematic is depicted in Fig.20.

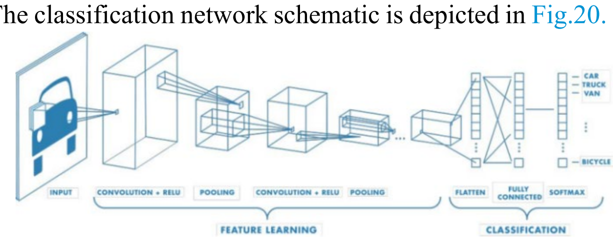

Fig.20 Schematic of classification network

SSD and RPN is two commonly used object detection networks. SSD is capable of detecting multiple objects in an image with a single shot. In contrast, single-shot object detection methods, like SSD, offer advantages over region proposal-based methods such as the R-CNN series. With single-shot methods, there is no need for separate stages of region proposal generation and object detection. Instead, the detection is performed directly on the convolutional feature maps, resulting in faster processing speeds. This efficiency is particularly beneficial in real-time applications where quick object detection is essential, but they may trade off some accuracy for real-time processing speed. sss also encounter challenges in detecting objects that are too close or too small.

To address these challenges, Feature Pyramid Network introduces the concept of feature pyramid design. FPN aim at improve recognition accuracy and processing speed, especially for targets of different sizes. The use of feature pyramids helps in handling smaller targets more effectively and enhances the overall performance of object detection systems.

6. Testing the system's operational functionality

6.1. *The setup and preparation of each component*

The feeding mechanism was adjusted by utilizing a cellph one app for debugging purposes. After the debugging pro cess, the initial angle of the rudder was set to 42°, resultin g in improved alignment between the feeding mechanism and the chassis hole position.

Following the adjustment of the feeding mechanism, the cellphone app was used to control the fish box and perform various actions. After testing, it was determined that functions such as pumping, oxygen pumping, automatic feeding, and lighting were operating normally. The temperature sensor section exhibited minimal difference between the processed data and the actual water temperature. Moreover, the heating equipment functioned as expected, activating when the water temperature fell below the user's set temperature to facilitate automatic control of the water temperature.

In the voice control part, the hardware construction was completed, and the focus shifted towards program writing and burning. The sU-03T module required the assistance of the UniOneUpdateTool burning tool to complete the program burning process. The firmware burning was carried out initially, followed by the power supply to the module. Sometimes, To ensure the successful burning of the firmware, multiple power supply attempts and power failure simulations were conducted. The process involved careful management of power supply and deliberate power interruptions. Please refer to Fig.21. for a visual representation of the Firmware burn-in design.

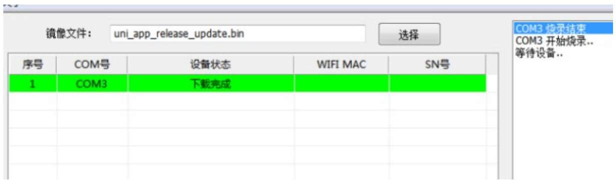

Fig.21 Firmware burn-in

To enhance training efficiency, the number of training iter ations is progressively increased from 20 to 50. By setting the number of rounds to 50, the model will undergo more iterations and have the opportunity to learn and optimize its parameters more effectively. Increasing the number of training rounds can potentially lead to better performance and higher accuracy in the trained model.

6.2. *Execute and obtain outcomes*

Once the control code is written, the smart fish box can be activated by issuing the command "Little Fish." Upon receiving the "lighting" command, the fish box will perform the corresponding action related to the lighting feature. To put the fish box back into the standby state, the "end" command is used. However, if further commands are to be executed, the fish box needs to be awakened again. The "end" command serves to return the fish box to the standby state, and subsequent commands would require the box to be awakened again.

Regarding the vision part, once the parameters are set, the model training process can commence. The model is trained using the specified parameters to learn and optimize its performance for vision-related tasks. The design of the Confusion matrix is shown in Fig.22.

	BACKGROUND	FISH_ALIVE	FISH_DEAD
BACKGROUND	99.5%	0.2%	0.4%
FISH_ALIVE	16.7%	83.3%	0%
FISH_DEAD	12.5%	0%	87.5%
F1 SCORE	1.00	0.83	0.64

Fig.22 Confusion matrix

The algorithm for the vision part is executed, and the model is deployed on Raspberry Pi4 to identify the survival status of fish. By running the command in the terminal, the model is compiled with full hardware acceleration, downloaded to Raspberry Pi, and the detection process is initiated. When an object is detected, the object's coordinates and labels are output, correctly indic ating whether the fish is dead or healthy in the interface[6]. The Code running interface is displayed in

Fig.23. While the Target detection effect is demonstrated in Fig.24.

Fig.23 Code running interface

Fig.24 Target detection effect

7. Conclusion

Undoubtedly, the field of smart home and Internet of Things is rapidly evolving in the contemporary world. The proposed design of the intelligent fish box in this research embraces this technological advancement. Through the amalgamation of diverse disciplines including microcontroller, machine vision, artificial intelligence, and voice control, this design showcases the synergy of knowledge domains, a comprehensive system is formed. It is anticipated that smart fish box, with their automation capabilities, will find broader applications in fish rearing in the future.

This design represents the integration of multiple disciplines to enhance the user's experience of human-computer interaction. As a result, there is a growing market demand for products of this nature. The integration of technologies and disciplines opens up new possibilities and opportunities for creating innovative and user-friendly smart fish box.

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