

Research and Innovation of "i-Pet" Intelligent Pet Feeder

Yina Liu*, Feng Li, Debei Wang, Yingying Qiu

School of Management Science and Engineering, Anhui University of Finance and Economics,
Bengbu 233030, China

Abstract

Cardiovascular diseases have become one of the most prevalent diseases in the world, and the detection and recognition of heart sounds plays an important role in early diagnosis. A heart sound recognition algorithm based on convolutional neural network is proposed to diagnose heart and blood diseases based on heart sound signals. Firstly, the structural characteristics of the heart and the generation of heart sounds are analyzed. Secondly, the analysis and extraction of heart sound features are realized by pre-processing the heart sound signal. Finally, the training was carried out by convolutional neural network, and the accuracy of the algorithm for heart sound recognition was effectively improved after experimental comparison.

Keywords

Pets; smart pet feeding; artificial intelligence; remote control.

1. Introduction

According to the survey data, nowadays more and more people keep pets, but they are often unable to take care of their pets themselves because of working, studying, traveling and other factors. Especially in today's society where the epidemic is rampant, many breeders are isolated and unable to go home due to the epidemic, and their pets have become their biggest worry and concern. As a result, the pets cannot have meals on time and have no one to take care of and accompany them. Foster pets to relatives and friends may also affect the pet's growth environment and bring unnecessary trouble to others, resulting in a series of bad problems.

This paper puts forward the idea of designing an intelligent pet feeder, and uses APP to assist the exploration, and makes a specific description of its design scheme. Its principle is the user feeding device through the APP, or direct operation, realize the timing quantitative feeding pets, infrared technology for measuring temperature of pet, if abnormal temperature instant remind owners, and to real-time monitoring the state of the pet, through online communication with pets, at the same time AR, VR technology is introduced for owners and pets across space communication, Let the owner have a feeling that the pet is around. Let the breeder realize the remote control of pets, to solve the owner's worries^[1,2,3]。

2. Market analysis of pet feeders

2.1. Existing product types

Intelligent feeders on the market can be roughly divided into two categories, one is the feeder with timing function only, and the other is a relatively high-end intelligent feeder. Most of the more popular feeders on the market can only do feeding, while a small number of intelligent products can be remotely controlled and monitor the feeding amount of pets. Most of them are made of plastic material and have a keen sense of smell, so it takes a long time for pets to adapt, and the price is high and the cost performance is low.

Our intelligent feeder will be made entirely from the perspective of pets, using appropriate materials, so that pets can have a better experience. At the same time, it breaks the constraints

of time and space and allows the owner to remotely control pet feeding and monitoring through the APP. Compared with the above two methods, the cost performance and sense of experience are far superior.

2.2. Main consumption objects

Customers mainly busy to study and work in college students, office workers, professional (lawyer/doctor/teacher, etc.), empty nester and left-behind children, through the remote feeding, across space contact, such as technology, help them to solve the problem of some current pet feeding, to provide more comfortable living environment for love dandle, promoting the further development of the pet industry, Provide more value to society. Thus it is beneficial to change the traditional feeding mode and inject new strength and source for the pet industry.

2.3. Function description of the product

This product studies the technical feasibility and practical significance of the following functions of the intelligent pet feeding device, so as to improve people's quality of life.

2.3.1. Remote control

Meet the needs of pets anytime and anywhere, break the traditional pet feeding methods, intelligent feeding, experience the unique charm of new feeding methods.

2.3.2. AR and VR technology

In the application of science and technology, AR and VR technologies are combined to provide more advanced services to realize the communication between the owner and the pet across the space, so that the owner has a feeling that the pet is around.

2.3.3. Timing and quantitative accurate feeding

Pet feeding device with a fixed time and quantitative feeding device, a set, feeding cycle, save time and effort; High-tech microcomputer control, accurate and convenient, to prevent mistakes. Let the pet develop a good habit of regular and quantitative eating, prevent the pet from eating too much food and becoming fat, effectively limit the pet's daily food intake, develop a regular diet, and make the food not bad [4].

2.3.4. Voice call pet

Send simple instructions to pets at any time, break the geographical limitations, and experience the warmth of pets;

2.3.5. Infrared temperature measurement

Real-time monitoring of pet health and timely reminder, nip in the bud.

2.4. This product has innovative features

2.4.1. Innovation points of VR and AR technologies

The "pet glasses" powered by VR are a byproduct of the technology's development. In order to create a virtual reality experience for pet companions, our VR glasses can also be used for watching movies, entertainment games and other aspects, bringing users immersive virtual reality effects.

This is to realize the original intention of pet owners, to be able to accompany anytime and anywhere. High-definition camera, high-decibel speakers, high-sensitivity microphones. VR glasses to the customer's family environment entry in the database, real-time video, language interaction, exclusive pet video, like the immersive feeling, pet owners get voice is no longer the cold machine, but can understand the pets around feeling, a higher degree reduction of pet and master the language communication, crack miss anytime and anywhere.

2.4.2. VR mini-games

Our APP has VR of pet little game, you can experience through of pet glasses, this belongs to our additional features, makes the APP is not only a real pet machine, and we can launch a virtual pet game, preliminary experience clearer feeling, let users for certain whether the verge of users with experience in keeping pets. In this regard, our APP can be divided into two types: the real type (mainly real users with pets) and the virtual type (mainly real users without pets). In addition, pet users can learn pet raising skills from virtual pets, just like online classes, which is more conducive to pet breeding.

2.4.3. Functional innovation

Preliminary research has been done in devices that already exist on the market, and the dissatisfaction of users for the feeder has been improved. New functions have been innovated, which are closer to the needs of users.

(1) The design of this experiment uses the fusion of sensor technology and embedded technology to make the feeding process of the feeder more intelligent and accurate. Not only good control of pet diet, but also reduce food and water overflow, resulting in pollution, to keep the environment clean.

(2) This design considers that some household pet appliances are placed outdoors, so that pets do not like drinking water in winter when the water temperature is too low, and drinking too little water will have long-term harm to the body of pets, so the design of automatic temperature regulation function, supporting simple disinfection function, more humanized.

(3) Real-time observation of pet status, infrared temperature measurement and instruction through speakers can also better ensure the safety and health of pets. When the pet is found abnormal, it will remind the owner of online medical treatment, and initially judge the pet's condition. As a kind of health guarantee for the pet at home, it can help the owner who is not with the pet for a short time to avoid worries.

3. System functional structure block diagram and introduction

The smart pet feeder in this experiment is mainly composed of single chip microcomputer as the core, wifi module, weighing sensor, temperature sensor and other functional modules [5]. The MCU adopts STM32F103 chip as the main control chip, which is mainly responsible for connecting other functional modules [6]. The concrete structure block diagram is as follows:

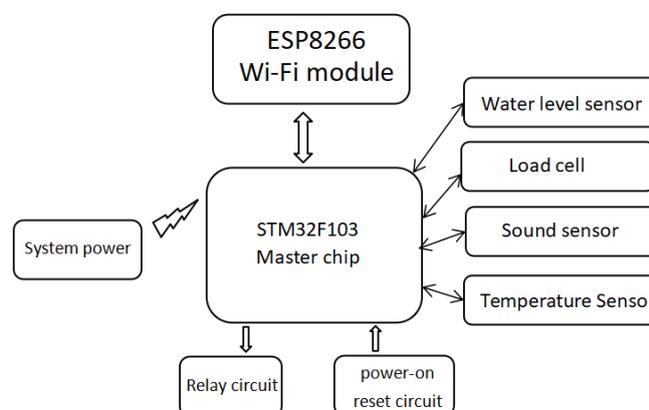


Fig.1 System structure diagram

3.1. Hardware Design

3.1.1. Micro controller chip selection

The MCU adopts STM32F103 chip, STM32F103 is a 48pin ARM processor based on the Cortex-M3 kernel produced by ST Company, with a maximum main frequency of 72MHz, 20K SRAM,

64K FLASH, 1 DMA controller, 1 advanced timer, 2 serial peripherals interface (SP), 3 universal synchronous asynchronous transceiver (US) ART), analog/digital conversion (ADC), three universal timers and so on, powerful, complete variety, and due to RCC external clock management, its power consumption is very low^[7]。

3.1.2. Wifi module

The ESP8266 chip is adopted to undertake the network link protocol layer transformation, and the mobile devices of the feeder and the breeder must be connected to the network to realize the remote control of the device. Internal programming realized AT instruction acceptance, network signal scanning, WIFI signal connection, TCP/UDP protocol implementation, network transparent transmission and other functions. During the test and experiment, the single chip microcomputer sent AT instruction, set the router and password and connected to the network. WIFI module on the feeder was connected successfully. Users can control the feeder through the APP on their mobile phones to achieve relevant functions.

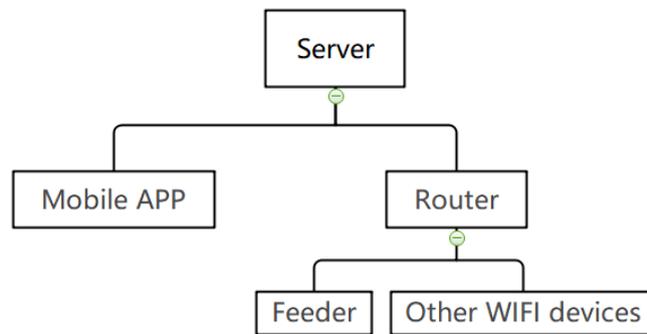


Fig.2 Schematic diagram of communication between mobile APP, server and feeder

3.2. Drinking Water Module

The function of drinking water module includes measuring water temperature, measuring water weight, heater and outlet device. The functional flow diagram of drinking water module consists of two parts.

The core content of the module is as follows: When the pet water reservoir receives the valve opening signal (adding water signal), the valve opens; when it receives the valve closing signal (stopping adding water signal), the valve of the water reservoir closes. The specific flow chart is as follows:

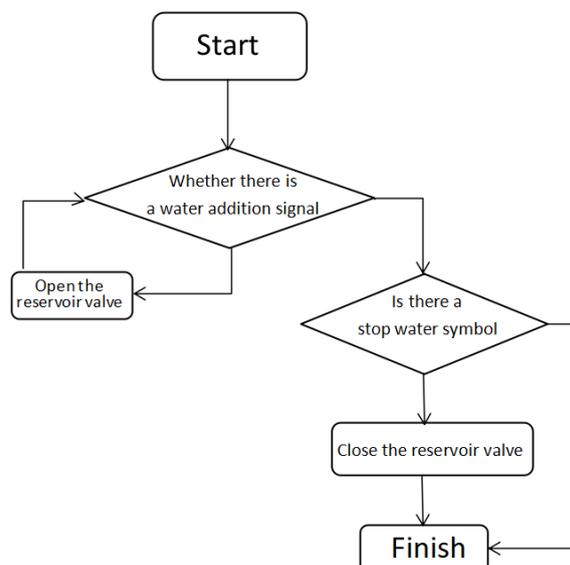


Fig.2 Flowchart of judging whether to add water

The logical structure of the module is similar to that of the water adding module, but the received signal is different from that of the water adding module. The decisive signals here are heating signal and stopping heating signal. The flow chart of whether to heat drinking water to ensure proper water temperature is shown in Figure 3 below.

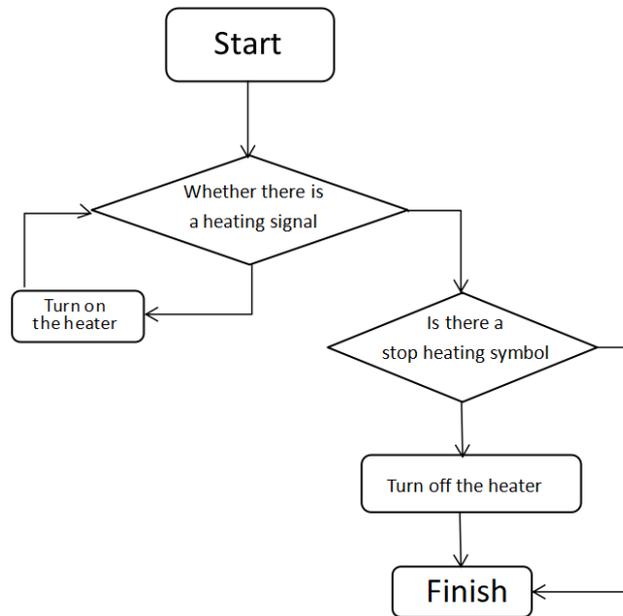


Fig.3 Flow chart for judging whether to heat

3.3. Feeding Module

The function of feeding module is relatively simple, including a device to measure the weight of pet food and a food outlet device. When the feeding module receives the signal of opening grain valve (feeding signal), it will open the valve of storage device, and when it receives the signal of closing the valve of storage device (stopping feeding signal), it will close the valve of storage device. The specific flow chart of feeding module is as follows:

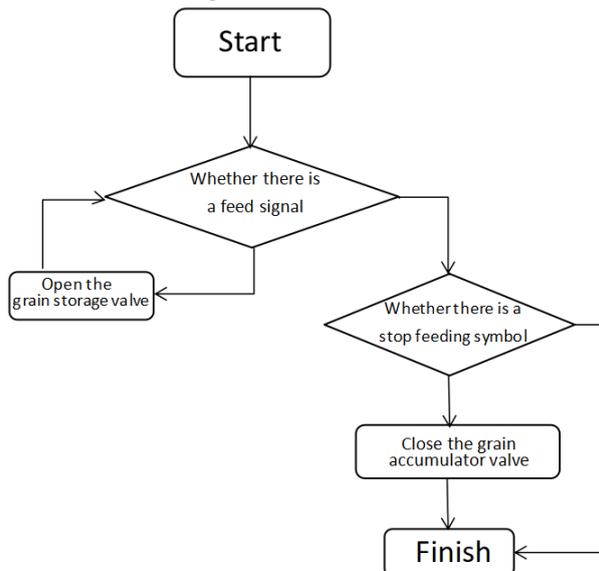


Fig. 4 Flow chart of feeding module

3.4. Sensor Technology

The system can automatically judge when to add water and food, whether the water temperature meets the requirements, so the need to use the corresponding sensor.

Sensor is a device that converts the received measurement into usable output signal, mainly used to collect the corresponding data. There are many kinds of sensors, and the sensors needed in this study are weighing sensor, temperature sensor and image sensor [8].

There are many kinds of weighing sensors, because the object to be measured in this design is cat food or dog food, generally the feed will be controlled between 50-200g, comprehensive consideration of the force sensitive sensor, as long as it meets the corresponding accuracy requirements, easy to interface with the embedded system.

Selection of temperature sensor: for controlling the temperature of pet drinking water, you can choose the contact sensor that is easy to interface with the processor. For monitoring pet body temperature, you can choose infrared radiation temperature sensor. Image sensors mainly use cameras to collect images of pet activities.

3.5. Embedded system technology

Simply put, the embedded system is a control program stored in ROM embedded processor control board, used to process the information collected by sensors, and issue corresponding control commands. That is, the processor compares the information collected by each sensor with the set water quantity, grain quantity and water temperature to determine whether water and grain or heating is needed. According to the results of the comparison, the corresponding control equipment is given the command, so as to realize the automatic control of the water feeder for cats and dogs.

3.6. Pets are equipped with frequency card

RIFD-RF card receives the measured variables processed by the sensor and converts them into usable output signals, and analyzes and processes the data. Adopt RFID technology to track pets in real time, so that pet owners can observe their pets in real time.

3.7. Software Design

3.7.1. APP development and design

In the development of the feeder App, Eclipse was used to write the code of the server side. Java was used as the server side to control the amount of food intake by the length of time and Angle. At the same time, a time was set. Spring Boot framework to build microservices ". Spring Boot is independently run through java-jar xx.jar as a JAR package. Choose to embed servlet containers such as Tomcat, JTTY, or Undertow so that you don't need to add projects as war packages [9]. After receiving the data from the SINGLE chip computer for analysis, the data will be fed back to the user. In order to prevent conflicts caused by the user obtaining liquid level again or the operation of the single chip computer will be overwritten before the analysis is completed, Map<string, object=""> static variable named lock Map, if not used, add logic lock to lock the device ([lock map. put(key, "1")), if used, do not send the specified micro controller and feedback to the user, if parsing is complete, </string,> Remove the logical lock (lock map.remove (key)), so that the level can be obtained through the URL, other processes such as sound, temperature, etc., are the same process principle.

Part of the software page is shown as follows:

3.7.2. AR and VR technology

The development of VR system requires a team to work together. In terms of responsibilities, product designer, experience designer, visual designer, 3D designer, sound designer, development engineer and test engineer are generally required^[10].

The development process is roughly as follows: firstly, the product designer needs to make a complete product planning and functional design for VR system, describe and analyze the needs of the product, market and business, and generate corresponding PRD, MRD and BRD respectively. Then, the experience designer needs to design the life scenes of cute pets and the

interactive process of remote interaction between customers and cute pets. Then, 3D designers use 3D modeling software to create VR scenes according to the living environment of pets, and make special effects for user interaction to improve the smoothness of the operation of the system. Visual designers beautify the models made by 3D designers, and design the UI interface; Finally, the development engineer integrates the results for programming, and makes a complete VR pet system. The details are shown in the figure below:

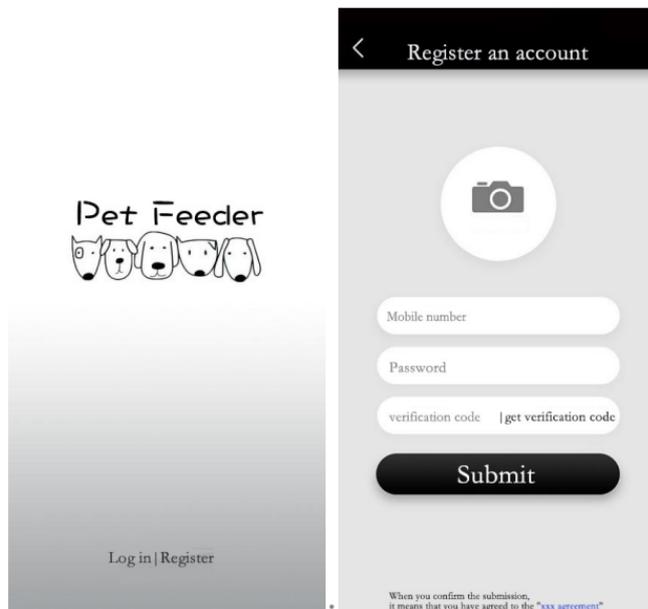


Fig.4 APP login page and registering an account

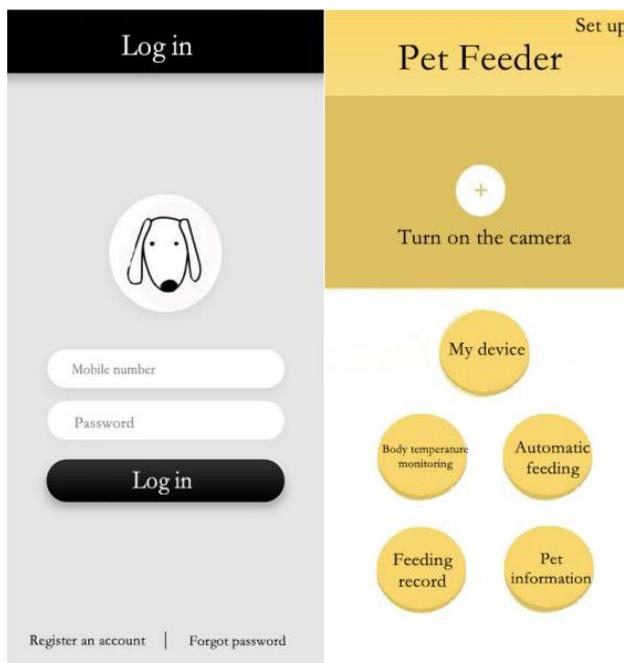


Fig.5 Login page and Main page

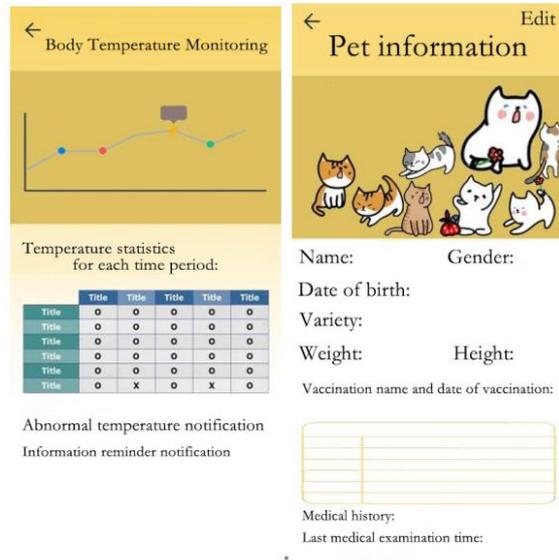


Fig.6 Body temperature detection and pet information

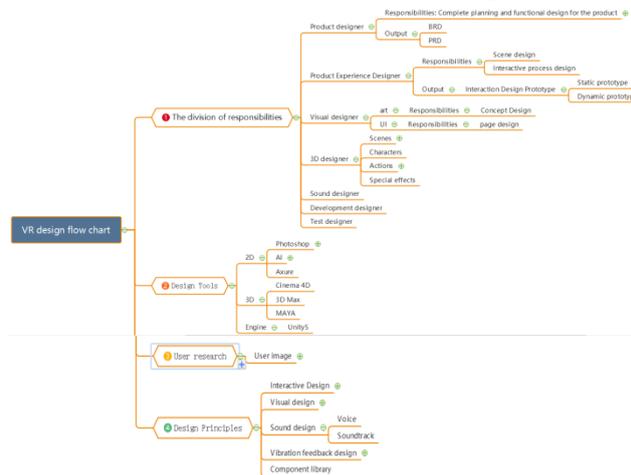


Fig.7 VR flow chart

4. Experimental tests

4.1. Preparation before test

4.1.1. Preparing test equipment

There are four mobile phones and four computers, and four intelligent feeders that can be easily assembled. Four sets of lighting devices, temperature control devices (air conditioning can be used instead of), four mercury thermometers.

4.1.2. Test pet preparation

Prepare one big cat, one kitten, one big dog, one small dog, and the physiological conditions of the cats and dogs are basically the same except for the species and color.

4.1.3. Preparing for Device Operation

(1) Lighting equipment adjustment

| | | | |
|-------------------------------|------------------------|--------------|------------|
| The intensity of illumination | Strong light condition | Normal state | dark state |
| The elapsed time(minutes) | 30 | 30 | 30 |

| | | | |
|---|------------------|---------------|--------|
| Running state | normal | normal | normal |
| (2) Temperature control equipment adjustment | | | |
| Temperature (Celsius) | 10 | 25 | 40 |
| The elapsed time(minutes) | 30 | 30 | 30 |
| Running state | normal | normal | normal |
| (3) Mobile terminal device adjustment | | | |
| function | Mobile terminal | computer side | |
| Whether the network connection is normal | normal | normal | |
| Whether to issue operation instructions normally | normal | normal | |
| Reception of signals | normal | normal | |
| (4) Simple and intelligent pet feeder adjustment | | | |
| function | Smart pet feeder | | |
| Whether the network connection is normal | normal | | |
| Can connect the pet transmitter properly | normal | | |
| Whether the signal can be sent normally | normal | | |
| Can you get a normal signal | normal | | |

4.1.4. Preparing the Test Environment

Prepare four rooms (or four independent areas) of the same size. The environment Settings are the same except for devices that have not been installed. After installing devices, ensure that the installation positions of all devices are the same to avoid interference from external factors.

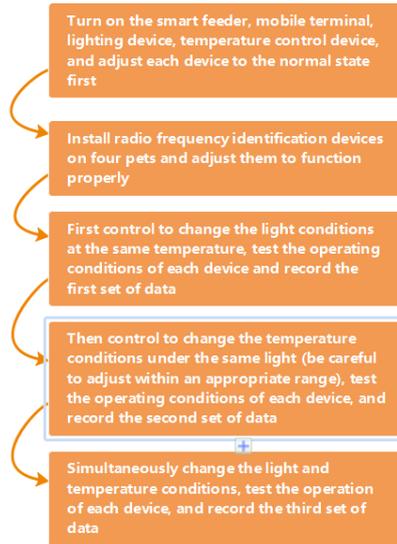
4.2. Test Scheme

4.2.1. Test content

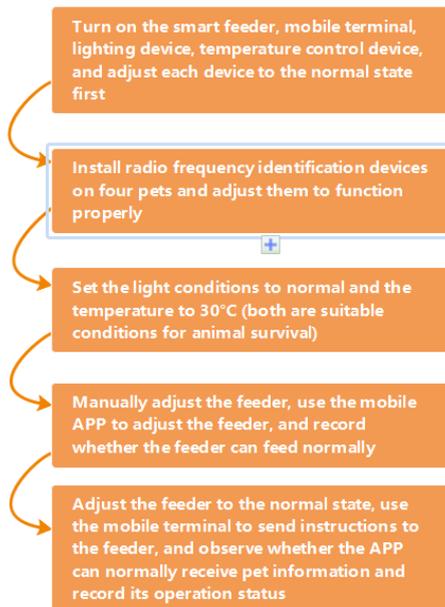
- Test whether the feeder can work normally under the simulated unmanned state;
- Set the automatic feeding time remotely at manual and mobile terminals, observe the feeding situation of the intelligent feeder after reaching the specified time, and record whether the feeder is abnormal, and repeat the operation for many times;
- Test the normal connection between the mobile APP and the feeder;
- Connect the feeder with the computer and mobile phone respectively, first check the connection to ensure the stability of the connection, and then check whether the information between each other can be transmitted normally.
- Test whether the mobile APP can remotely control the normal operation of the feeder;
- Two kinds of mobile terminals are used to set automatic feeding time and operate the feeder remotely, and observe the running status of the feeder.
- Test whether the sensors and RIFD can normally measure various data of pets;
- Start RIFD, check the connection, observe the data sent from the chip in the pet in real time, and directly measure the data in the pet in real time for comparison to ensure the accuracy of data.
- Test whether it will affect the operation of the feeder in different environments.

4.2.2. Test process

- a. test 1



b.test 2



4.3. Test environment setup

4.3.1. Temperature Environment construction

After debugging, adjust the temperature control devices in the four rooms to the same temperature (normal temperature), and ensure that there is no abnormal reaction of pets.

4.3.2. Lighting environment construction

After debugging, the lighting devices in the four rooms are adjusted to the same lighting state, and the pets will not have abnormal reactions due to lighting.

4.3.3. Equipment construction

(1) Connect two mobile terminals (mobile phone and computer) to the network respectively, and ensure smooth network connection to minimize the wrong instructions caused by poor network and mobile terminal Settings.

(2) The intelligent feeder is placed in the position of the original conventional feeder.

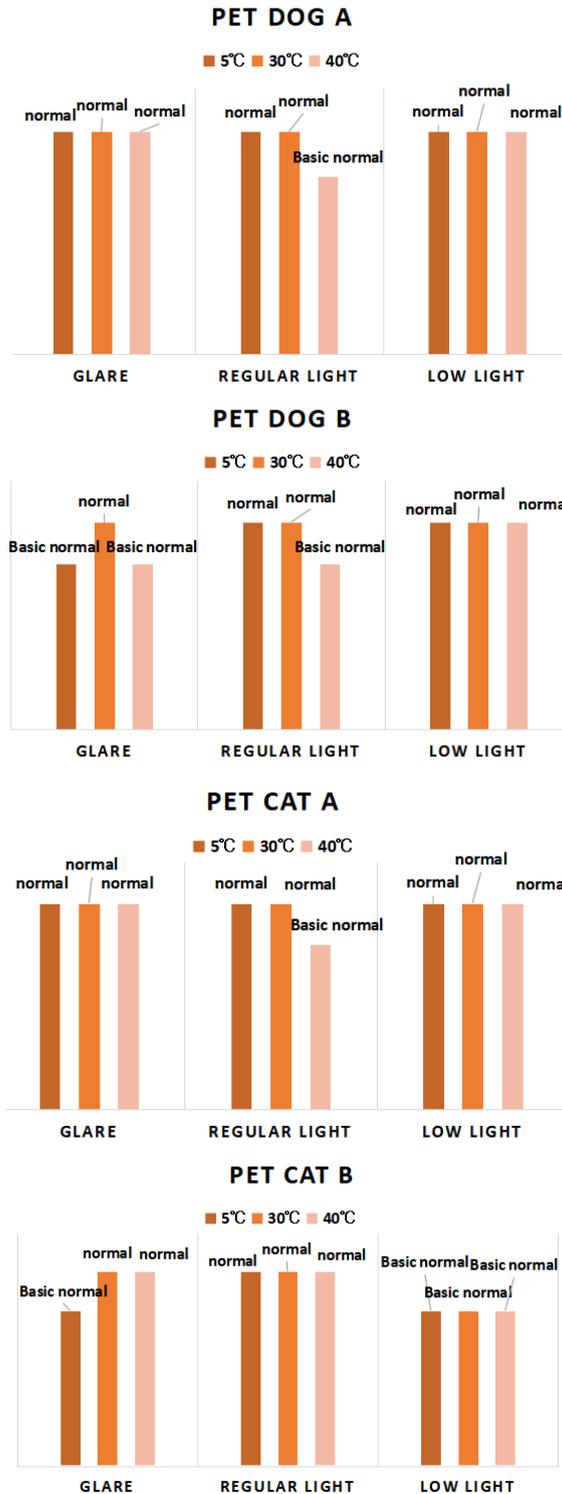
4.4. Test Data

4.4.1. Operation of all equipment under temperature and light intensity changes

Light intensity: strong light, normal light, weak light.

Temperature: 5°C, 30°C, 40°C

① The operating status of intelligent



② The running status of sensors and RF cards

Note: Set light intensity to normal and only change temperature

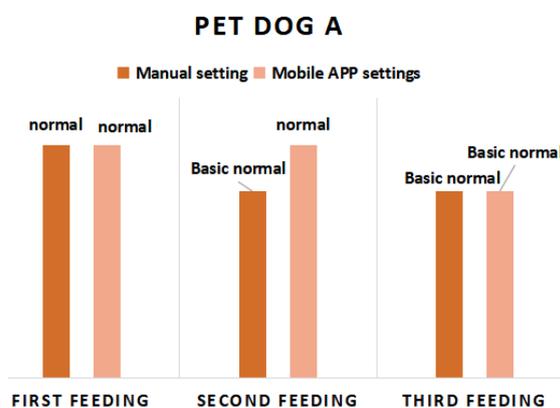
| | Temperature (Celsius) | Data displayed on mobile APP using sensor and RFID technology (Degrees Celsius) | Use a mercury thermometer directly to measure your pet's temperature (Celsius) |
|-----|-----------------------|---|--|
| pet | 5 | 38.2 | 38.1 |
| dog | 30 | 38.1 | 38.1 |
| A | 40 | 39.1 | 39.3 |
| pet | 5 | 37.8 | 37.8 |
| dog | 30 | 38.6 | 38.6 |
| B | 40 | 38.8 | 38.7 |
| pet | 5 | 37.4 | 37.6 |
| cat | 30 | 37.9 | 37.9 |
| A | 40 | 39.2 | 39.2 |
| pet | 5 | 38.4 | 38.4 |
| cat | 30 | 38.1 | 38.1 |
| B | 40 | 38.7 | 38.8 |

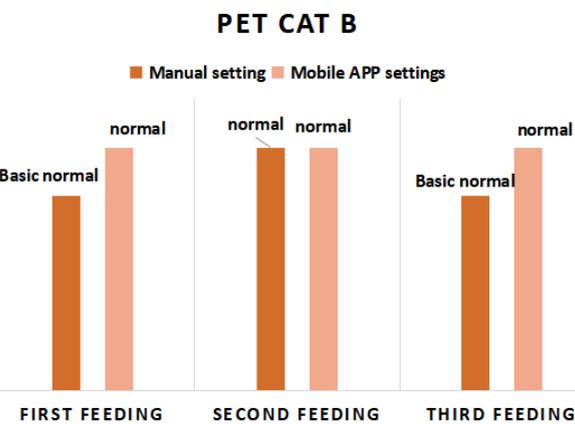
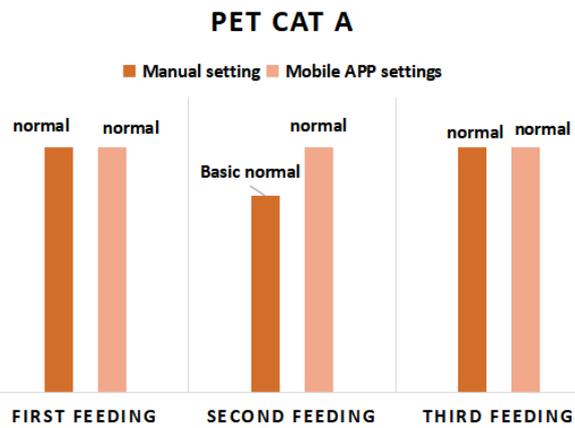
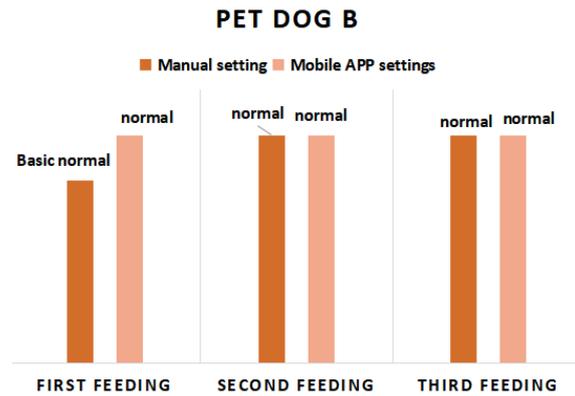
Note: Set the temperature to 30°C and only change the light intensity

| | Light intensity | Data displayed on mobile APP using sensor and RFID technology (Degrees Celsius) | Use a mercury thermometer directly to measure your pet's temperature (Celsius) |
|-----------|-----------------|---|--|
| pet dog A | Weak light | 38.2 | 38.2 |
| | conventional | 38.1 | 38.1 |
| | Bright light | 39.0 | 39.2 |
| pet dog B | Weak light | 37.9 | 37.8 |
| | conventional | 38.6 | 38.4 |
| | Bright light | 38.8 | 38.7 |
| Pet Cat A | low light level | 37.2 | 37.5 |
| | convention | 37.9 | 37.9 |
| | blaze | 39.1 | 39.2 |
| Pet Cat B | low light level | 38.4 | 38.3 |
| | convention | 38.1 | 38.1 |
| | blaze | 38.6 | 38.8 |

4.4.2. Operation of all devices under normal conditions

Feeding situation of the feeder when automatic feeding is set manually and the mobile APP is set automatically





Whether the two mobile devices can receive and send signals normally

| | Issue instructions | Receive pet information | pet physiological | Pet positioning |
|---------------|--------------------|-------------------------|-------------------|-----------------|
| Pet dogs A, B | Mobile phone | normal | normal | normal |
| Pet cats A, B | computer | normal | normal | normal |

4.4.3. Test the accuracy of the feeder sensor when all conditions are in the conventional state

| | Feeder sensor data (food) | Manually weigh the data | Feeding sensor (Drinking water) | Manually weigh the data |
|---------------|---------------------------|-------------------------|---------------------------------|-------------------------|
| pet dog First | 200.00g | 200.00g | 2.00L | 2.00L |

| | | | | | |
|---------|----------------|---------|---------|-------|-------|
| A | feeding | | | | |
| | Second feeding | 200.00g | 200.50g | 2.00L | 2.01L |
| | Third feeding | 200.00g | 200.32g | 2.00L | 1.97L |
| pet dog | First feeding | 200.00g | 199.30g | 2.00L | 1.98L |
| | Second feeding | 200.00g | 200.00g | 2.00L | 2.03L |
| | Third feeding | 200.00g | 200.00g | 2.00L | 2.00L |
| B | First feeding | 200.00g | 198.93g | 2.00L | 2.00L |
| | Second feeding | 200.00g | 199.22g | 2.00L | 2.00L |
| | Third feeding | 200.00g | 200.13g | 2.00L | 2.04 |
| Pet cat | First feeding | 200.00g | 200.00g | 2.00L | 2.11L |
| | Second feeding | 200.00g | 201.00g | 2.00L | 2.00L |
| | Third feeding | 200.00g | 200.57g | 2.00L | 2.00L |

5. Test analysis

5.1. Analyze the test of each equipment under the change of temperature and lighting conditions

(1) Under various conditions of temperature and light, the feeder can basically complete normal operation, but under high temperature conditions, the feeder may have a greater probability of failure, and the change of light conditions basically does not affect the feeder work;

By radio frequency identification device (2) a pet physiological information as you can see, the data with the use of pet mercury thermometer measured body temperature are basically the same, and the degree of its affected by environmental temperature change is small, more accurate data, and regular pattern measure of pet body data from the environmental impact is bigger, not high stability;

5.2. Analysis of feeding conditions of the feeder under conventional conditions

Under the condition that the ambient temperature and lighting conditions are suitable, feeding time of the feeder can be set manually or set remotely at the mobile terminal. When the specified time is reached, feeding work of the feeder can be complete and normal.

5.3. Analyze the connection between the mobile terminal and the feeder

Under the condition that all conditions are appropriate, the remote mobile terminal can normally complete the operation of the feeder, and can accurately receive the pet physiological information from the feeder, and can accurately locate the location of the pet.

5.4. Analyze the control of food quality by the feeder sensor

When all the conditions are up to the conventional state, the quality of the feeding device was compared with the food quality measured by the sensor. The data measured by the sensor and

the data measured by the manual are not different, and there is a certain error in the manual measurement, and the range of change is large. The feeder sensor is reliable in a short time.

5.5. Problem Summary

(1) Improve the high temperature resistance of the intelligent feeder, improve the shell of the feeder, improve the quality of the internal chip, ensure that the feeder can operate normally in high temperature weather, improve the reliability of the intelligent feeder;

(2) Broaden the identification function of the RADIO frequency card to ensure that it can measure more pet body information in the future and accurately send it to the user's mobile APP, so as to comprehensively analyze the pet's body condition;

(3) the optimization of the internal structure of intelligent feeding device, because the entire intelligent feeding device used in all kinds of technology is more, all the different kinds of intelligent devices that will be all sorts of intelligent equipment and embedded into the feeding device is bound to cause of feeding volume too big problem, therefore, on this issue as much as possible to simplify the internal space of the feeding device, reduce unnecessary space. At the same time, the volume of intelligent equipment is reduced, so as to achieve the advantages of easy movement and light weight of the feeder.

(4) To improve the reliability of intelligent feeders, the hardware level of intelligent feeders must be improved when various technologies are applied to intelligent feeders, such as the use of sensor technology. In this experimental study, the main function of sensors is to accurately control feed intake and measure the physiological data of pets. As for the precise control of feeding weight, it is necessary to ensure that the feeding quantity control will not be inaccurate due to the quality of the feeder for a long time.

6. Conclusion

Guided by the intelligent technology of domestic pet feeders, this paper explores the innovation of intelligent pet feeders and the development of APP and other technologies in depth according to the living characteristics and behavior characteristics of domestic pets in different environments, combined with the existing intelligent technology, APP development technology and the development status of the pet market. Revolve around the idea of innovation to explore the feasibility for intelligent domestic pet feeder is more safe, effective, scientific and reasonable, cannot be at home to take care of the pet's owners have something problem, at the same time to give pets more comfortable living environment, add life interest, in the end for home appliances intelligent technology development provides reference value!

Acknowledgements

Project name: This article is the research of "i-Pet" intelligent pet feeder based on AI technology of --2021 National University Student Innovation and Entrepreneurship Project of Anhui University of Finance and Technology (202110378201).

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