Smart Pet Feeding Device Based on Single Chip Microcomputer

Qiaoping Su¹a, Yuan Liu ²b*, Haojian Wu¹c

¹Institute of Intelligent manufacturing, Anhui Xinhua University, Hefei, China
²Department of medical devices, Anhui Medical College, Hefei, China
a e-mail: suqiaoping@axhu.edu.cn, c e-mail: 379065352@qq.com
*Corresponding author: b e-mail: 39384253@qq.com

Abstract: In modern society, more and more young people take pets as their emotional sustenance. However, due to the busy daily work, we can't take care of the pet's diet in time. In order to make this kind of people more convenient to feed their pets, we designed an intelligent pet feeder based on MCU. This design can solve the problem that the pet owner can't take care of the pet's diet for various reasons to a certain extent. The system uses STC89C52RC single chip as the main control chip, which can manually set the feeding times and feeding time of pets, display the data through LCD1602 screen, and use step motor to control the opening and closing of the intelligent pet feeder. A sound prompt module is set up, which uses the buzzer to send out feeding signals during feeding time to attract pets to eat.

1. Introduction
With the rapid development of social economy and the improvement of people's living standards, as an emotional support, more and more people begin to keep pets. Due to a variety of reasons, when pet owners go out for a long time, the supply of food and drinking water for pets can not keep up. Therefore, an intelligent pet feeder is designed to solve the problem of pet feeding when pet owners work or go out.

2. Hardware design

![Overall block diagram of the system.](image-url)
The system is based on STC89C52RC MCU, and includes lcd1062 LCD, ULN2003 drive module, voice prompt module, stepper motor, function keys, clock module and power module. The clock module can realize the function of clock. The function key module can set the feeding times and time manually, and display the corresponding data through LCD1602 LCD. The stepping motor can be used to control the opening and closing of the food box of the intelligent pet feeder. When the feeding time is up, the buzzer will send out the feeding signal to attract the pet to eat. The overall block diagram of the system is shown in Figure 1.

2.1 Clock module circuit
The clock module selects DS1302 to realize the precise clock function. DS1302 has eight pins, easy to use and can store more time information[1-2]. The connection between DS1302 and MCU is very simple. It only needs reset, data line and serial clock to set the clock and display time. The wiring diagram of DS1302 and MCU is shown in Figure 2. Among them, reset, serial clock and data line are respectively connected with p3.5, P3.6 and P3.7.

Figure 2. DS1302 wiring diagram.

2.2 Design of function key module
The function keys designed in this system are all non self-locking keys. One end of the key is grounded, and the other end is connected to the I / O interface of MCU. The four function keys are connected with the MCU P2.3, P2.4, p2.5 and p2.6 respectively. The functions of each key are impairment, value addition, selection and setting. When the MCU detects that the input digital value of an I / O interface is zero, it means that the corresponding key is pressed and the corresponding operation needs to be performed. The circuit diagram of the module is shown in Figure 3.

Figure 3. Function key module.
2.3 Design of stepper motor drive module
Stepping motor, also known as pulse motor, is a kind of motor which can change electric pulse signal into corresponding angular displacement or linear displacement. The stepper motor used in this design is 5-wire 4-phase stepper motor, and the driving chip is ULN2003[3]. The red wire of stepping motor is VCC, connected to com terminal of ULN2003. The other four wires are phase wires of each phase. The blue wire and pink wire are a group, connected to 1c and 2C ports of ULN2003. The yellow wire and orange wire are a group, connected to 3C and 4C ports of drive. They drive each phase respectively. The circuit diagram is shown in Figure 4.

![Figure 4. Schematic diagram of stepping motor drive module circuit.](image)

2.4 Circuit design of other modules
The sound prompt module of this system is composed of buzzer and triode, which is used to remind pets to eat. Due to the large current required to drive the buzzer, the single chip microcomputer can not provide it, so a triode is used, and the control of the buzzer is realized by P1.7.

The display module of the system uses LCD1602, its data port is connected with port P0 of MCU, and RS, R/W and E terminals are connected with P2.0, P2.1 and P2.2 of MCU respectively, so as to realize the display of clock, setting feeding time and other information[4-5].

3 software design

![Figure 5. Overall flow chart of the system.](image)
3.1 Main program design
This system is designed to initialize after power on, then scan the four keys, read the data of DS1302 and display it through LCD1602. When the MCU receives the feeding signal, the stepper motor starts to work and gives the corresponding state indication. The main program flow chart is shown in Figure 5.

3.2 Function key processing program
There are four function keys in the system. The function to be carried out is determined the number of key K4 pressed. When K4 is pressed for the first time, K1 ~ K3 are used to set time, week and date. When K4 is pressed for the second time, K1 ~ K3 set the timing time 1. When K4 is pressed for the third time, K1 ~ K3 set the timing time 2. When K4 is pressed for the fourth time, K1 ~ K3 set the timing time 3. When K4 is pressed for the fifth time, the key processing ends and the subprogram returns. The specific flow chart is shown in Figure 6.

3.3 Motor driver design
The system adopts 5-wire 4-phase stepping motor, adopts 4-phase 8-beat operation mode, and can operate in forward rotation and reverse rotation. By looking up the table, the four phase and eight beat operation mode of stepping motor can be realized. The forward conversion data table is: uchar code FFW[] = {0x01,0x03,0x02,0x06,0x04,0x0c,0x08,0x09}. The reverse data table is: uchar code Rev[] = {0x09,0x08,0x0c, 0x04,0x06,0x02,0x03,0x01}. [6-7] Through SETP_MOTOR_FFW() can realize the forward running of the stepper motor, which represents the beginning of feeding. Through SETP_MOTOR_REV() can realize the reverse operation of the stepper motor, on behalf of the end of the feeding process and take back the food box. The angle of positive and negative rotation is determined by the constant count. By calculation, count is set to 400. The forward rotation procedure of stepper motor is as follows.

```c
void SETP_MOTOR_FFW()
{
    uint i=0;
    for(i=0;i<8;i++) //8
    {
        MOTORSTEP=FFW[i];
        delaymoto(speed);
    }
}
```

Figure 6. Key processing subroutine.
The reversing procedure of stepper motor is as follows.
void SETP_MOTOR_REV()
{
    uint i = 0;
    for(i=0;i<8;i++) //8
    {
        MOTORSTEP = REV[i];
        delaymoto(speed);
    }
}

The feeding process depends on three factors. One is whether it is necessary to feed. The system defaults to the feeding mode, which is identified by flag, and its initial value is 1. The second is the feeding time. If the feeding time is up, the flag bit Zheng = 1. The third is whether the feeding is finished. If the feeding is finished, the flag bit fan = 1. When flag = 1 and Zheng = 1, it means that the feeding is needed and the feeding time is up. The stepping motor rotates forward to open the food box to the pet. When flag = 1 and fan = 1, it means the end of feeding. At this time, the stepper motor reverses and closes the food box. The function is realized by subroutine motor_CTR() which is shown below.
void MOTOR_CTR()
{
    uint i, j;
    if((zheng == 1) && (flag == 1))
    {
        i++;
        flag_busy = 1;
        SETP_MOTOR_REV();
        if(i >= count)
        {
            i = 0;
            flag = 0;
            zheng = 0;
            flag_busy = 0;
        }
    }

    if((fan == 1) && (flag == 0))
    {
        j++;
        flag_busy = 1;
        if(j >= count)
        {
            j = 0;
            flag = 1;
            fan = 0;
            flag_busy = 0;
        }
        SETP_MOTOR_FFW();
    }
}

The system can set the start time and end time of feeding arbitrarily by four buttons. When the start time of feeding is completely consistent with the clock time, it will set the zheng flag. When the end
time of feeding is completely consistent with the clock time, it will set the fan flag, so as to realize the identification of feeding or taking back the food box.

4. Conclusion
After testing, the stepper motor of the system can operate normally according to a certain speed, and can open the food box in the set feeding time period. When the set feeding time period is reached, the buzzer can send out the feeding signal normally. When the feeding action is finished, the stepper motor can close the food box in time, and the expected function can be realized.

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