Sun Lixiang

Master of Engineering; Lecturer in School of Mechanical and Electric Engineering; *orcid.org/0000-0002-8030-1131*
School of Mechanical and Electric Engineering, Yancheng Polytechnic College, Jiangsu Yancheng 224005, P.R. China

Wang Chunmo

Bachelor of Engineering; Professor in School of Mechanical and Electric Engineering;
orcid.org/0000-0003-0630-9220
School of Mechanical and Electric Engineering, Yancheng Polytechnic College, Jiangsu Yancheng 224005, P.R. China

AN ELECTRONIC DEVICE INTEGRATING LINEAR AND NON-LINEAR METERING

***Abstract.** This paper designs an intelligent electronic metering device for the post office. Programs realize the non-linear relationship between the price and the weight of letters. The whole system is mainly composed of hardware and software. The hardware design uses STC89C52 MCU as the core control device of the system. MPX4115 pressure sensor collects the weight data and sends the output analog data to ADC0832. The converted digital data will be sent to the single chip microcomputer for data processing and the digital tube will display the data. The system is equipped with a matrix keyboard and four independent keys, which are used to select the delivery location (local port or foreign port), express delivery or letter type (ordinary or registered letter) and screen clearing function. The matrix keyboard is used to input the unit price. The prominent feature of this design is that it can not only realize the weighing of the weight and price of general merchandise in a linear relationship, but also realize the weighing of the weight and price in a non-linear relationship such as express delivery or letter. The design of the device can improve the deficiency of the electronic weighing system in application and has certain practical significance.*

***Keywords:** STC89C52 MCU; non-linear weighing; digital tube; MPX4115 pressure sensor; ADC0832; matrix keyboard*

Introduction

At present, the weighing scale used by the post office, whether it is mechanical or electronic, can only finish the linear weighing of weight and price. The post office staff needs to calculate the price according to the weight, the type of letter and the place of delivery, which is time-consuming and work efficiency. With the low disadvantage, this paper proposes a new electronic pricing device that can achieve linear weighing and can also achieve non-linear weighing of letters and express delivery. This paper proposes a new electronic pricing device, which can achieve linear weighing, and can also achieve non-linear weighing of letters and express delivery. It can be widely used in post offices, logistics and other industries to improve work efficiency, and also for the logistics industry staff Provides a low-cost and easy-to-expand new model.

Overall system design

The overall design idea of this system, as shown in Fig. 1, includes the design of software and hardware. The hardware design includes the minimum system of the SCM, the acquisition module, the A/D conversion circuit, the key and keyboard circuit, and the LED display circuit. The software design consists of five parts: main program, acquisition and processing program, key scan program, nonlinear processing program, and LED display program. Fig. 2 is the circuit block diagram of the system hardware design, regards STC89C52 one-chip computer as the core, it is the necessary part of the work of this one-chip computer that three blocks on the left, the content of the upper and lower box serves as the man-machine interaction part of this system – Key input, the right side of the human-computer interaction – display and detection unit.

Hardware circuit design

Pressure sensor

There are six types of load cells, resistance strain and differential transformer sensors, capacitive and differential transformer sensors, piezo magnetic sensors, piezo sensors, vibration frequency sensors, and gyro sensors. The weighing of the sensors used is critical to the system and requires a combination of actual needs and the performance parameters of the various load cells.
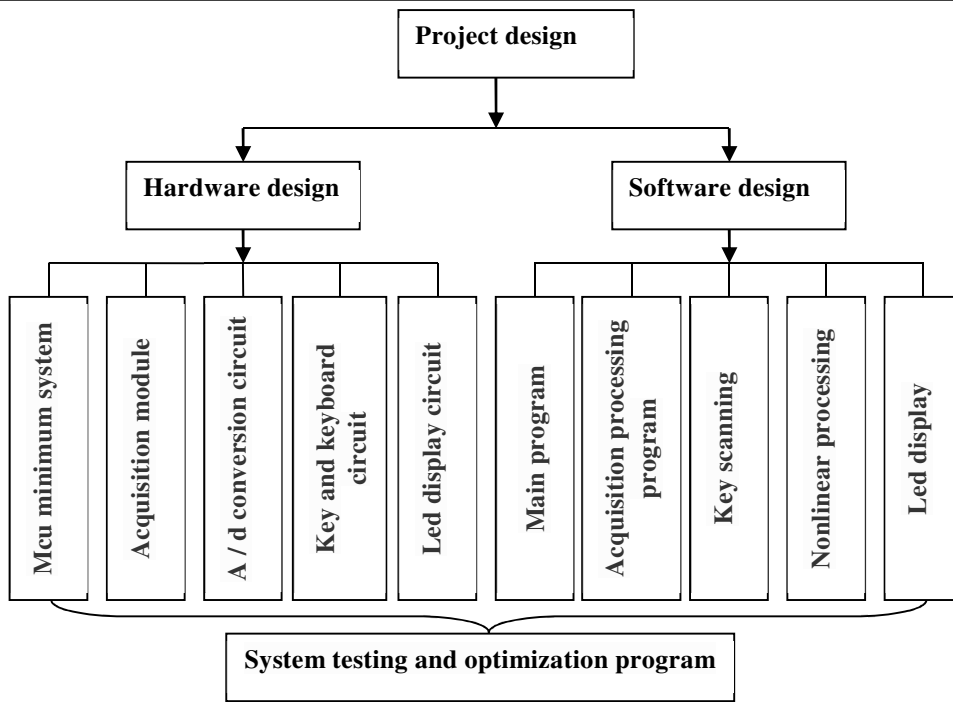
Project design

Hardware design
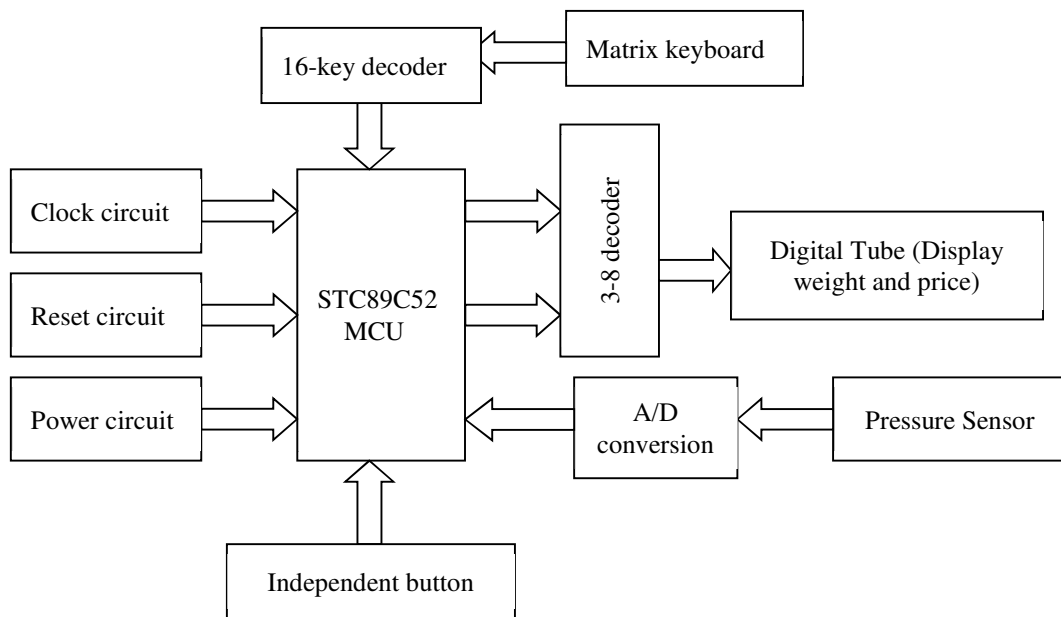
Software design

- Mcu minimum system
- Acquisition module
- A / d conversion circuit
- Key and keyboard circuit
- Led display circuit
- Main program
- Acquisition processing program
- Key scanning
- Nonlinear processing
- Led display

System testing and optimization program

Figure 1 – Overall design of system

16-key decoder

Matrix keyboard

Clock circuit

Reset circuit

Power circuit

STC89C52 MCU

3-8 decoder

Digital Tube (Display weight and price)

A/D conversion

Pressure Sensor

Independent button

Figure 2 – System hardware circuit block diagram

This design uses the most widely used resistance strain-type load cell, its structure is relatively simple, the technology is more mature, easy to make, high accuracy and good stability. After comprehensive consideration, the integrated pressure sensor MPX4115 of Motorola, Inc. of the United States is used, this has a temperature compensation capability and can overcome the temperature drift problem of the semiconductor pressure sensor, as shown in Fig. 3.

The pinout of the MPX4115 pressure sensor is shown in Table 1 below:

*Table 1 – **Pin Description of Pressure Sensor MPX4115***

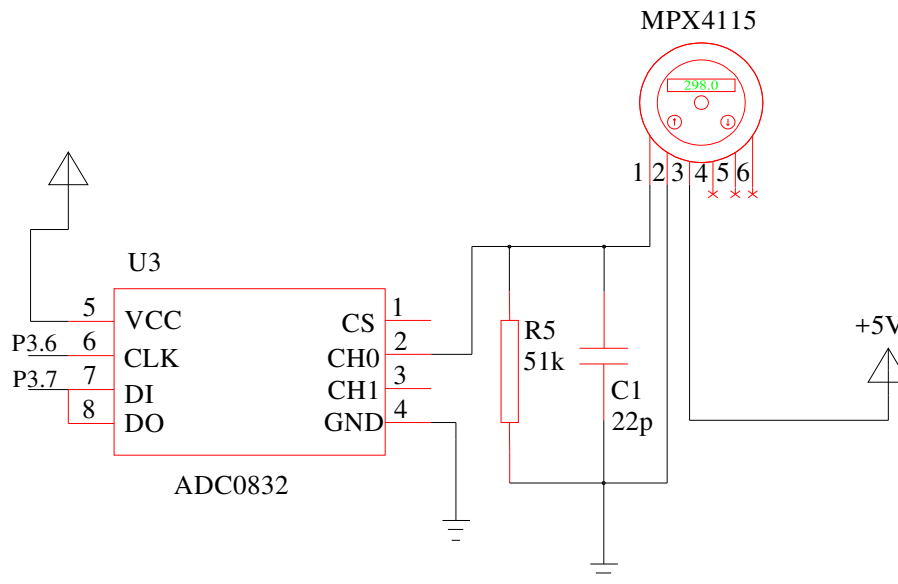| Pin1	Pin2	Pin3	Pin4	Pin5	Pin6
VOUT	GND	VS	NS	NS	NS

Figure 3 – Circuit diagram of MPX4115 and ADC0832

A/D conversion chip

The output of the MPX4115 pressure sensor is an analog voltage, so an analog-to-digital conversion must be performed before it can be received by the microcontroller. For the actual needs of the circuit, and taking into account the degree of difficulty and the corresponding performance indicators of the external circuit to achieve, select the chip ADC0832 to achieve A/D conversion. The ADC0832 is an 8-bit resolution, dual-channel A/D conversion chip produced by National Semiconductor. Due to its small size, strong compatibility, and high cost performance, it has a very high penetration rate.

The MPX4115 pressure sensor is connected to the analog input channel 0 of the ADC0832. The output signal of the ADC0832 is digital and is sent to the P3.7 pin of the microcontroller. The ADC0832 clock signal is provided by the microcontroller P3.6 pin. The specific circuit connection is shown in Figure 3.

MCU minimum system

The so-called single-chip minimum system refers to the formation of a single-chip microcomputer system that can work independently with as few external circuits as possible, that is, the minimum system configuration necessary to ensure that the microcontroller can work.

First of all, to ensure that each circuit can work, there must be a power supply.

Secondly, the SCM is a digital circuit, and its operation cannot be separated from the clock, so the clock circuit must be configured to the SCM.

In addition to ensure the reliable operation of the microcontroller, it must also configure the reset circuit.

That is, the power supply circuit, clock circuit, and reset circuit constitute the smallest system of the microcontroller. Based on the above three necessary

conditions, the control circuit required by the application system is added to form a complete hardware system.

The minimum system diagram of the MCU in this design is shown in Fig. 4. The MCU selects the STC89C52RC chip. The 20th and 40th pins in the Proteus are hidden pins. The default is ground and power supply respectively. The actual circuit is also separately grounded and powered. The clock circuit is connected to the microcontroller's XTAL1 and XTAL2 pins with a 12-MHz crystal and two 22-μF capacitors. The XTAL1 pin is the input of the oscillator inverting amplifier, which connects the capacitor to one end of the external crystal. XTAL2 is the output of the oscillator inverting amplifier, connecting the capacitor and the other side of the external crystal. If the oscillator does not start up, the system will not work; if the oscillator is not operating properly, there will be a time error when the system executes the program, which will cause the communication application to not work properly. The reset circuit consists of 9-pin connected resistor, electrolytic capacitor can constitute a power-on reset circuit, that is, when the system is powered on using the principle that the voltage across the capacitor can not be mutated to give the system a short-term low; then in the capacitor Simultaneously, a button can also be used for manual reset. Press the button to turn on the low level to reset the system, and release to reset the system to work normally. If the hand is held down, the system will always reset, and it will not work. The 31 foot connects to the high level, which represents the use of on-chip program memory, ie the program is stored in the program memory ROM inside the microcontroller.

Connecting 16 keys under a separate key structure requires 16 I/O resources, which is a waste of microcontroller resources. Therefore, in the case of a large number of keys, a matrix-type keyboard is used. As

shown in Figure 5. The matrix-type keyboard requires the row and column to jointly determine the key values of the keys. At the instant of closing and opening, the voltage fluctuation phenomenon may occur due to the deformation of the spring switch. As shown in Fig. 6.
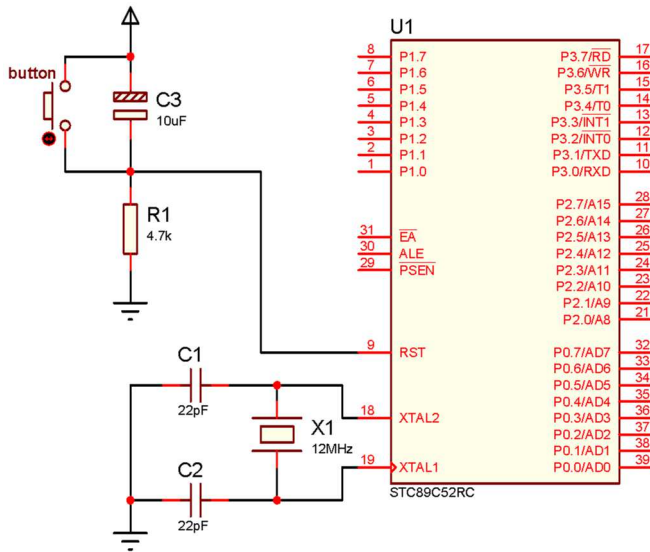

Figure 4 – STC89C52 microcontroller minimum system

MM74C922 is a dedicated coded keyboard interface chip, which is a dual-inline 18-pin package. The pin functions and connections are as follows: X1-X4 is the column key input of the matrix keyboard; Y1-Y4 is the row key of the matrix keyboard. Input; OSC is the external lead of the oscillator, can be connected to the external input pulse or capacitor, the design is connected to the capacitor C2; A, B, C, D for the data output, and the microcontroller P1 port of the lower four Connected; KBM is a key shake shielding end, this is a prominent

feature of the MM74C922 chip, use a capacitor to eliminate keyboard jitter, that is, when pressing a matrix keyboard, the chip can automatically give the corresponding code information, and The elimination of jitter automatically eliminates the need to use software delays of 10ms to eliminate jitter in software design. OE is the data output enable terminal, active low, DA is valid for data output, active high, OE is connected to the P3.4 pin of the microcontroller via the NOT gate and the DA pin; VCC is the supply pin, shared with the microcontroller 5v power supply, GND is grounded.

Independent keys

Stand-alone keys refer to individual keys that are directly connected to the I/O lines. Usually one key occupies one I/O line. There are four free-standing keys in this design, which represent the choice of the place where the letter was sent (this letter or another letter) and the type of letter (flat or registered). One end of the free-standing button is connected to the P0 port of the microcontroller and the other end is interconnected and grounded. Because of the special structure of P0, it needs an external pull-up resistor. R1-R4 is a pull-up resistor in the Fig. 7.
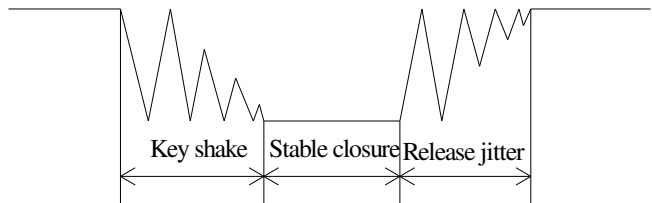

Figure 6 – Button jitter
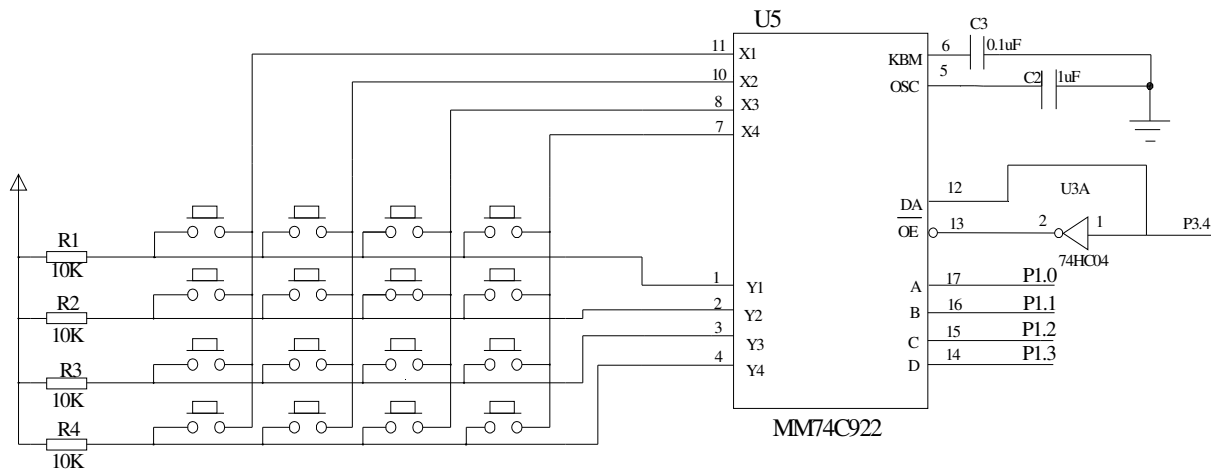
Matrix Keyboard and Interface Circuit

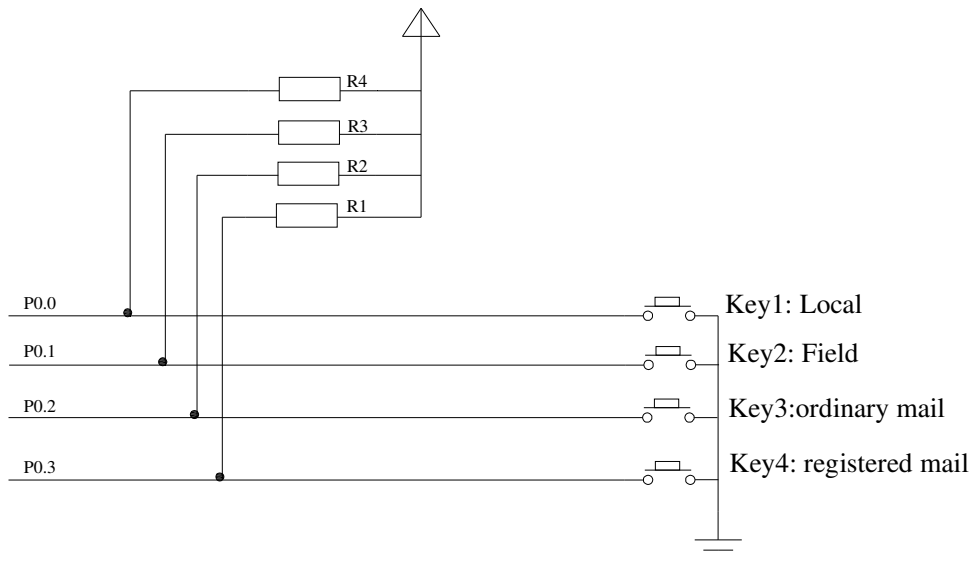*Figure 5 – Matrix keyboard and interface circuit*

Figure 7 – Independent keys
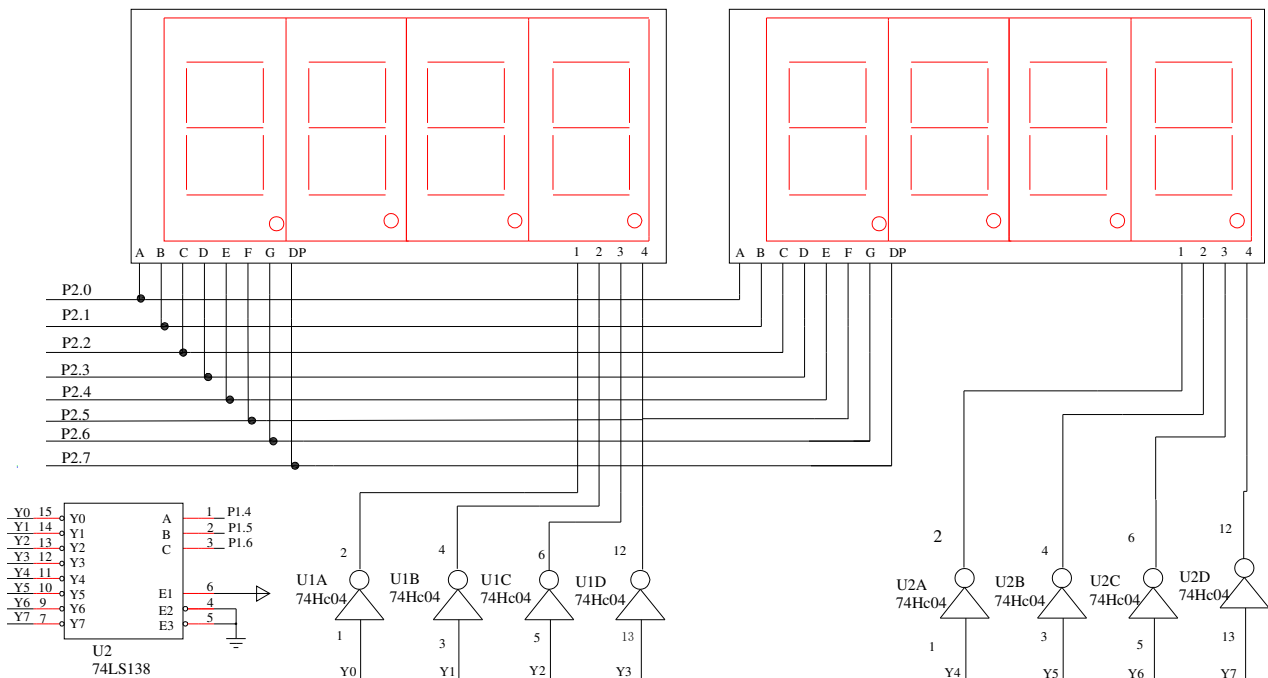
Digital display and interface circuit

Figure 8 – LED digital display and interface circuit

The design shows the weight and price of the letter or courier, which is a purely digital display, no other such as letters or Chinese characters, although the liquid crystal display is extremely power saving, but the use of temperature limits, and because it is reflective, in When the external light is bright, it is easy to see clearly, and the digital tube display is more clear, and it is more suitable for displaying under bright light conditions during the day. In addition, the digital display is more intuitive and concise. Therefore, in this design, the two-piece four-in-one common-yang digital tube display as shown in the figure 8 is selected, and the two-piece four-

in-one digital tube segment selection A, B, C, D, E, F, G, DP interconnection. They connected to the 8 bits of the P2 port of the SCM, and the 4 bit selectors (1, 2, 3, and 4) of the four-in-one digital tube are connected to the output of the 74LS138 decoder through the 74HC04. The 74HC04 is a high-speed silicon-gate CMOS device and is compatible with a low-power Schottky TTL circuit. It contains six identical inverters. Its role in addition to the role of high and low conversion, there is an important role is to increase the signal drive capability, the signal is generally sent from the MCU, the ability to directly drive other devices is not enough, in the middle plus a logic

circuit to increase the drive capability . The 74LS138 is a 3-wire-8-wire decoder. The truth table is shown in Table 2. Its working principle is: when the strobe end (E1) is high, the other two strobes ((/E2) and (/E3)) When it is low, the binary code of the address (A, B, C), that is, the single-chip microcomputer (P1.4, P1.5, P1.6) can be decoded at a corresponding output terminal with a low level. The other outputs are all default levels – high level output.

*Table 2 – **74LS138 decoder truth table***

IN					OUT							
E1	$\overline{E2}+\overline{E3}$	A2	A1	A0	$\overline{Y0}$	$\overline{Y1}$	$\overline{Y2}$	$\overline{Y3}$	$\overline{Y4}$	$\overline{Y5}$	$\overline{Y6}$	$\overline{Y7}$
0	X	X	X	X	1	1	1	1	1	1	1	1
X	1	X	X	X	1	1	1	1	1	1	1	1
1	0	0	0	0	0	1	1	1	1	1	1	1
1	0	0	0	1	1	0	1	1	1	1	1	1
1	0	0	1	0	1	1	0	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1	1	1
1	0	1	0	0	1	1	1	1	0	1	1	1
1	0	1	0	1	1	1	1	1	1	0	1	1
1	0	1	1	0	1	1	1	1	1	1	0	1
1	0	1	1	1	1	1	1	1	1	1	1	0

System software design

The system program is written on the software development tool Keil uVison2, and is designed using a modular programming concept. According to the software design part of the overall design of the system, taking into account the relationship between the various modules, the software flow chart is designed, as shown in Fig.9.
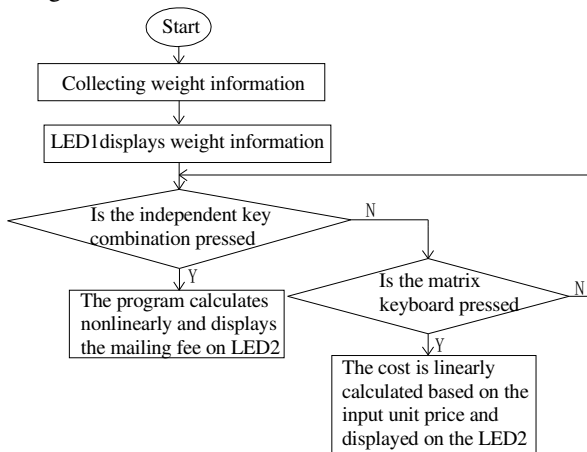

Figure 9 – Software design flow chart

The design of the main function

The entry function of the program is the main function void main. At the beginning of the main function, usually the program initialization operation is performed on the external device and the microcontroller, and the program enters an infinite loop. In the process of program design, it is necessary to pay attention to the use of sub-functions or subroutines. Call these sub-functions or subroutines in the void main program so that they can be easily modified and read. The main function cycle calls the data acquisition program, data processing program, key scan program, LED display program and so on. The main function program is as follows:

```
void main(void)
{
    uchar w,i,getdata;
    while(1)
    {
        getdata=Adc0832();
      if(14<getdata && getdata<243)

        {

temp=(int)((((10.0/23.0)*getdata)+9.3)*10);

            for(i=0;i<4;i++)
            {
                dispbuf[3-
i]=temp%10;

                temp/=10;
            }
        }
            key();
        w=getboard();
    judge(w);
        display();
    }
}
```

Design of Non-linear Processors

According to the actual letter or express delivery requirements, on the basis of ensuring that the hardware does not change as much as possible, by changing the software design to achieve the corresponding function. For example, the post office mailing charges are as follows: flat letter and foreign currency, according to the first weight and continued weight, the first weight is less than 100 grams, 20 grams per weight (less than 20 grams is calculated as 20 grams). 0.80 yuan. Continue to weigh 101 to 2,000 grams, 100 grams per weight (less than 100 grams calculated by 100 grams) 1.20 yuan in this case, 2.00 yuan in foreign capital. Registered letters, on the basis of the above flat-rate tariffs, each additional registration fee 2.00 yuan. The key subfunction of the main function call is the non-linear processing function implemented.

Simulation debugging

According to the system hardware design and software design, the circuit diagram of the hardware design is drawn on the proteus software. In the hardware, the circuit diagram shown in Figure 6 above is added only on the basis of the original electronic scale, that is, the 4 buttons represent the local, Foreign, flat letters, registered letters.
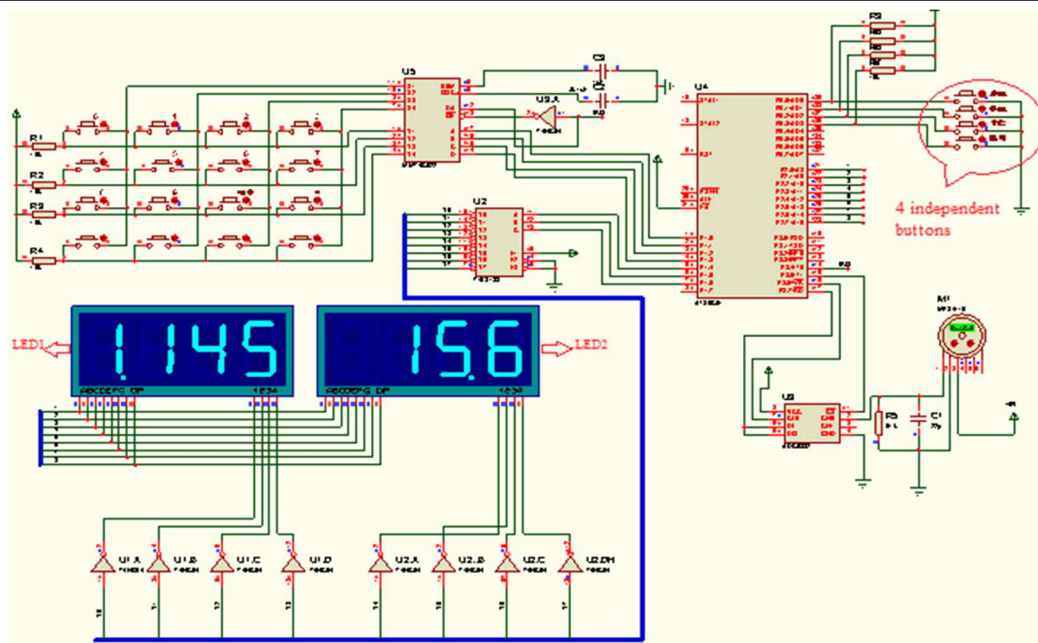
Figure 10 – Simulation and debugging

According to the location of the letter and the type of letter, select the combination of keys, the combination includes: local + flat letter, local + registered letter, field + flat letter, field + registered letter; microcontroller receives the key transmission data, through this key built-in program The calculation of the letter charge is displayed on the digital tube. The debugged software program generates the .hex code file. This code file is imported into the microcontroller in the circuit diagram drawn by the proteus software. After the simulation is run, the simulation and debugging diagram is randomly adjusted. The pressure sensor MPX4115 shown in Figure 10 is an analog letter. Or the express weight change, will see the figure digital tube 1 (the left four-in-one digital tube) the value will change accordingly, this change is the weight value of the letter or courier.

If the system is used as a general electronic scale, when the numeric keypad of the matrix keyboard in Fig. 10 needs to be pressed, the digital tube 2 will display the corresponding number, which is the unit price of the input weight. After the unit price is set, press the matrix keyboard. "=" button, after the software linear processing, will re-display the analog price or cost on the digital tube 2.

Summary

The non-linear pricing function of letters or courier can improve the efficiency of the postal staff and save time. It is a very valuable thing to develop such devices. The dissertation starts with the overall design idea of the system, gives the hardware block diagram of the system, and presents the hardware circuit diagrams, writes the program, and uses the proteus and Keil software to realize the simulation debugging work, basically completing the development of a non-linear pricing device. However, there are still many areas for improvement.

First, in the hardware design, additional intelligent functions, such as voice prompts, coin-operating functions, automatic letter-grabbing functions, etc.

Second, although the debugging of the program is successful, it still needs to continue to be optimized. For example, there are several signs of repetition when sending the fee in the key subroutine to the digital control.

Third, we can design in the upper computer, configure WiFi and virtual instrument software LabVIEW technology wireless data transmission and monitoring, to achieve letter or express weight detection, non-linear cost calculations, wireless transmission and remote monitoring and management of the machine function.

In short, to make the device truly market-oriented and competitive, there is still a lot of work to be done later.

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Сун Лісянг
Магістр інженерії; викладач кафедри механіки та електротехніки; *orcid.org/0000-0002-8030-1131*
Школа механіки та електротехніки, Янченский політехнічний коледж, Цзянсу Яньчэн 224005, П.Р. Китай
Ван Чунмо
Бакалавр інженерії; професор кафедри механіки та електротехніки; *orcid.org/0000-0003-0630-9220*
Школа механіки та електротехніки, Янченский політехнічний коледж, Цзянсу Яньчэн 224005, П.Р. Китай

ЕЛЕКТРОННИЙ ПРИСТРІЙ, ЩО ІНТЕГРУЄ ЛІНІЙНЕ ТА НЕЛІНІЙНЕ ВИМІРЮВАННЯ

Анотація. *Цей документ розробляє інтелектуальний електронний дозатор поштового зв'язку. Програми реалізують нелінійні співвідношення між ціною та вагою листів. Вся система в основному складається з апаратного та програмного забезпечення. Апаратне проектування використовує STC89C52 MCU як основний контрольний пристрій системи. Датчик тиску MPX4115 збирає вагові дані та надсилає вихідні аналогові дані до ADC0832. Перетворені цифрові дані будуть відправлені на мікрокомп'ютер для одного чіпа для обробки даних, а цифрова трубка буде відображати дані. Система оснащена матричною клавіатурою та чотирма незалежними клавішами, які використовуються для вибору місця доставки (місцевий порт або іноземний порт), експрес-доставки або типу листа (звичайна або зареєстрована літера) та функції очищення екрану. Матрична клавіатура використовується для введення ціни одиниці. Найважливішою особливістю цього дизайну є те, що вона може не тільки усвідомити вагу та ціну загального товару в лінійній взаємозв'язку, але й реалізувати вагу ваги та ціни в нелінійних відносинах, таких як експрес-доставка або лист. Конструкція пристрою може поліпшити дефіцит електронної системи зважування у застосуванні та мати певне практичне значення.*

Ключові слова: *мікропроцесор STC89C52; нелінійне зважування; цифрова трубка; Датчик тиску MPX4115; ADC0832; матрична клавіатура*

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Link to publication