# Design of Fertilizer Application System Based on Single Chip Microcomputer

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**Abstract.** With the rapid development of computer, electronics, machinery, communication and other technologies, MCU has been widely used in agriculture. Based on the dielectric characteristics of air and the difference between fertilizers and dielectric properties, the capacitance detection circuit is set up by using single chip microcomputer and capacitance conversion chip. The differential capacitance sensor is effectively used to obtain the output micro capacitance signal. The system can detect the flow rate of fertilizer on line and achieve high accuracy variable fertilization.

## 1. Introduction

China is a large agricultural country, the demand for agricultural products is very large, and so how to improve the output and quality of agricultural products has become the focus of modern agriculture. The amount of fertilization plays an outstanding role in controlling the yield and quality of agricultural products. It can be seen that the precision control of fertilization is very important for the growth of agricultural products.

Proposed by Du Qinglin, it is based on soil test and fertilizer field experiment, and puts forward the amount, period and method of fertilizer application. The content of nitrogen, phosphorus and potassium, trace elements, organic matter and so on in the soil were detected by using the fast measuring instrument of soil fertilizer nutrient of Okoch soil, so as to measure the soil scientifically, so as to apply fertilizer reasonably. Yu Hongfeng and others have designed a kind of fertilizer performance testing device based on belt scale fertilization machine. It can measure the fertilizer flow rate of the fertilizer outlet and the fertilization amount per unit area of the fertilizer machine, and achieve the purpose of rational fertilization. Although through photoelectricity and image method can be used for accurate measurement, but fertilizer powder can easily cover the probe, which results in deviation of measurement results.

In this paper, a kind of on-line measuring system of fertilizer quantity based on single chip microcomputer is designed. The detection circuit is built by using single chip computer and capacitance, and the relationship model of fertilizer mass flow rate and capacitance output is established by the influence law of environment temperature change on flow sensor. It is verified to realize high precision variable rate fertilization.

## 2. System Structure

During the normal operation of the fertilizer machine, the fertilizer falls freely in the closed fertilizer pipe. When the height of the fertilizer box is different, the density of the material at the bottom of the box will change by the action of gravity. The higher the material height is, the higher the material height will be when the ultrasonic wave is used to get the material height. The smaller the solenoid valve, the higher the material height is inversely proportional to the solenoid valve opening.

The speed sensor obtains the running speed of the car body. The faster the speed is, the greater the opening of the solenoid valve is, and the speed is proportional to the opening of the solenoid valve.

The system is mainly composed of ultrasonic wave, solenoid valve, speed sensor and upper computer. Fig. 1 shows the structure of the system. The system adopts RS232 bus structure, which can realize the distributed on-line detection of each fertilizer pipeline, and is convenient to extend the nodes of different width fertilization machine. The solenoid valve is installed on the fertiliser disk,

which is mainly used to obtain the on-line mass flow of fertilizer; the forward speed sensor is located on the forward ground wheel, which is mainly used to obtain the advancing speed of the machine; and the upper computer is located in the cab. It receives the information in real time through the built-in RS232 bus adaptation module, and processes the information. The amount of fertilizer was shown later. During the normal operation of the fertilizer machine, the fertilizer falls freely in the closed fertilizer pipe. When the height of the fertilizer box is different, the density of the material at the bottom of the box will change by the action of gravity. The higher the material height is, the higher the material height will be when the ultrasonic wave is used to get the material height. The smaller the solenoid valve, the higher the material height is inversely proportional to the solenoid valve opening. The speed sensor obtains the running speed of the car body. The faster the speed is, the greater the opening degree of the solenoid valve is, and the speed is proportional to the opening degree of the solenoid valve.
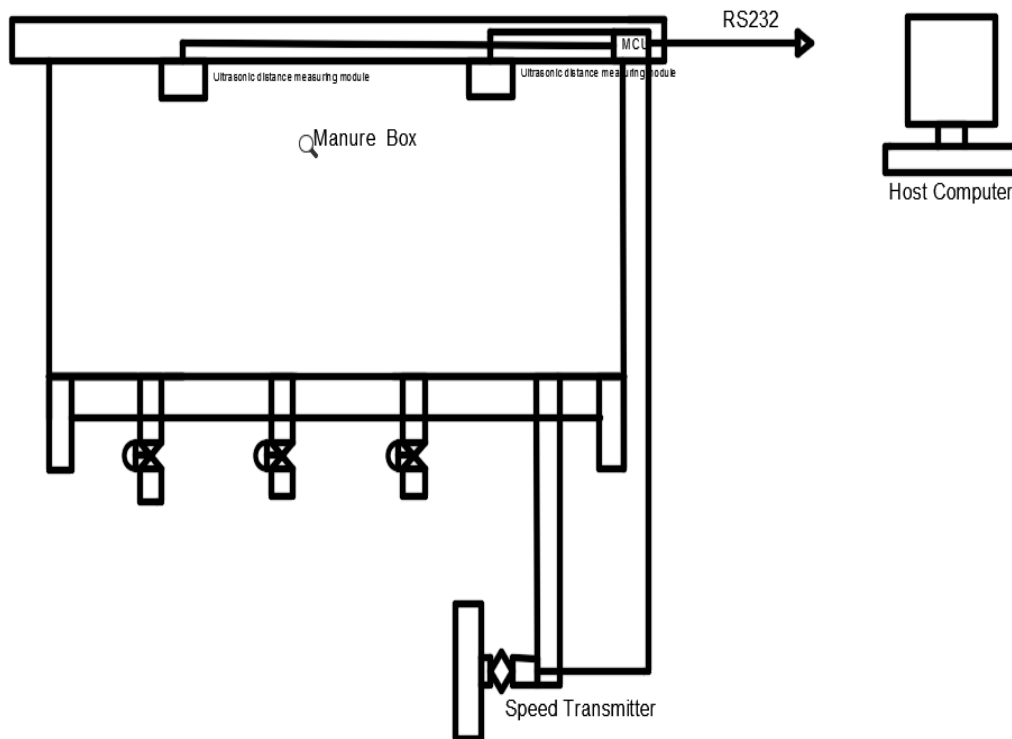


Fig. 1. Schematic diagram of fertilization amount detection system

## 3. Single chip microcomputer minimum system and circuit design

The smallest microcontroller system can make the microcontroller work normally, and can play a complete computer system of the normal function of the core controller. Output equipment, timer, and communication interface, all of which need to be concentrated on a small chip. STC89C52RC is cheap, simple to develop and can achieve a lot of functions, which is suitable for some small projects. The general block diagram of system design based on single chip microcomputer is shown in Fig. 2.
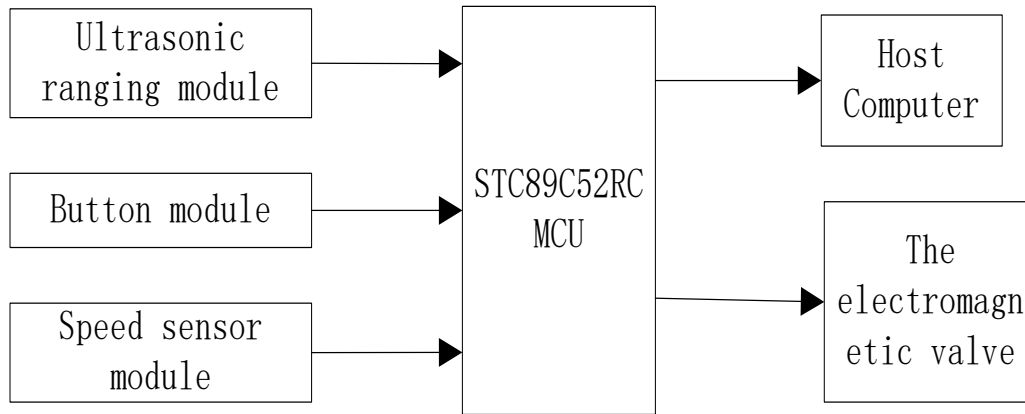
Fig. 2. General block diagram of system design

## 3.1 Power Supply Circuit

This design external power supply is 220V power frequency AC power supply. In order to make the system work normally, it is necessary to carry on the steps of transformer, rectifier, filter, voltage stabilization and so on. Change the 220V AC to 5 V, 15V and-15V DC.

LM78/LM79 series three-terminal voltage stabilizer chip to form a voltage regulator power supply does not need too many peripheral components, and there are overcurrent, overheating and adjustment tube protection circuit integrated in the chip, The numbers behind the LM78 or LM79 in this series of integrated stabilizer IC models represent the output voltage of the three-terminal integrated voltage regulator.

## 3.2 Motor circuit

Select AC motor to achieve the movement of the machine, MCU can not directly control the motor; we choose the relay to control the motor. The main/secondary windings of single-phase motor are different, the main/secondary windings cannot be exchanged, and otherwise, the motor will burn out. General agricultural single-phase motor should have four terminals: 1/2 main winding 3/4 as secondary winding, positive rotation. If the reverse rotation is to be done, the correct way is to switch the first and end connection of one winding, so four relays are used to control the drive motor circuit of the roll screen machine. The motor module circuit is shown in Fig. 3.
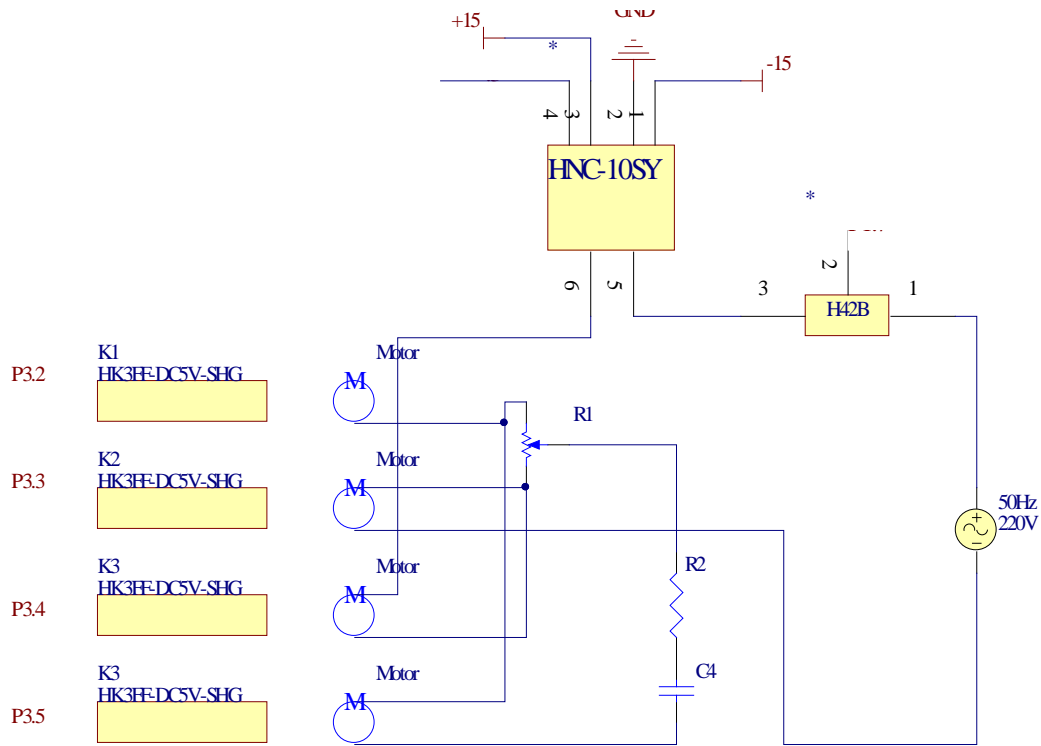
Fig. 3.  Motor circuit

## 3.3  Ultrasonic signal adjusting circuit

Ultrasonic module after the ultrasonic, start the time, the longer the material lower, the greater the opening of the valve.

The ultrasonic module begins to count after the ultrasonic wave is started. When the ultrasonic wave is received, the counting ends. The longer the time is, the lower the material is, and the greater the opening degree of the valve is. The principle of ultrasonic detection distance is as follows:

$$h=H-vt \tag{1}$$

In the h=H-vt formula, the mass height v is the velocity of ultrasonic propagation, this half of the time of ultrasonic transmission. Fig. 4 shows the ultrasonic circuit.
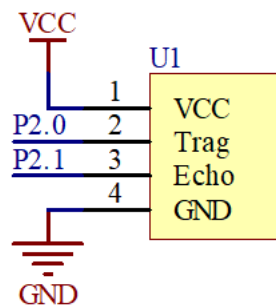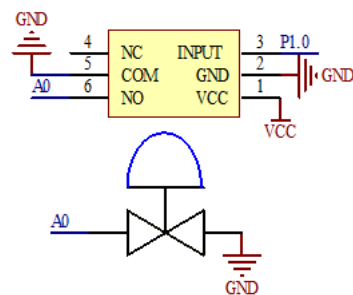


Fig. 4.  Ultrasonic circuit



Fig. 5.  Solenoid valve circuit

## 3.4  Solenoid Valve Circuit

The more material or the speed of the machine, the solenoid valve is more open. Fig. 5 shows the Solenoid Valve Circuit.

## 4. System software design

After power on, Starting initialization, ultrasonic material height detection, speed sensor detection of machine tool speed, data transmission to SCM, control the opening of electromagnetic valve, and data through RS232 bus sent to the upper computer.The flowchart is shown in Fig. 6.
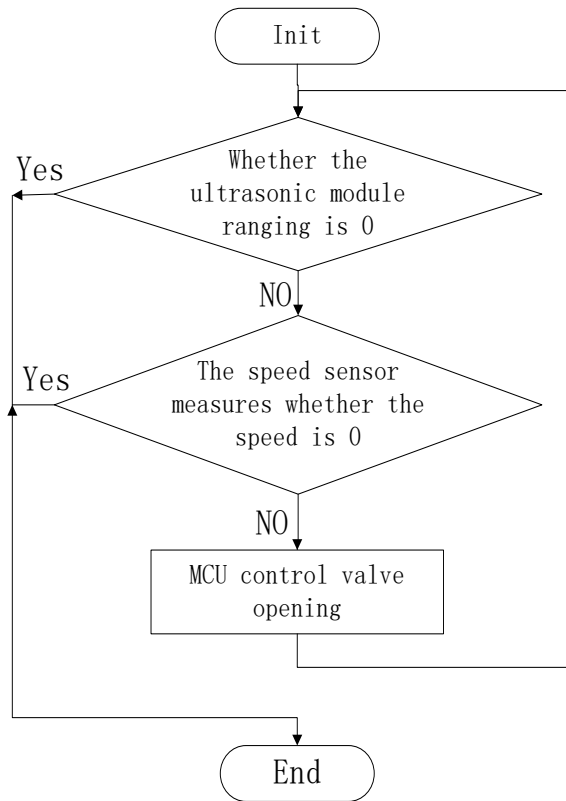


Fig. 6. Software design flowchart

## 5. Conclusion

The design detects the material height and driving speed of the machine and implements the function of displaying the information from time to time and controlling the amount of fertilizer. The data can also be transmitted to the monitoring center through the communication interface. The control system can let the user not leave home to control the equipment fertilization. Simple hardware circuit, high cost-performance, low power consumption, very suitable for individual users.

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