Researches on the Technology of Measuring Grain Moisture based on 555 Integrated Circuit

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Abstract. Grain is the material basis of human existence and development. Food quality has an important effect on people's physical health for our country. Moisture content of grain has been an important factor in affecting food quality. Every year, a substantial part of the food production is lost because of too much water contained in the food without drying. According to the annual statistics of the country’s harvest, loss of food due to drying time caused by water take up 500 - 1000000 tons, according to approximate 1.5% - 3% of the total grain output. With the development of science and technology, grain moisture detection, especially the real-time and accurate detection, has attracted more and more purchase, production, processing, storage, transportation, and attention from various aspects. Under this problem context, hardware-circuit-control system of grain moisture detection based on ATmega128 has been investigated and designed.

1. Introduction
China is the most populous country in the world and is also the most populous country of food consumption. Food and agriculture development has been a national problem in our country, because of our country’s population and the relative scarcity of resources. It is very necessary and important to solve the grain problem with the development of social economy and the growth of population. China has been the world's largest country of food production and consumption. Each year, there has been about 500 million tons of grain production. The production of rice was about 160 million tons in 2003 among the total output of grain [1][2]. In some areas in our country, especially in the southern region, it often meets a rainy weather in the rough rice-harvesting season because of the temperature, climate, and other reasons. This request will receive from the paddy grain timely drying, to meet the requirements of humidity, in order to better stored grain. It thus is very necessary to design the grain-moisture-measurement system.

2. Introduction of the grain moisture detection

2.1 Capacitance method
Capacitive grain moisture detection method is based on the water content in different grain, grain dielectric constant is also different grain drying and relative dielectric constant is much smaller than that of water, and the water content of grain relative dielectric constant of drying grain and water between the principle to measure the moisture content in grain. Capacitance method has the
advantages of simple detection of economy, high reliability, and convenient operation, where the defects are that it is affected by the environment and temperature, and the follow-up data-processing is complex.

2.2 Resistance method
The principle of resistance method is the use of grain moisture content is different, its conductive ability is also the conductivity of different principle to measure grain moisture content method. Resistance and moisture content relation can be expressed as:

\[ M = k_1 + k_2 \ln R \]

\(k_1\) and \(k_2\) are constant. Resistance method has the advantages of simple structure and low cost. The deficiency is that measuring result by commissariat breed the impact is bigger, and prior to grain grinding, made according to required size and shape of the sample for the detection.

2.3 Microwave method
Microwave method of grain moisture detection technology, is the use of water on microwave absorption of energy and microwave cavity resonator frequency, phase and other parameters with the moisture variation principle for moisture measurement method. Microwave method has the advantages of high sensitivity, fast speed, and non-destructive measuring sample, where the disadvantages are complicated device and high manufacturing costs.

2.4 Magnetic method
Magnetic method is the high technology content of the method for measuring grain moisture content, the principle is that under certain conditions, whose nuclear spin reorientation, thereby allowing the food at a frequency determined by the absorption of electromagnetic energy, which energy is absorbed and the amount of samples contained in the nucleon number proportional relationship. Magnetic method has the advantages of high accuracy, rapid measurement, wide measuring range, and being able to distinguish the bound water and free water. The disadvantage is it leads to high cost and large cost of equipment maintenance.

Grain moisture detection method has many other methods such as infrared method, neutron method, sound method as so on. It has enough space to introduce all methods due to the length of relationship.

3. The 555 integrated circuit in grain moisture detection application

3.1 Detection principle
The grain moisture measurement system has been investigated in this paper. The first is the need to select the core control chip. Then, Atmega128 single chip is used according to the task requirements. ATmega128 MCU is the AVR series of high-end products made by ATMEL company, which has a low power and high speed, super function, and reduced instruction characteristics. ATmega128 has 133 instructions, of which most instructions can be completed within one clock cycle, and has as many as 32 general registers and peripheral control register. This can eliminate common SCM Single cumulative data processing that brings bottleneck phenomenon. Thus, the instruction code is more flexible, more easy coding.

Capacitance method is used for measuring grain moisture in this paper. The method can save the cost for enterprises, and the hardware and software are relatively easy to achieve. The principle of measurement is that the food to be measured has contained certain moisture, equivalent to the capacitance relative dielectric constant. It can be easy to get the frequency needed with the help of 555 integrated circuit. The frequency can be converted into a corresponding humidity value through the corresponding formula. The result can be displayed by LCD finally.

3.2 Testing circuit diagram
ATmega128 MCU is used as the core of grain moisture measurement control system. Oscillation circuit produced by 555 chip is used for frequency output signal. It can make the system in grain
moisture measurement more faster and more efficient executed by using RISC structure of the Atmega 128 chip [8].

![Circuit Chart](image)

**Figure 1** The circuit chart of humidity signal acquisition

AS is shown in figure 1, where 555 chip output port is connected with the corresponding port3 of Atmega128 MCU. Detection of food frequency signal will be sent to single-chip analysis, where processing. Humidity measurement result value will be displayed on the liquid crystal display finally.

### 3.3 Program design

The whole process of grain moisture measuring system is that the control system has been connected with the power supply, where the control system will start self-checking and parameter initialization, assigne a corresponding port address, so that the temperature and humidity signal will be acquired respectively. The measured results will be displayed in the LCD. The whole control system of grain moisture measuring instrument will begin to enter the normal working state. The flow chart of system program is shown in figure 2.

![Flow Chart](image)

**Figure 2** The flow chart of system program
3.4 Insufficient

It will have the advantages of simple structure, low cost being easy to realize the continuous rapid measurement with the application of the principle of grain moisture detection system. The deficiency of this method is that the measurement of the accuracy will not be high enough, and the output frequency will fluctuate with the ambient temperature changing greatly.

3.5 Need for improved technology prospect

Some improving measures will be included in the signal anti-interference circuit in order to improve measured results. The influence of signal input source will be improved in addition to the grain moisture content moisture signal input end.

This can be done by adding a low-pass filter circuit. The low-pass or band-pass filter circuit can be increased in order to get the frequency of the signal accordance with the grain moisture detection of the actual needs. So the measured results can get high precision value.

4. Conclusion

Grain moisture measuring technology is a field of agricultural production that has a very important significance. Some developed countries abroad, such as the former Soviet Union, Japan and other countries began the research earlier. With the grain moisture measuring technology has made great progress, the market has also introduced a lot of good products. In our country, the research in this area is relatively late, Some schools such as Wuhan Polytechnic University, Shenyang University of Technology and Heilongjiang Bayi Agricultural University have done a lot of research on measuring the moisture content of grain. Some domestic scientific research institutes such as Wuhan Kate electronics have done a lot of research in this area at an earlier time, and introduced to the market a lot of convenience and practicality of grain moisture measurement products.

The grain moisture measurement control system investigated in this paper has been in the full reference of the existing research results, design, development of a novel, energy-saving and environmental protection type grain moisture measurement products. ATmega128 single chip microcomputer is the core of hardware of grain moisture measuring instrument, and on this basis the software has been designed and developed.

Modular structure design ideas have been used in this system. Computer serial communication technology has been introduced in order to achieve automation and intelligent operation.

The PROTEL DXP 2004 software produced by Altium company has been used to design the system hardware circuit. The software part has adopted CodeVisionAVR integrated development environment, In the course of system development proteus software has been used for circuit simulation.

5. References

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