

## ULTRASONIC DISTANCE MEASUREMENT

Ju Yangyang

Scientific adviser: A. Soldatov

Linguistic adviser: T. Mylnikova

Томский политехнический университет, 634050, Россия, г. Томск, пр. Ленина, 30

E-mail: [1374586947@qq.com](mailto:1374586947@qq.com)

Ultrasonic distance measurement is a very effective non-contact method of measurement. It has been widely applied in navigation, probing, engineering design, construction and other fields due to its precise, fast, stable and easy operating characteristics.

Therefore, in-depth study of the ultrasonic distance measurement method is of practical significance. In order to further improve the precision of the ultrasonic distance measurement, the research focuses on the type of the ultrasonic distance measurement device based on temperature compensation of the microcontroller.

The ultrasound is a sound with the frequency greater than the upper limit of human hearing, this limit being approximately 20.000 Hz. The ultrasound is widely applied to measure distance and ultrasonic cleaning because of the ultrasound characteristics such as short wavelength, high frequency, strong penetrability, cavitation and atomization effect, and so on. It is obviously efficient in medical, military, industrial industry and agriculture.

Since the ultrasound directivity is strong, energy consumption is slow and the propagation characteristics in the medium are high, the ultrasound can be used for distance measurement.

The basic theory of the distance survey measurement is the following. To measure the distance we use the principle of reflection. The ultrasonic transducer is on one side of the distance under measurement, and the object, which can reflect the ultrasonic object, is on the other side.

When measuring the distance, timing starts when the reflector emits the ultrasonic wave.

It is reflected back after it reaches the obstacles, and after the sensor receives the reflected pulse to immediately stop timing. The distance can be calculated as:

$$D = \frac{1}{2} ct,$$

where  $c$  is the ultrasonic velocity;

$\frac{1}{2} t$  is the half time period of one-way transmission.

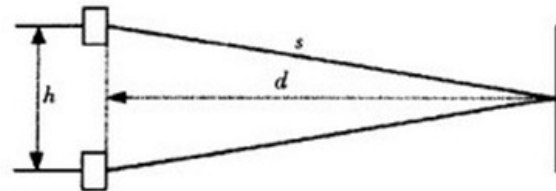


Fig. 1. Illustration of reflection principle

Basic elements of the ultrasonic distance measurement were given in the following structure.

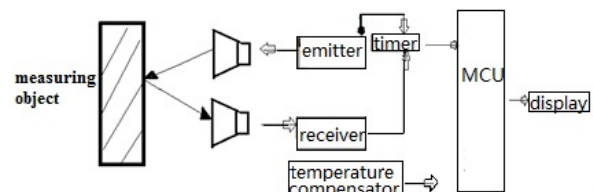


Fig. 2. Measurement scheme

The temperature compensator is used in the ultrasonic distance measuring system to make it more precise than before and increase the function of the result broadcasting.

The ultrasonic rang finder includes a hardware circuit and software design.

The entire hardware circuit is composed of an ultrasonic transmitter circuit, ultrasonic receiver circuit, power circuit, display circuit, and other modules. The temperature compensation adjustment is used in data processing, with four LED nixie tubes displaying distance or temperature by switching. Using this device, the precision of the ultrasonic distance measuring system has been improved.

The system includes the ATMG16 single chip processor, an ultrasonic transmitting circuit, and a receiving and displaying circuit.

The hardware circuit is made of data collecting sections, a core processor, display, data storage and power supply.

Basing on the given explanation, we can get the structure as shown in Fig. 3.

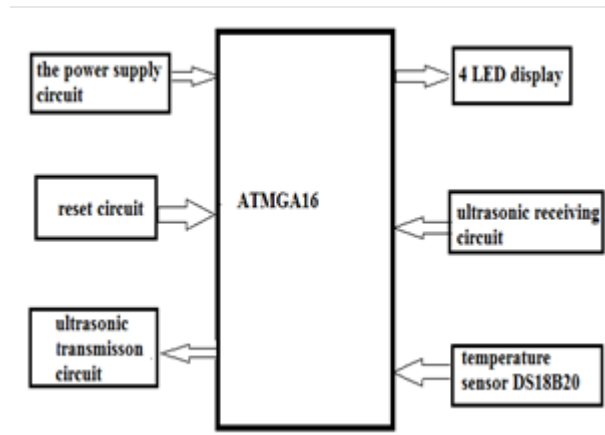


Fig. 3. Structure of ATMGA16

The major functions of the system include:

1. Using MCU to control the emission and to receive the ultrasonic wave;
2. Calculating the distance according to the measured time;
3. Testing the air temperature to use it for temperature compensation to calculate the distance under measurement;
4. The LED display shows the distance and temperature;
5. When the system is not normal, the reset circuit starts.

The probe signals are integrated and analyzed by SCMC to perform various functions of the ultrasonic distance measurement instrument. This made the basis for the software design.

The software system is the part of the C language SCM process which makes the software more readable. The software includes the main program, interruption program, launch subroutines, receiving subroutines, display subroutines, and etc.

The program flow chart is shown in Fig. 4.

Ultrasonic ranging is widely used at present. The ASIC is used to design various distance measuring instruments considering the principle of ultrasonic ranging. However, it is a single function of the application-specific integrated circuit and its cost is high. A single chip processor as the core of the distance measuring instrument can realize the preset, multiple port detection, display, alarm and other functions. It is characterized by simple design, low cost, high control accuracy, and reliability.

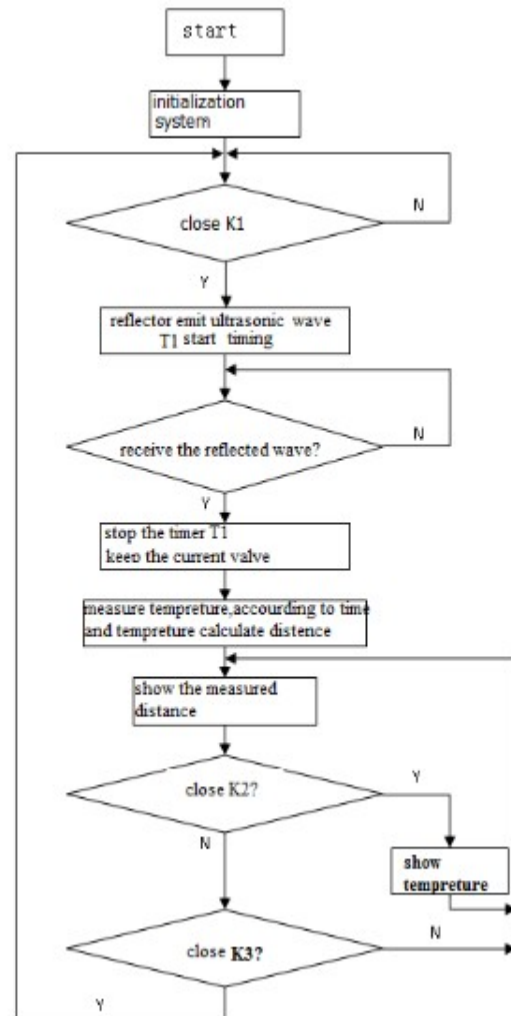


Fig. 4. Program flow chart

The design of the block diagram has been developed. It is going to be tested for further analysis and improvement to increase its accuracy and practicability.

References:

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