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Mixed Traffic Information Collection System based on Pressure Sensor

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Abstract

The traffic information collection is the base of Intelligent Traffic. At present, there exist mixed traffic situation in urban road in China. This paper researched and implemented a system through collecting the vehicle and bicycle mixed traffic flow parameters based on pressure sensor. According to information collection requirements, we selected pressure sensor, designed the data collection, storage and other hardware circuitries and information processing software. The experiment shows that the system can meet the demand of traffic information collection in the actual.

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Keywords: Mixed-Traffic; Preesure sensor; SCM

1. Introduction

At present, there exists the mixed traffic phenomenon of motor vehicles and bicycles in our urban road, this mixed traffic effects the road traffic order, increases of traffic accident potential and reduce the road capacity. Accessing the mixed traffic information timely and reliable can provide basic data for Urban Transportation Research in the mixed traffic flow; it is the basic work to solve the problem of the mixed traffic caused the city traffic jams[1]. Currently, the majority of traffic flow information collection methods are relies on collecting the motor vehicle traffic flow, they do not adapt to the China's unique mixed traffic environment. In view of this situation, we research and realization a detection technology using pneumatic rubber tube (PRT) to collect motor vehicles and bicycles mixed traffic flow parameters collection system.

This Detection technique uses pneumatic rubber tube laying on the road, the equipment will generate the airflow to hit the air-switch when the vehicle ran over, the switch will generate electrical signals to detect the motor vehicle data. The Vehicle weight are generally more than 1500kg, while the bikes are less than the weight of 100kg, also the width of the wheels and axle spacing of motor vehicles and bicycles, so when they ran over the airflow generated are very different. Therefore, it is very practical to use the size of air-pressure to distinguish the traffic flow between motor and bicycle. The PRT technology also can classify vehicle type according to axle spacing and calculate traffic flow, speed and other traffic flow parameters. So use the PRT technology to collect motor vehicle and bicycle mixture traffic flow data is a simple and practical way.

This information collection system is composed of the roadside signal collection unit and the transportation data analysis system two parts. The main function of Roadside signal acquisition unit is: When the vehicles ran over the two PRTs which lay on the road and vertical the traffic direction, the collecting unit records the time when the vehicle ran over and the size of the pressure. After collecting the data information, the collection unit uploads the data to the computer; then the transportation data analysis system processes the collecting data and gets the mixed traffic flow parameters.

2. The Hardware Design for Signs-Collection Unit

This System is composed of central processing unit of SCM, signal-collection module, storage module and communications unit. As show in Fig. 1:

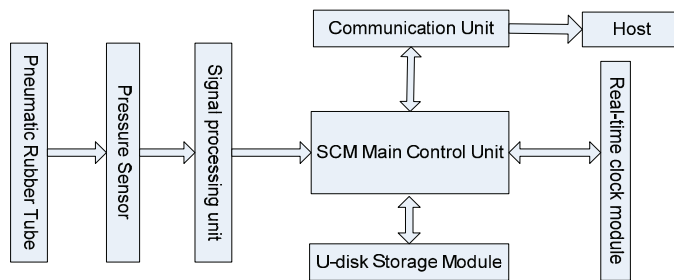


Fig. 1 The System hardware block diagram of traffic information collection instrument

2.1 Selection of Pressure Sensors

The pressure signal collection is the core of the whole system; the system strictly to the working environment of sensors, its working position is close to the road side, and easy to encounter by rain soaked, sand burial, human destruction and so on. So the sensors require high sensitivity, stable and durable, good corrosion resistance and no external powder. In order to reduce the sensor collects signal interference in the amplification process, using the zoom amplification function with built-in pressure transmitter. The pressure transmitter provides an amplification electric circuit and related components matched to pressure sensors, so that output a standard signal.

The detail technical parameters of pressure transmitter as show:

- (1) The electric powder is 5VDC
- (2) The Linear precision meets of 0.25%
- (3) The Pressure Range 0~20kPa
- (4) The output signal is 3-wires 0.5~4.5V

- (5) The temperature is $-20\sim+80^{\circ}\text{C}$
- (6) The Compensation temperature is $0\sim+70^{\circ}\text{C}$
- (7) The Pressure form is Surface pressure

2.2 SCM Control System

SCM control system can achieve data collection, A/D conversion, data storage, system reset, data upload and other functions. STC89C52RC is a new generation single-chip of super anti-interference, low power and high speed, which has 6 clock/machine cycles and 12 clock/machine cycles can be chosen arbitrarily, super encryption and online program. The instruction code of STC89C52RC is fully compatible with the traditional 80C51 microcontroller. The power supply and operating level of this SCM is 5V, and it can work normally under the battery power. So it meets the requirements of the system design.

This system has used almost all ports resource of 89C52RC. They are bidirectional port (P0), quasi-bidirectional ports (P1,P2), timer (T0), reset operation (REST), two communication pins---serial input (RXD) and serial output(TXD), the external data memory write enable(WR), external data memory read enable (RD), address latch enable (ALE), timer interrupt (T0) and the two pins of crystal oscillator (X1,X2).

2.3 Design of A/D Circuit

MAX196 is used as A/D chip, which has multi-input ranges and 12-bit data acquisition system [2]. MAX196 has sampling holder inside and its converting time is $6\mu\text{s}$. The sampling rate is up to 100Ksps. The internal or external clock can be selected by software. High conversion rate, high resolution and single 5V power supply of the chip make it suitable for the design of this system. Interface circuit is shown in Fig. 2.

The normal work mode, internal clock mode, input voltage range of $0\sim+5\text{V}$, external control acquisition and dual-channel acquisition are selected in this system. Pin CLK is connected to ground with a 100PF capacitance, using the internal clock. CS is the chip select pin and effective at low level. Pin INT is connected to P07, as the status indication of AD conversion end and data output, effective at low level. RD as a flag bit of data reading signal is connected to P06. If the level of CS is low, the rising edge of RD will enable the data from dateline. WR is connected to P05. In the internal acquisition control mode, if the level of CS is low, the rising edge of WR will latch configuration data, then a collection and a conversion cycle is started.

2.4 Design of Clock Circuit

The DS1302 of DALLAS Company is used as a clock chip for time management. DS1302 has the feature of high performance, low power, simple interface using a bit of CPU I/O, automatic adjustment in the leap year and no “millennium bug” [3]. DS1302 which uses serial data transmission can provide programmable charge function for power fail safeguard, and it only needs a button battery to be achieving the continuation of system time.

The interface circuit of DS1302 and 89C52 is shown in Fig. 3. SCLK is the internal serial clock of chip used to control the time sequence, which is connected to P16. RST is the reset pin, connected to P10. I0 as the input of serial data is connected to P15. VCC2 is the main power supply. Pin X1 and X2 are connected to an external 32.768K crystal oscillator which provides timing pulse for the chip.

2.5 The Design of Data Storage Module

The chip PB375A and the design proposal of USB flash disk are used in this data storage unit. There is almost no modification in current system using design proposal of udisk with PB375. PB375A provide two communication modes, SPI and UART. We can use a few simple IO pin imitating SPI bus communication with PB375A to write and read U disk. The hardware is simple with little change. There are only a few resistors and capacitance in the chip's circuit.

PB375A is a single U disk/SD card read-write chip, which is integrated with the USB HOST protocol and file system. It is no longer necessary to understand the USB HOST protocol and the complicated file system in your design. And you should send command offered by PB375A merely. PB375A supports these files operations, new, delete, read-write data, open, close, U disk/SD card exists detect, etc. It meets the requirement of microcontroller and embedded systems in U disk and SD card read-write operation.

Only four lines are used in the connection with MCU. They are CS, SCK, SDI and SDO. So the hardware connection is simple. The MCU communicate with PB375A using 4 general I/O pins to imitate SPI bus.

3. The Design of Signal Collection Software System

The functions of roadside signal acquisition unit are: (1) Detecting the pressure change of two rubber and record effective stress data through the pressure sensor. (2) Using SCM to imitate drive the minutes and seconds, milliseconds, and use DS1302 to manage and check the time. (3) Storing the stress data and the time when it appears with the PB375A U disk read-write modules.

3.1 The Program of Data Collection

(1) Digital filter

The pressure wave at the time of a car getting over the rubber hose is shown in Fig. 4. In this figure, the longitudinal axis is the digital data after AD sampling and the horizontal axis is sampling times.

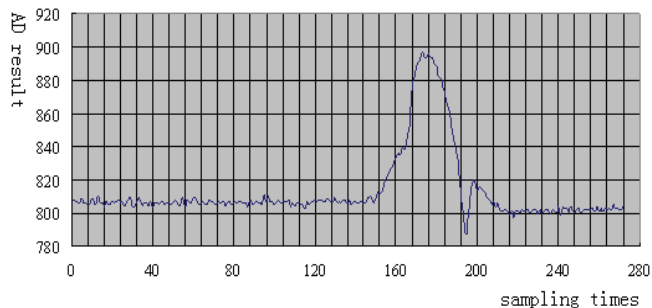


Fig 4 The wave of pressure signal

As shown in Fig. 4, the peak which is more obvious is the useful signal when the vehicle ran over. The small saw tooth wave and raised irregular peak are the interference. We have done a lot of Analysis of the pressure signal wave produced when bikes and vehicles run over and find that these two are main

interference of this system. External interference influence little on the required data. Therefore, the digital filter in program is only used in this system.

Threshold value is set beyond the small STW (saw tooth wave). The signal will be generally treated as interference, if it is below the threshold value. A constant N is set beyond the width of the peak signal. It is considered as a car passing, if signal is above the threshold value and the times is more than constant N.

The threshold value is determined using the method of weighted averaging. Besides all, atmospheric pressure changes with temperature, and the pressure in sealed rubber tube will be affected by the impact of changes in atmospheric pressure. So the threshold can not be fixed. We get the variation law of actual air pressure changing with the variation of the atmospheric pressure by experiment. And the system automatically change the threshold value according to this law. Weighted averaging method to determine the threshold is implemented as follow.

```
void getmx ()
{
    max196 (0x40);          // Call max196 (), complete the AD conversion
    menxian1= (datah<<8) +data1;    //save AD result to threshold variable
    max196 (0x40);          // Call max196 () again, complete the AD conversion
    menxian1= (menxian1+ (datah<<8) +data1)/2;    //Calculate the average
    max196 (0x40);          // Call max196 (), complete the AD conversion
    menxian1= (menxian1+ (datah<<8) +data1)/2; // Calculate the average
    max196 (0x40);          // Call max196 (), complete the AD conversion
    menxian1= (menxian1+ (datah<<8) +data1)/2; // Calculate the average
    max196 (0x40);          // Call max196 (), complete the AD conversion
    menxian1= (menxian1+ (datah<<8) +data1)/2; // Calculate the average
    menxian1=menxian1+15;        //adjust fixed offset of threshold
    Printf ("%u\n", menxian1);
}
```

(2) Data Acquisition program

MAX196 has 6 channels. According to the different keywords, you can choose different channels and switching accuracy. Dual-channel acquisition is used in this system. Only channel 0 and a channel 1 are selected. The keywords are 0x40 and 0x41. The selected channel can be changed only by changing the transmission parameters. Data Acquisition program is mainly consisted of compare1 (), compare2 () and other functions. Specific program flow is shown in Fig. 5.

AD sample value is compared with datah1 and data11 if it is above threshold value and n is added with 1. If it is the bigger, save it in datah1, data11. The max data of AD result is saved in datah1, data11 through repeated cycle. When AD result is below threshold again, and N is bigger than a certain value, that means enough time; we can determine a valid data but not interference.

3.2 The Programming of Data Storage

The main program of STC89C52 first complete the I/O pin settings and related register configuration, then initialize the communications port PB375A. Input control commands to the PB375A, send command to check whether U disk has been inserted, and whether the U disk has get ready for it and so on. Data acquisition files of new text file format in the U disk, and open it, lead file pointer to the end of file in order to write the data collection down. After all the task have been completed, the data can be appended in the order. Finally, we must pay attention to close the file, Otherwise, all stored data will be lost.

3.3 The Programming of Time Management

The clock module is mainly responsible for the normal operation of the system time and accurate records of time point. The system selected is DS1302 that is a high accuracy and real time clock chip, Timing accuracy level is second, but the time scale level of mixed traffic flow axle needs Millisecond. The system uses the single chip timing functions, and though the single chips interrupt to achieve millisecond timing. This system uses a way of combining DS1302 clock and millisecond timing of single chip in order to time more accurately, the way is timing verification. So that both can make up for the shortcomings for each other.

3.4 The Analytical System of Traffic Data

By the analytical system of traffic data on analytical processing of time scale of axle and pressure raw data, we can get vehicle type, speed, traffic and other relevant data in mixed traffic flow. It can generate a variety of charts that traffic volume is changed following time, at the same time it achieves many of functions that contain statistics, management and demand for data acquisition. Concrete program and implementation are not described in detail here.

4. Conclusions

There is a parameter collection system of mixed traffic flow in the cycling road that achieves the performance of low-cost and portable. After extensive field testing experiments, this system is running well, more accuracy and reliability, have good practical value and promotion prospects.

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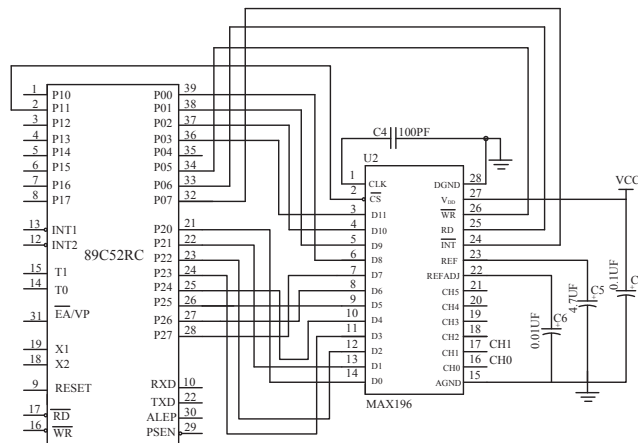


Fig 2 the interface circuit of MAX196 and 89C52

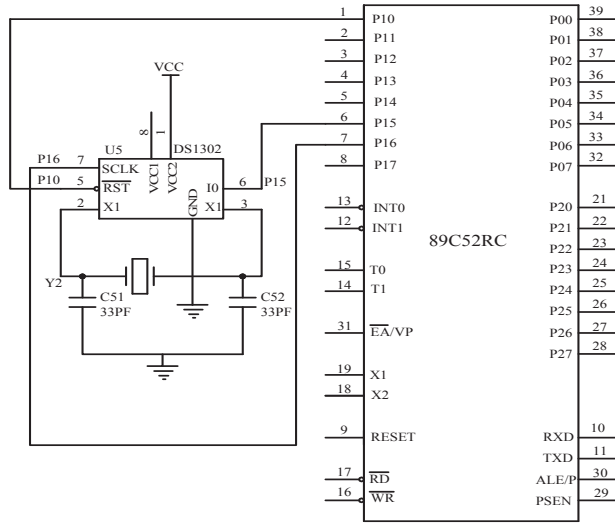


Fig.3 The interface circuit of DS1302 and 89C52

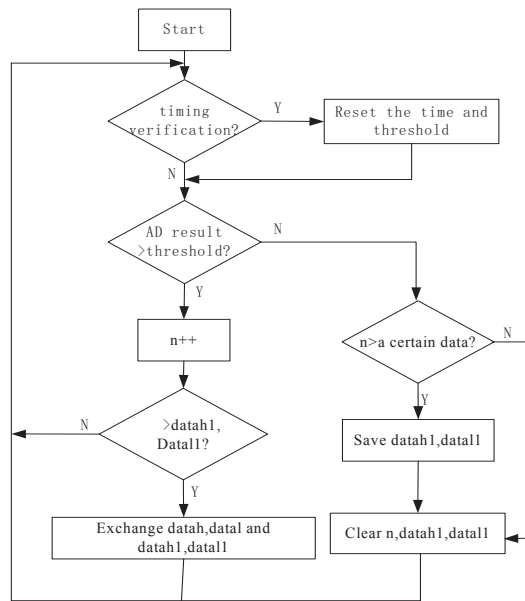


Fig 5 Program flow of data Acquisition module