Design of Portable Car Body Posture Monitoring System

Zhang Cong[1,a], Chen Chong[2,b], Ma Yuebo[3,c]

[1,2,3]School of Transportation and Automotive Engineering, Xihua University, Key Laboratory of Automobile Engineering of Sichuan Province , Chengdu, 610039,China

[a]zhn1025@hotmail.com, [b]cyh64@263.net (corresponding author), [c]272525421@qq.com

Keywords: posture; monitor; data acquisition

Abstract. By real-time data acquisition of pitching and rolling angle in the process of driving, portable car body posture monitoring system designed in this paper executed the analog-to-digital conversion of these acquisition signals, and displayed the real-time posture of vehicle on LCD after analyzing. Finally, the feasibility and reliability of this system were verified by vehicle road testing.

Introduction

In the process of driving, the intermittent shock of car body leads to the change of body posture, which impacts the automobile ride comfort and handling stability [1]. This paper designed a portable car body posture monitoring system on the basis of SCM which provides an implementation method of monitoring the car body posture from the point of view of combining software with hardware. And the function of it was realized by the vehicle road testing. Portable car body posture monitoring system is strongly practical due to its lower production cost, real-time performance and convenient operation.

Hardware composition of monitoring system

The hardware of portable car body posture monitoring system consists of SCM 89C52 [2], dual-axis angle sensor, TLC2543 analog-digital converter and LCD. The hardware structure of monitoring system is shown in figure 1.

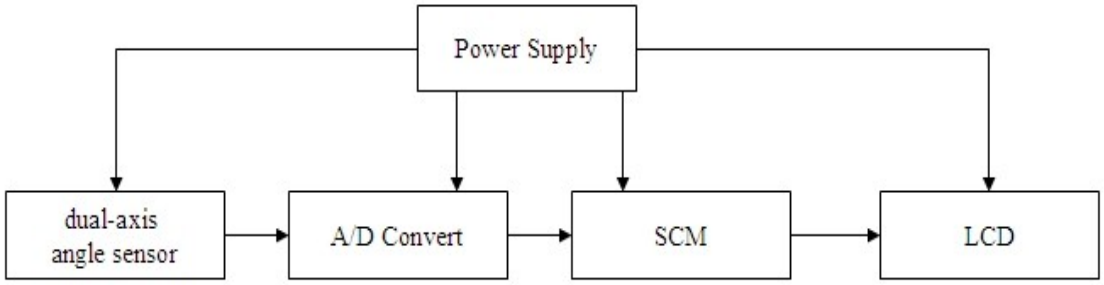

Fig. 1 Hardware structure chart

In order to monitor the car body posture under different running conditions, a high precision dual-axis angle sensor was chosen in this system , whose measurement range is -15°~+15°. With the minimum resolution of 0.001°, this dual-axis angle sensor meets the measurement requirements [3]. Additional, the output parameter of this sensor is analog voltage and the voltage of zero position is 2.5V. According to the linear input-output characteristics of dual-axis angle sensor, the relational expression between analog voltage and output angle can be described as below:

Output angle = (analog voltage – zero position voltage)/sensitivity

TLC2543 is a 12 bit-serial multi-channel A/D chip with the resolution of 12 bits which provides 11 analog input channels, and the converting process can be finished in only 10μs. According to the range of Analog voltage, its accuracy can reach 0.007° when it converts the analog voltage into car body posture angle. At the end of conversion, the end-of-conversion (EOC) output goes high to

indicate that conversion is complete. And the final relational expression can be described as below after the analog-to-digital conversion :

Output angle = (analog voltage*5/4095 – 2.5)*6;

LCD1602 plays an important role in displaying the pitching and rolling angle of car body. It can not only display 32 characters simultaneously but also scroll the display.

Software design of monitoring system

Software and corresponding program design are the important link of car body posture monitoring system. The control center of this system is SCM89C52. By reading the programs which designed for the working process, the SCM89C52 controlled the dual-axis angle sensor, analog-digital converter and LCD1602 to perform with high stability and reliability so that the system can fulfill the task of monitoring car body posture.

The software of portable car body posture monitoring system consists of three modules, namely signal acquisition module, A/D convert module and LCD display module, each module has its own function [4]. The role of signal acquisition module is to obtain the information outputting from the dual-axis angle sensor and transfer it to the next section, and the A/D convert module is responsible for converting the analog voltage to pitching and rolling angle, while the LCD display module completes the task of showing the posture of car body clearly. The program flow chart of software is shown in figure 2.

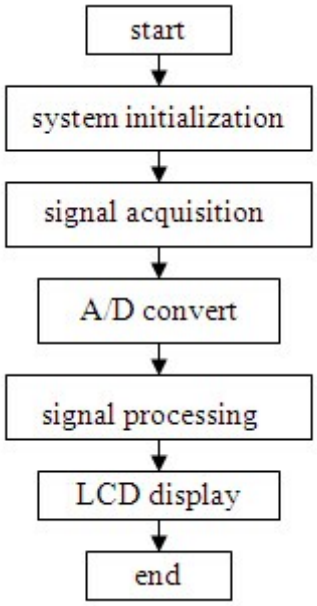

Fig. 2 Program flow chart of software

Programming of LCD display module is composed of three parts. Writing and reading data program is used for executing the order that received from SCM. Initialization program is to ensure the precision of displaying information. And the display program is used to show the final results. The program flow of LCD is shown in figure 3.

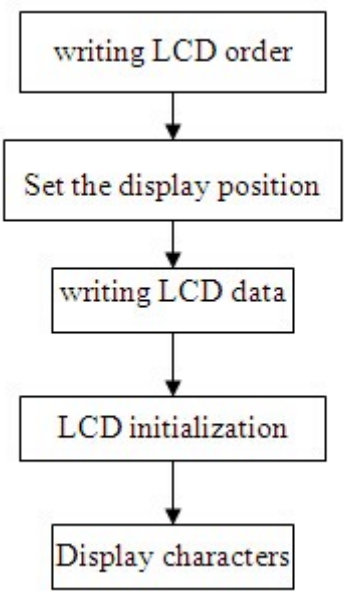

Fig. 3 Program flow of LCD

Testing and conclusion

To ensure the precision of every component, the working process of this system was simulated before vehicle road testing. As there is no dual-axis angle sensor in simulation system, two sets of voltages and variable resistances were used to collect the signals of pitching and rolling angle. The collected analog voltage was converted by A/D chip, disposed by SCM, and then the results were displayed on LCD. The simulated effect is shown in figure 4.

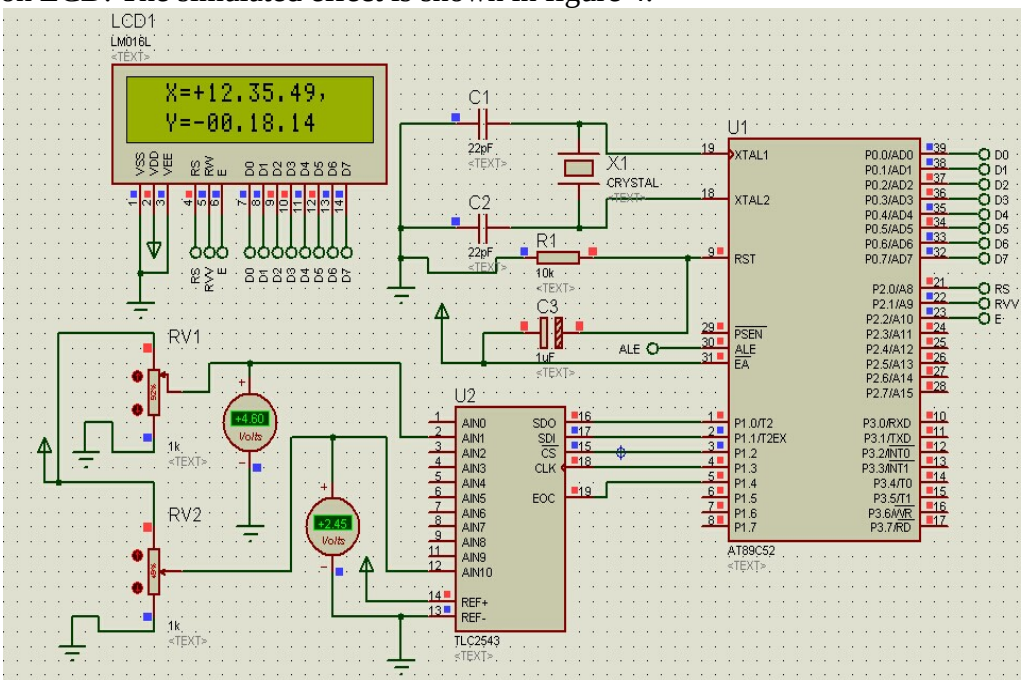

Fig. 4 Simulation diagram

To verify the function of the monitoring system, road testing was carried out. And the results showing in LCD reflected the real-time car body posture correctly. It is indicated that the design goal of this system was reached.

Automotive dynamic parameter is the direct embodiment of running states. The measurement of various parameters is not only the developing requirement of testing system, but also the key to

improve performance of vehicle. With the advantages of low cost, reliable work, high precision and strong real-time, portable car body posture monitoring system designed in this paper has realized the expected design purpose of posture monitoring, and it has a broad application prospect in the area of improving the automobile ride comfort. Meanwhile, with the progress of science and technology, the monitoring system has a wide range of applications in mechanical engineering as well as in military field [5]. For instance, it is necessary to maintain the level of vehicle platform to ensure the accuracy of the sophisticated equipment such as vehicle laser. Combined with the design principle in this paper, the real-time posture of vehicle platform can be monitored to judge whether it keeps in a horizontal work state, which lays the foundation of achieving the automatic leveling of vehicle platform as well as improving the accuracy of the equipment.

Acknowledgements

This thesis is supported by the Research Fund of Key Laboratory of Automobile Engineering of Sichuan Province (SGXZD9902-10-1) and the Innovation Fund of Postgraduate Xihua University (YCJJ2014095).

References

[1] Xia Zebin. Study on Measuring and Testing System for Vehicle Dynamic Parameters Based on Multi-GPS [D]. Xihua University 2013.p.14-16(In Chinese)

[2] Cheng Guogang. 51 SCM application development case manual[M].BEIJING: Publishing House of Electronics Industry 2011.p.52-56(In Chinese)

[3] Luo Changzheng. The Development of Vehicle Attitude Controller Based on DSP F2812 [D].Xihua University 2013.p.31-33(In Chinese)

[4] Zhang xiaolong, Chao kainian.The development of automobile road test data acquisition instrument based on 80C196KC SCM [J].Instrument technique and sensor.2004 (09).p.16-17(In Chinese)

[5] Li Guizhen, Jiang Qiao. GPS/electronic compass posture positioning system based on SCM [J].The application of SCM and embedded system.2012 (05).p.40-42(In Chinese)