Sensors & Transducers, Vol. 181, Issue 10, October 2014, pp. 52-59

Sensors & Transducers

Design of Racing Electric Control System Based on AVR SCM

Shuang WAN, Chenchen HE, Mingxin XIE, * Yuezhen FAN
School of Technology, Beijing Forestry University, Beijing, 100083, China
Tel.: 18695618536,
* E-mail: 490400135@163.com

Received: 6 July 2014 /Accepted: 30 September 2014 /Published: 31 October 2014

Abstract: A racing car's instrument system, signal system and monitoring system were designed based on the rules of the competition (FSAE, Formula SAE). The main components of the instrument system were selected by comparing the advantages and disadvantages of various instrument systems. And the circuit diagram and PCB diagram of the instrument system was drawn by Altium Designer. Then, the instrument system with Single Chip Microcomputer (SCM) as the main body was set up according to the circuit diagram. Besides, programs were written according to the function of instrument system. Finally, the instrument system was debugged. In the aspect of the design of signal system and monitoring system, the circuit diagram of signal system and signal system were drawn according to the racing design requirements and rules. Currently, the instrument system has been successfully debugged. And the design of circuit diagram of signal system and monitoring system has been completed. *Copyright © 2014 IFSA Publishing, S. L.*

Keywords: Electric control system, Formula SAE, Speed measurement system.

1. Introduction

The FSAE is a formular student racing organized by SAE (Society of Automotive Engineers) of the countries for the graduates and undergraduates. It is required to design a racing car with outstanding performance in acceleration, braking, and handling. Furthermore, it must be durability and stable enough to be able to successfully complete all the items listed in the rules of FSAE. Therefore, the research on the FSAE racing becomes a hotspot by the students from the vehicle engineering of the universities.

Jinsan Li gave a design and optimization on the general layout of the FSAE racing. Including: selecting the basic size and quality parameters of the main contents of the FSAE racing, designing and calculating the axle load distribution and transmission ratio of the main retarder [1]. Literature [2-4] gave a structural strength analysis of the racing frame, furthermore optimized its structure. Bang Qiao boost the racing car's comprehensive performance with the finite element analysis of racing car and original frame structure [2]. Zhao Cheng carried out the dynamic strength test and modal test of FSAE, which showed stress distribution of the suspension and main frame [3]. Liman Jiang optimized the design of the frame structure by analyzing the comprehensive static and dynamic performances of the frame with CAE software, DASP modal test equipment and e-DAQ stress test equipment, which finally [4]. Literature [5, 6] achieved the lightweight design of the FSAE racing. Shaohua He optimized the strength and stiffness properties of the racing's frame based on the finite element analysis of the frame, to achieve the goal of losing weight. Finally, optimization effect and safety were verified by finite element analysis, and the accuracy of the finite element model was confirmed through experiment [5]. Qiang Zhao carried out the frame topology optimization to improve the mechanical properties of FSAE racing and reduce racing's weight [6]. Meiyan Liu analyzed the car's handling and stability suspension by the finite element method [7]. Literature [8] analyzed the steering stability of the racing suspension. Jianyu Wu, Jun Wang, D. Robertson, et al optimized the structure of the racing suspension [9-12]. Xing Wang and Wu Zhang analyzed the handling stability of the racing based on a simulation [13, 14]. Tian Cai analyzed the performance of racing based on the simulation [15]. Tongyang He, W. Attard, S. Wordley, et al optimized intake system of the FSAE racing [16-18]. D. Corrigan and J. Walkingshaw studied the performance of the racing's engine [19, 20]. Giovanni Belingardi designed a certain car crash simulation tests for a racing [21]. Qiu Fang designed the instrument system for racing, and layout the location of the various electronic devices [22]. H. Enomoto, and Y. Miyazaki, designed a front impact attenuator to improve the security performance of the racing [23]. The research on the FSAE racing mainly focused on optimizing the structure and engine of the racing basing on the improvement of the power performance and ride comfort. Few studies have addressed the electronic control system of the racing. So we thought it's meaningful to design the electronic system of the FSAE racing.

The FSAE racing electronic control system include the design of instrument system, signal system and monitoring system of the racing. In the system, the signal of sensor, light and current is sent into the SCM. Then the SCM sends signal to the actuator and the actuator makes appropriate actions.

A good design of racing electronic control system should decrease the complexity of the driver's manipulation and improve the reliability and controllability of the racing car. The electronic system design includes designing system hardware circuit, building the physical circuit, writing C language programs according to the certain function and debugging the circuit.

2. Design Rules and Outline

The design of racing electronic control system aims to improve the accelerating performance, power performance and control ability of the racing car, which increases the diversity of the racing control, makes the racer know the racing real-time status and strengthen self-protection feature of the racing car itself. So it becomes safer to drive the racing car. The design of FSAE electronic system consists of 3 parts: Racing instrument system design, Racing monitoring system design and Racing signal system design.

2.1. Master Switch

According to the rules, the racing must be fitted with two master switches to control any of the main switch can turn off the engine.

The 1st master switch must be located on the drivers' right side, near the main ring, nearly the same height as the riders' shoulder, and easy control outside the car. All the circuit including the battery, alternator, lights, fuel pump, ignition and electronical control systems can be break. All battery current passes through this switch. It must be a rotary switch and pass through the two relay control circuit.

Master switch of the cockpit (the 2nd switch) must be placed in the position in an emergency. And it must be installed in the position where driver fasten with his/her seat belts still can easily touch. Close to the steering wheel, but is not hidden by the steering wheel or other partial occlusion. It's recommended to place on the side of the steering wheel as the shift handle. It must be the press/pull emergency switch. Press the switch can cut off the fuel pump and ignition power in the on position and pull the switch can be switched on the ignition and fuel pump power in the off position.

Furthermore, the total circuit can be controlled by relay. And the International Electronical Identification must be marked near the main switch: triangle logo characterized by red lightning white border on blue background. All the design should comply with the rules.

2.2. Racing Instrument System Design

The racing instrument system is equipped with special speed sensor. It can display real-time speed, diagnose the racing condition automatically, alarm and memorize the condition of the driving conditions [24]. The instrument system consists of the sensor circuit, the electronic circuit and the liquid crystal display circuit. The working process of the speedometer is that: speed sensor sends speed signal to the SCM, the SCM receives the signal and calculate the speed every certain time period, the LCD device to display real-time speed driven by the SCM [25]. So the design of instrument system include: selecting sensor, SCM and LCD display, circuit diagram drawing, printing circuit board design, building electronic control system with the SCM as the main body according to the circuit diagram, simulation and debugging of the electronic circuit [26-28].

2.3. Racing Monitoring System Design

Due to its fast speed, the gravity center need to be as low as possible, so racers need to lie in the racing car. But it leads to a narrow field of vision. In order to improve the control ability and security of the racing car, cameras need to be installed in the front and rear of the car, which makes the racers get the real-time condition of the road. This circuit needed to connect to LCD, the frontal and rear camera [29, 30].

2.4. Racing Signal System Design

Racing signal system shows car's position to the other vehicle's driver and pedestrian by light signals and sound signals to ensure the safety. The light signals include turn light signal, brake signal, reversing signal. The sound signals include electric horn signal and reverse buzzer signal. The circuit design of the signal system includes the main brake lights circuit, turn signal circuit, reversing light circuit and electric horn circuit design.

The red brake lights are mounted in the rear of the racing car. The role of the brake lights is to make the back of the racing to know status and preventing rear-end accidents. Brake light circuit is to achieve when the brake pedal is depressed.

Turn lights are important indicators to prompt before and after racing and pedestrians when the racing is steering. The role of turn signal circuit is to inform racers and pedestrians of its directions.

Reversing light is used to warn vehicles and pedestrians behind the car when the racing is reversing.

The racing is equipped with electric horn to warn pedestrians and other vehicles for safety [31].

2.5. Work Process of Speed Measurement

2.5.1. Generation of Hall Signal

A permanent magnet was fixed on the edge of the wheel rim. A Hall sensor made of Hall A3144 was fixed near the wheel rim. The vertical distance between the magnet and Hall sensor is less than 2 mm.

Then transit a constant electronic current to the Hall probe. When the wheel is rotating, the Hall sensor would feel the alternating current magnetic induction by the influence of magnetic field of the magnet fix on the edge of the wheel rim. When the Hall probe is aligned with the magnet, the magnet produce the low level, otherwise produce the high level. There is a square wave output of the Hall sensor per revolution. We can calculate the speed of the vehicle according to the frequency of the square wave [32].

2.5.2. Timing Counting and Calculation of SCM

The pulse signal produced by the Hall sensor is sent to the AT mega 16 SCM to be counted every 10 ms after shaping. The accuracy and sensitivity of the SCM can be adjusted by changing the counting time. When the counting time is 10 ms, the reaction time of speed measurement is 10 ms.

The timer 0 is used to count and counter 2 is used to timing. Firstly, the timer 0 initialized and set up the counter 2:

$$TCCR0|=(1<<CS02)|(1<<CS01)|(1<<CS00), \quad (1)$$

The pulse signal is input from the T0 pin, and triggered by the rising edge. And set the timer 0 count register.

$$TCNT0=0x00, \quad (2)$$

If the initial value is set to be 0, timer 2 is initialized, set timer 2 control register.

$$TCCR2 |=(1<<CS22)|(1<<CS21)|(1<<CS20), \quad (3)$$

Due to the pre fraction frequency is 1024, so 1024/7.3728= =138.89 us, the number of timing is 1024/7.3728=138.89 us times. Because timer is 8-bit and the overflow value is 256, the initial value is 255-72=183, converting to the hexadecimal number is 0xB7. So set the counter 2 control register:

$$TCNT2 = 0xB7, \quad (4)$$

Then enables the timer2 overflow interrupt and total interrupt, set interrupt mask register and interrupt register.

$$TIMSK |= (1<<TOIE2), \quad (5)$$

$$SREG = 0x80, \quad (6)$$

Counter 0 plus 1 from 0, timer 2 plus 1 from 0xB7. When the highest bit of timer 2 overflows, the interrupt flag bit TOV1 of timer 2 is set. TOV1 to be 1 means 10 ms timing. Timer2 overflow and apply for the interrupt to CPU. The CPU correspond the interrupt to enter the interrupt service routine. Shield timer 2 overflowing interrupts, record the number of the times of pulse signal in 10 ms. Interrupt counter plus 1, reset the initial value and set the interval of timing interrupt to be 10 ms:

$$TCNT2 = 0xB7, \quad (7)$$

If the times of interrupt are 50, the wheel speed is:

$$n=60*m/(0.01*2*50)r/min, \quad (8)$$

where n is the speed of the wheel, m is the number of pulse signal in 1 s.

Then the speed is:

$$V=n*3.14*D*3.6/60km/h, \quad (9)$$

where D is the diameter of the wheel.

Then clear the number of pulse memory, interrupt counter and the interrupt flag bit of counter 2. Reset the initial value of counter 0. Enable the timer 2 overflows interrupt and global interrupt. Counter 0 continues to acquire the pulse signal of the sensor. If the total number of the pulse signal is less than 50, acquire to collect [34].

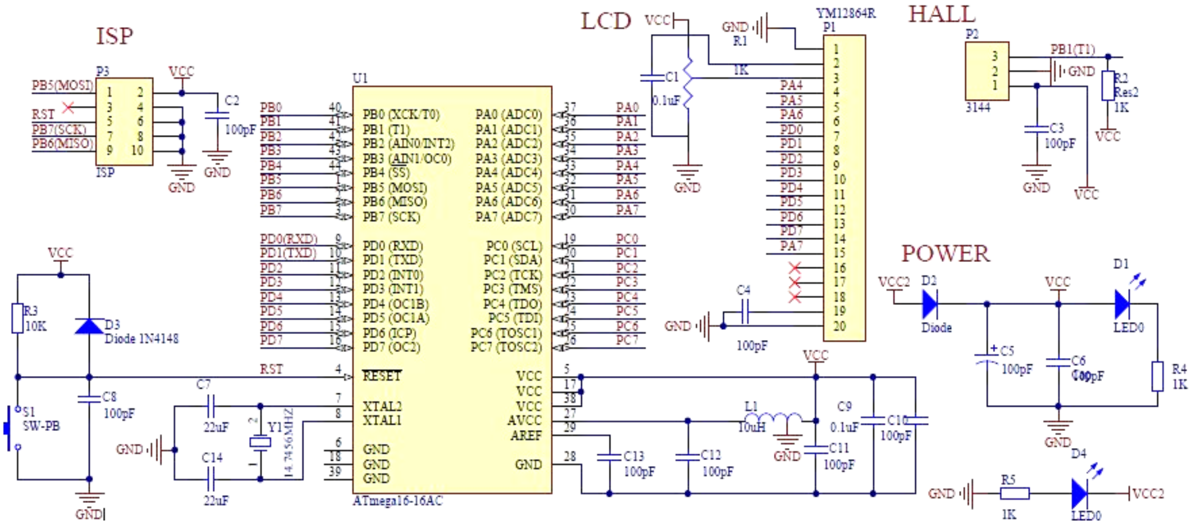


Fig. 1. Circuit principle diagram of the instrument system.

2.5.3. LCD Display

The wheel speed calculated by SCM is sent to the LCD12864 driven by the chip 7920A. LCD has a low speed, so it has to judge if the busy bit is low before execution of each instruction. If it's low, it means not busy. Otherwise the construction fails. Therefore, to display the driving state of the racing on LCD has to judge if it's busy, if not, set the display position and contents of the character and send the speed of the vehicle to LCD to display.

2.6. Battery

All batteries (such as a car power) must be securely mounted to the frame. Any battery containing electrolyte within the cockpit must be placed on an insulating freight contain error an analogue thereof. In all racing, hot terminal must be insulated.

3. Hardware Implement

3.1. Instrument System Circuit

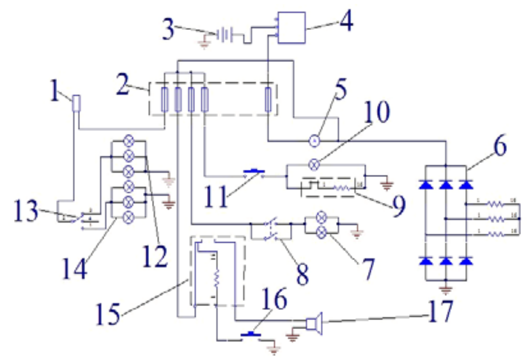
The racing instrument system consists of the speed measurement circuit and speed display apparatus of the racing. The speed measurement circuit is composed of SCM and speed sensor. LCD uses the speed displaying device.

In the design of FSAE racing instrument system, SCM with high CPU speed and reduced instruction set which is produced by the ATMEL is the core. The highest basic frequency can reach more than 20 MHZ, ten times of the MCS-51 SCM at least [36].

Hall A3144 is used as the speed sensor, and YM12864R which can display Chinese characters and pictures as the displaying device. The circuit diagram of the speed measurement system is shown in the Fig. 1.

3.2. Signal System Circuit

FSAE racing signal circuit composed of the brake light circuit, turn signal circuit, reversing signal circuit and electric horn circuit. The design only involves the racing signal system circuit design, which is just a preliminary design. Detailed selection of electrical components will be involved in the subsequent design. The preliminary design of racing signal system circuit is shown in Fig. 2.



1 – Flash relay; 2 – Fusebox; 3 – Battery; 4 – Starter; 5 – Ammeter; 6 – Generators; 7 – Brakelights; 8 – Brake switch; 9 – Reversing buzzer; 10 – Pour headlights; 11 – Reversing switch; 12 – Left signal lights and indicators; 13 – Steering light switch; 14 – Right signal lights and indicators; 15 – Horn relay; 16 –Horn button; 17 – Electric horn.

Fig. 2. Signal system diagram of racing.

When the racing does not start and powered by the battery as shown in Fig. 2. All signal devices get power from a backup power unit. When the racing car operates, the power will come from a generator. Current in the circuit always flow through a fuse box, and then flows into the respective electrical equipment. The role of the fuse is to protect the circuit. When the current in the circuit is too large the fuse is broken, shutdown the circuit to prevent excessively large current fry power equipment.

When the driver depresses the brake pedal, the brake switch close, and the brake light turn red.

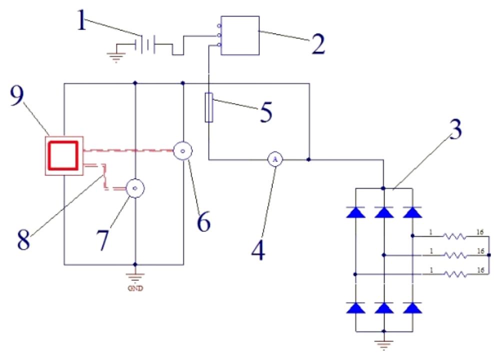
In the case of turning, the left or right turn signal light is issued twinkle signal. When racing turning, the racer controls turn signal switches through the steering wheel, left or right lights and indicators light when steering control left or right [33].

In the case of reversing, the racer hanging reverse, reversing light switch mounted on the transmission cover is closed, reversing light is illuminated while reversing buzzer intermittent chirping.

Electric horn on the racing car, controlled by horn button and a horn relay. In case of overtaking or encounter pedestrian, the driver presses the horn button, horn relay coil produce electromagnetic suction to pick up the armature [34]. The speaker connects into the circuit, so the speaker beeps. The purpose of doing so because large current required in the horn operating, if a direct switch is directly controlled, then the switch will be burned, plus a relay inside the circuit, the switching control relay, the relay sent electricity to speakers, so that the switch will not be burned. Horn relay is using the small current control the big current which plays the function to protect switch [35].

3.3. Monitoring System Circuit

The racing traffic monitoring system is to monitor the road conditions. The monitoring system composed display device and traffic monitoring device. Traffic monitoring device consists of front and rear cameras. The role of the front camera of the racing is to ensure that the dead angle of the front can be displayed on the screen in the forward process so that the driver see the entire front road condition, so the camera is installed on the intermediate position of the racing fairing front. Due to the wind resistance caused by the glass rear view mirror installed on the fairing the rear camera is installed on the frame. After installation, the monitoring range is extended to the largest. LCD is selected to be the traffic monitoring device, which makes it easy for racer to observe traffic condition. The LCD is installed on the car dashboard. Racing monitoring system circuit diagram is shown in Fig. 3. The camera is connected with the LCD through the signal wire and, the power on the camera and LCD supplied by the power of racing [36]. This system has changed the traditional observation way of racing rear view, the racers can get a whole view of the before and after road when traveling and reversing, which improves driving safety [37].



1 – Battery; 2 – Starter; 3 – Generator; 4 – Ammeter; 5 – Fuse; 6 – Front camera; 7 – Rearcamera; 8 – signal lines; 9 – LCD.

Fig. 3. Traffic monitoring system circuit diagram.

4. Software Design

The program of racing instrument system consists of main program, speed acquiring program, speed processing program and LCD displaying program.

4.1. Design of Main Program

The main program mainly consists of the initialization program and speed processing program. And the initialization includes the LCD initialization and Hall sensor initialization.

The initialization program of LCD is as follows:

Void Init_12864()

1. CTRDDR←CTRDDR |(1 << RS)|(1 << RW)|(1 << E)|(1 << PSB)Δinput the data in parallel reading mode;

2. LcdDdr←0xffΔset the data port as the output;

3. psb()←1; Δinput in the parallel mode;

4. call Lcd WriteCmd(0x30) Δselect the basic instruction set;

5. call Lcd_WriteCmd(0x0c) Δdisplaying with no vernier and no reverse;

6. call Lcd_WriteCmd(0x01) Δclear the LCD, and set address to be 00H;

7. call Lcd_WriteCmd(0x06) Δset the direction of cursor's movement and shift distance of displaying when reading or writing the specified information;

The initialization of Hall sensor is as follows:

Void Hall begin()

1. DDRB←0x00ΔPB

2. PORTB←0xffΔset PB port to be the input port;

ΔThe initialization program of counter 0; Δ

3. TCNT0←0x00Δclear the counter 0;

4. OCR0←0x00Δset the initial size of compare counter to be 0x00;

5. TCCR0←TCCR0 | (1<<CS02)|(1<<CS01)|(1<<CS00) Δset the T0 pin to be the input clock, triggering the rising edge.

ΔThe initialized overflow program of timer 2 Δ

6. TCNT2←0xB7Δset the timing to be 10ms;

7.TCCR2←TCCR2|(1<<CS22) | (1<<CS21) | (1<<CS20) Δset the pre fraction frequency to be 1024;

8. TIMSK←TIMSK | (1<<TOIE2) Δenable the timer 2 overflow interrupt;

9. SREG←0x80Δenable the internal interrupt;

10. coderls←0Δset the rotate speed to be 0;

The speed measurement system calls the Hall sensor program to get the rotate speed of the wheel. Then calculates the speed of the car and sends it to display on LCD. The main program flow chart is shown in Fig. 4.

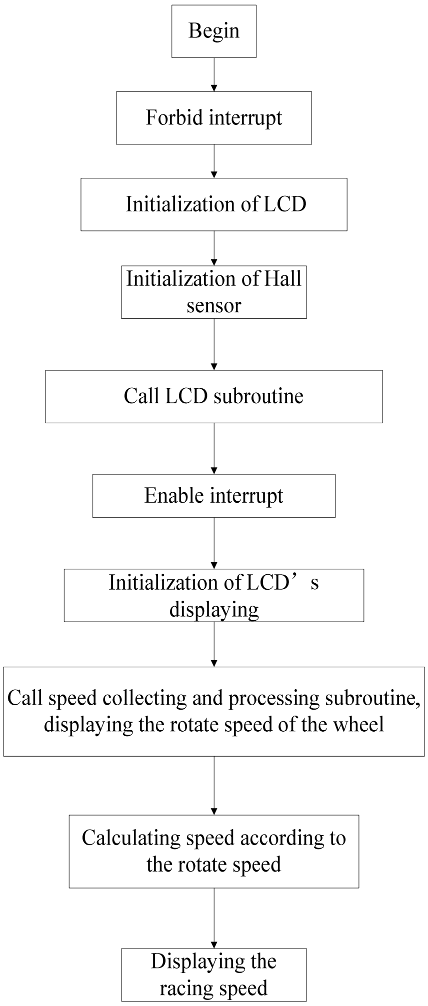


Fig. 4. Flow chart of the main program.

4.2. Design of Speed Acquiring and Processing Program

In the procedures of speed acquisition system, the timing of timer 2 is set to be 10 ms, counter 0 counts the quantity of the pulse, and then get the vehicle speed. Timer 2 controls the start and stop of the counter 0 in the interrupt way, came into the interrupt service subroutine when interrupt once, and interrupt counter add 1. When the times of the interrupt reach 50, the rotate speed and speed of the wheel are calculated. Speed acquiring and interrupt service subroutine is as follows:

SIGNAL(SIG_OVERFLOW2)

{

1. TIMSK ← TIMSK & 0xbf Δ shield timer overflow interrupt;

2. TCNT2←0xB7Δset the timing to be 10 ms;

3. Hall_temp1 ← Hall_temp1 + 1 Δ count 1 every interrupt;

4. temp← temp + TCNT0 Δ record the number of pulse;

5. TCNT2←0xB7Δset time interval of interrupt to be 10 ms;

6. if Hall_temp1==50

1. then coderls←temp*60Δcalculate the rotate speed of wheel;

2. temp←0Δclear the pulse number memory;

3. Hall_temp1←0Δclear the interrupt counter;

4. TCNT0←0Δreset the initial value of counter0;

7. TIFR←TIFR|0x40Δclear the flag bit;

8. TIMSK←TIMSK|0x40Δenable the overflow interrupt of counter 2;

9. SREG←0x80Δenable the internal interrupt;

10. call sei() Δ jump out of the interrupt service subroutine;

}

4.3. Design of LCD Displaying Program

Set the LCD displaying to be 4 lines. The first line is the racing rotate speed. The forth is the racing speed, and another two used as the position of the subsequent racing instrument design.

Result and Discussion

To test the accuracy of the instrument system, the comparative experiments were done. The results of the comparison are shown in Table 1, a table of the actual value measured by the precision speedometer. Error analysis shows that the error of the speed measurement less than 8 %. It becomes smaller with the increase in speed preset value.

Table 1. Test data.

No.	Actual Value (km/h)	Test Value(km/h)	Error Rate (%)
1	10	10.08	0.80
2	20	20.15	0.75
3	30	30.20	0.66
4	40	40.30	0.75
5	50	50.30	0.60

5. Conclusions

In the design of FSAE racing, circuit design continued throughout the process, which playing an important role in the design of electronic control system. The design of racing electronic control system included the instrument system, signal system and monitoring system. By the selecting the main components of the electronic control system of racing and drawing the circuit diagram, an electronic control system with the SCM has been built. And the electronic control system has been debugged and verified. The research results and conclusions of the paper are as follows.

1. Instrument design. Firstly, select the major components such as microcontroller, vehicle speed sensor and LCD display and designing circuit of the minimum system referring to domestic and foreign racing's instrument. Secondly, design the sensor's circuit according to the requirements of inputting pulse of microcontroller's counter, leading the sensor outputting the pulse signal in line with the requirements of the microcontroller's timing. Meanwhile, design the LCD monitor circuit according to the microcontroller pins. Thirdly, prepare the electronic components according to the circuit's schematics to build a speedometer's circuit. Fourthly, writing C language program according to the set requirements of pulse signal of the sensor and each register of microcontroller and input timing's requirements of LCD pin. The C program completes the acquisition of sensor pulse signal, deriving wheel speed pulse signal to acquire the racing's speed, and send it to the LCD to display. Finally, debugging and simulation the circuit to achieve the speed display.

2. Signal and traffic monitoring system design. In this part, designing and drawing of the circuit of signal system and road monitoring system were completed.

3. LCD display. Using a liquid crystal display the racing's speed by numerical, instead of the speedometer pointer to improve the visibility of the instrument system, which making the racer grasp the traveling condition of racing more quickly and accurately, improving the manipulation and operability t of racing. And avoid the use of multiple modules to show racing's driving conditions, which leading the racer cannot focus quickly, increasing the risk of driving. Owing to the use of liquid crystal display speed can not only display the racing's speed, other parameters of the racing be added to in the subsequent design, can be also displayed on the LCD monitor, so that riders acquire the racing's current driving situation at a glance.

4. The design and debug of the instrument system of the FSAE racing have been completed. And the experiments show that the hardware interface circuit of the instrument system is simple, reliable and functional. It meets the requirements of the racing car.

Acknowledgements

This paper was supported by Beijing Forestry University FASE racing project.

References

[1]. Jinsan Li, FSAE racing car layout design and optimization, Master Thesis, *South China University of Technology*, Guangzhou, China, 2011 (in Chinese).

[2]. Bang Qiao, The optimization of college student's Formular one racing frame structure based on the finite analysis, Master Thesis, *Henan University*, Henan, China, 2012 (in Chinese).

[3]. Zhao Cheng, A study on structure strength test of FSAE formula car frame, *Journal of Beijing Information Science and Technology University*, Vol. 28, June 2013, pp. 43-48 (in Chinese).

[4]. Liman Jiang, Structure dynamic characteristics analysis and optimization of FSAE racing's frame, Master Thesis, *Beijing Information Science and Technology University*, Beijing, China, 2012 (in Chinese).

[5]. Shaohua He, Racing car lightweight system methods and frame optimization, Master Thesis, *Guangdong University of Technology*, Guangdong, China, 2013 (in Chinese).

[6]. Qiang Zhao, Topology optimization of a formula SAE car frame, *Agricultural Equipment & Vehicle Engineering*, Vol. 7, 2011, pp. 33-39 (in Chinese).

[7]. Meiyan Liu, FSAE race car suspension performance simulation and analysis, Master Thesis, *Hunan University*, Changsha, China, 2008 (in Chinese).

[8]. Guofei Yu, Frame strength and stiffness calculation and analysis of FSAE racing based on finite element, *Journal of Xiamen University of Technology*, Vol. 17, December 2009, pp. 29-32 (in Chinese).

[9]. Jianyu Wu, Suspension design and optimization of Formula SAE racing car, Master Thesis, *South China University of Technology*, Guangzhou, China, 2011 (in Chinese).

[10]. Jun Wang, Design of double-wishbone independent suspension of FSAE racing car, *Agricultural Equipment and Vehicle Engineering*, Vol. 51, August 2013, pp. 17-19 (in Chinese).

[11]. Jianyu Wu, Optimization of double-wishbone independent suspension for FSAE racing car, *Machinery Design & Manufacture*, Vol. 10, October 2011, pp. 120-122 (in Chinese).

[12]. D. Robertson and G. Delagrammatikas, The suspension system of the 2009 cooper union FSAE vehicle: A comprehensive design review, *SAE International Journal Passenger Cars – Mechanical Systems*, Vol. 3, Issue 1, 2010, pp. 366-380.

[13]. Xing Wang, Study on the handling and stability of formula racing car, Master Thesis, *Guangdong University of Technology*, Guangdong, China, 2013 (in Chinese).

[14]. Wu Zhang, The research on FSAE racing car controllability and stability simulation, Master Thesis, *Hunan University*, Changsha, China, 2005 (in Chinese).

[15]. Tian Cai, Analysis and research on performance of FSAE racing car, Master Thesis, *Hunan University*, Changsha, China, 2006. (in Chinese).

[16]. Tongyang He, Design and manufacture of the engine intake system in the FSAE racing car of scut, *Academic Communication*, Vol. 11, 2012, pp. 20-23 (in Chinese).

[17]. W. Attard and H. Watson, Comparing the performance and limitations of a downsized formula SAE engine in normally aspirated, supercharged and

turbocharged modes, *SAE Technical Paper*, 2006, paper ID 2006-32-0072.
[18]. S. Wordley and J. Saunders, Aerodynamics for formula SAE: initial design and performance prediction, *SAE Technical Paper*, 2006, Paper ID 2006-01-0806.
[19]. D. Corrigan and G. McCullough, Evaluation of the suitability of a single-cylinder engine for use in FSAE, *SAE Technical Paper,* 2006, Paper ID 2006-32-0053.
[20]. J. Walkingshaw, S. McClintock, G. McCullough, C. McCartan, et al, Experimental validation of an FSAE engine model, *SAE Technical Paper*, 2008, Paper ID 2008-32-0079.
[21]. Giovanni Belingardi, Design of the impact attenuator for a formula student racing car: numerical simulation of the impact crash test, *Journal of the Serbian Society for Computational Mechanics*, Vol. 4, 2010, pp. 52-65.
[22]. Qiu Fang, Electronical and instrument settings and developping of FSAE racing, *Journal of Xiamen University of Technology*, Vol. 17, December 2009, pp. 33-37 (in Chinese).
[23]. H. Enomoto and Y. Miyazaki, Development of CFRP monocoque front impact attenuator for FSAE with VaRTM, *SAE Technical Paper*, 2007, Paper ID 2007-32-0120.
[24]. Guojun Zhao, Design and research of auto instrument panel based on SCM, *Mechatronics Engineering*, February 1996, pp. 12-15.
[25]. Yuezhen Fan, Fachao Jiang, and Enrong Mao, Design of driving training simulator speed table drive module, *Micro Computer Information*, 2007, pp. 264-272 (in Chinese).
[26]. Zhenghai Wang, Mao Tian, and Yuhao Wang, Channel-aware Bayesian model for reliable environmental monitoring sensor networks, *Journal of Communications*, Vol. 6, No. 5, 2011, pp. 355-359 (in Chinese).
[27]. N. N. Qadri, M. Fleury, M. Altaf and M. Ghanbari, Emergency video multi-path transfer over ad hoc wireless networks, *Journal of Communications*, Vol. 4, No. 5, 2009, pp. 329-338.
[28]. Luca Becchetti, Luca Filipponi, and Andrea Vitaletti, Privacy support in people-centric sensing, *Journal of Communications*, Vol. 7, No. 8, 2012, pp. 606-621.
[29]. Robert C. Qiu, Changchun Zhang, Zhen Hu, and Michael C. Wicks, Towards a large-scale cognitive radio network testbed: spectrum sensing, system architecture, and distributed sensing, *Journal of Communications*, Vol. 7, No. 7, 2012, pp. 552-566.
[30]. Bijan Kumar Debroy, Muhammad Sheikh Sadi, and Md. Al Imran, An efficient approach to select cluster head in wireless sensor networks, *Journal of Communications*, Vol. 6, No. 7, 2011, pp. 529-539.
[31]. Chunhua Zhang, Automotive electric and circuit, *People's Posts and Telecommunications Press*, 2003, pp. 139-153 (in Chinese).
[32]. Ning Lv, SCM speed measurement system, *Application Design*, September 2006, pp. 64-67 (in Chinese).
[33]. Guangxia Xu, Yu Liu, Yunpeng Xiao, and Yanbing Liu, A secure data transmission scheme for body sensor network, *Journal of Communications*, Vol. 8, No. 5, 2013, pp. 307-314 (in Chinese).
[34]. Xinghua Zhou, Teaching you how to learn AVR SCM C program design, *Beijing University of Aeronautics and Astronautics Press*, 2009, pp. 3-5 (in Chinese).
[35]. Enbo Shao, How to read automotive circuit diagram, *China Electronical Power Press*, 2005, pp. 63.
[36]. C. A. R. Hoare, Monitors: an operating system structuring concept, *Communications of the ACM*, Vol. 17, Issue 10, 1974, pp. 549-557.
[37]. Feng Zhao, Improvement of traffic monitoring system, *Electronic Measurement Technology*, February 2007, pp. 28-30 (in Chinese).