2011 International Conference on Mechatronic Science, Electric Engineering and Computer
August 19-22, 2011, Jilin, China

The application of CAN-bus technology in the vehicle

Shuqing Guo
College of Transportion-Engerring
Beihua university
Jilin,jilin city,China
e-mail: qingshuguo2008@163.com

***Abstract*—It is the application of Controller Area Network (CAN) that changed vehicle electrical system wiring and control mode, wiring harness and controller pin count were decreased, so the cost was reduced. The comparative method is applied in this paper base on traditional vehicle circuit and CAN-bus circuit. The result shows CAN-bus not only can improve reliability and control function, but reduced the costs and the car failure rate.**

Keywords-CAN-bus control;traditonal circuit; ABS electric control system

I. OVERVIEW OF CAN BUS TECHNOLOGY

As more and more electrical equipments are applicationed in automotive, automotive electrical system has formed a complex large system which is concentrated control in the cab. The electrical equipments are from engine control to the transmission system control, from the driving, braking, steering control to the safety assurance system and instrument alarm system, what is more, and all the effort to make comfort from power management. Moreover, with the development of ITS recently, the emergence of new electronic communication products, i.e. 3G, has put forward higher requirements in the car cabling interaction and information sharing.

It is analysised from the wiring perspective, most of the traditional electrical system uses a single point to point communication, which is lack of contact with each other, so that the wiring system will inevitably lead to large. According to statistics, cable lengths are up to 2000 meters and 1500 electrical nodes in the Luxury cars when traditional wiring were used. What's more, the figure was about growing 1 time per decade, thus the conflicts exacerbated between the thick wiring harness and the limited available space of a car. In terms of the efficiency or the costs of materials, the traditional wiring was not suitable for the car development.

It is analysed from the information sharing perspective, the modern classic control units are including the electronic fuel injection system, electronically controlled transmission, anti-lock braking system (ABS), anti-skid control system (ASR), exhaust gas recirculation control, cruise control and air conditioning systems. In order to meet real-time requirements of each subsystem, it is necessary to implement sharing of public data, engine speed, wheel speed, throttle pedal position etc. in the car.

However, each control unit on the requirements of real-time differs from data update rate and the control cycle. It requires the data exchange network based on the priority of competing models and has a high communication rate, CAN bus is designed to meet these requirements.

According to the specific models network can be configured different nodes, it forms a CAN network topology. The picture below shows a typical network topology CAN BUS.

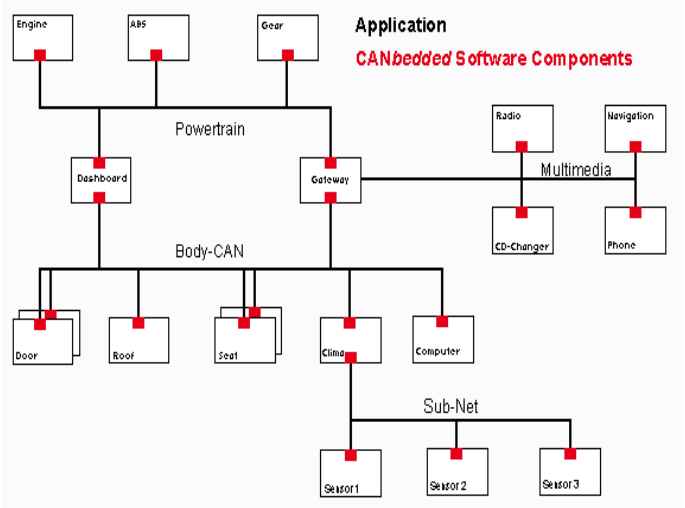


Figure 1 CAN-bus application

From what shows in the picture, the entire network segment is composed of three parts, namely, power system parts, body control part and the audio entertainment section. Usually, power system uses high-speed CAN communication and body control and audio entertainment system uses low-speed CAN communication. The high-speed CAN communication network usually refers to faster than 125Kbps, such as 250Kbps and 500Kbps. The high-speed CAN communication network usually refers to less than 125Kbps, such as 125Kbps, 64Kbps and 50Kbps etc. The above diagrams of the three parts are connected via a gateway which can achieve the exchange of information among different segments. With the rapid development of computer technology, network technology has already integrated with control engineering, namely, the bus which makes our imagination come true. Users can put the electronic control unit, which was produced by different company and been suitable for the bus standards, as a single entity. Therefore, an excellent performance control system can be founded.

CAN is a serial communication protocol. It has a communication rate of 5Kbps/10Km and 1Mbps/40m. The maximum numbers of CAN nodes can be up to 110. It has several transmission media such as twisted pair and

978-1-61284-722-1/11/$26.00 ©2011 IEEE

coaxial cable. CAN can receive data via point to point, multipoint, and global broadcast sending. CAN system is a no primary structure. In the system, each node can take the initiative to send a message and has the same position.

CAN bus uses differential voltage as a digital signal. There are two differential voltage states. When there are 2V presure between two lines, it is called the dominant state. However, when the bus line voltage is equal, it is called the recessive state. Obviously, there is as long as a node on the bus that sends dominant signal level, it will keep dominant. If it is being recessive, all nodes send recessive signal level. CAN protocol do not require 0 or 1 representatives dominant? But in the actual application, 0 generally represents the dominant position, 1 represents recessive.

CAN was consisted of four frame-the data frame, remote frame, error frame, and overload frame. CAN node has a function of automatic off. When the node detects the bus error state, an error frame will be sent to the bus. If a severe error happened, CAN node will cut off the connection with the bus automatically, so it would do not affect the bus work. When the node is busy and can not receive data, a load frame will be sent. Data link layer is generally used to control the error and overload frame sending.

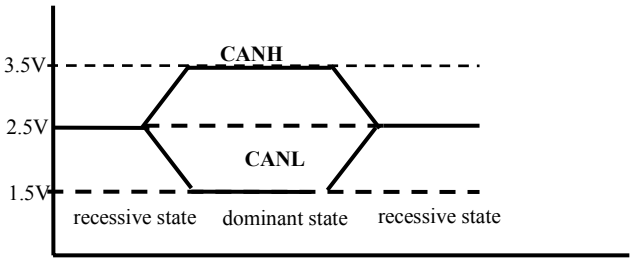


Figure 2 differential voltage and bus state in the CAN-bus

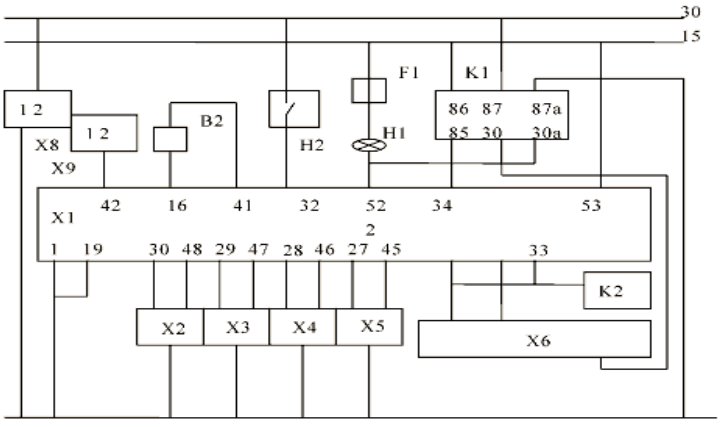
Idle CAN bus is stated at recessive, a dominant bit transition marks the beginning of a frame. Then all the nodes can start sending digital. Arbitration domain, which is mainly made up by the arbitration domain identifier and a RTR bits, sends the first. The frame is determined the priority of identification code, that used to compete for the bus arbitration; RTR bit indicates that the frame is a data frame or remote frame. Nodes that send dominant bit causes the bus to be dominant, and each node is received while sending. When a node sends a recessive bit, but the received bit is dominant. It was thought the node has a higher priority than other nodes which transmit bit at the same time. Then the node quit to sending and the high priority continues sending, so there is no loss of time. Therefore, So CAN bus can be achieved without delay arbitration priority and improve the real-time.

II. THE APPLICATION OF CAN-BUS TECHNOLOGY APPLIED IN ABS OF THE AUTOMOBILE CIRCUIT

A. CAN-bus controlled circuit

- Circuit wiring

  The traditional circuit wiring mainly based on the general principles of the circuit. According to each electrical equipment element position, each electrical equipment element is connected to form a complete circuit, the system can work normally. In the traditional ABS wiring harness, each component and control switch must be connected by the wires. With more electrical equipments and more complex control, circuit wire harness increase in root number in a corresponding, total length of wire is bound to increase and the number of connectors also will increase, so circuit in the car will lead to be more complex.



Figture 3 ABS control circuit

  It was known from the picture above, wiring were decreased greatly, the control is more reliable.

- Fuse

  The only way to improve safety measures in traditional car circuit, that is, when the electrical equipment and related components of a short circuit, the fuse wire fuse, so that the safety of electrical equipment is protected and even the vehicle. As the electrical equipment is generally parallel with the circuit, if the electrical equipment increases, slip also increased, the power configuration circuit increases. It makes the power configuration supply circuit wire root more numerous accelerated the circuit to be

complicated. Therefore, the singleton safety measures do not to adapt to rapid development of car industry.

- Control switch

  In the traditional car circuit, the switch is general connected in series in the circuit, the load electrical equipment (i.e., current) goes through the switch directly, then the ablation phenomenon may occur during switch turned on or off.

  The big electric currents were not needed directly when the switches were controlled by the hand, this causes switch's attrition aggravating. It not only must increase the black-white control in the circuitry, but also causes the wire radical to increase, the line becomes more complex.

- Electric equipment

  In traditional circuit electrical equipment, such as motor stall occurs and light type power, the value-added is not large, the wire can also occur due to the current increase and heat transfer, which aging wiring harness was resulted in . If there is no treatment for a long time without , it can make the wires short-circuit or even lead to disaster. The only security measure is passive safety, namely, fuse blown.

- ECU wiring

  After electronic control unit is installed in the car, the control unit were connected with input and output devices through number of wires (Figure 4 shows). If the control unit of different systems requires the same signal, multiple wires need be connected to the corresponding input element. So the root number of wires increases and the difficulty of wiring harness in the wiring harness are increasing, automotive circuits become more complex. At the same time, the appropriate signal processing system need add in the relevant control unit. The costs were improved. In the view of wiring, if CAN bus technology was applied, the net can be greatly optimized. The group of gateway system was shown in Figure5.

In terms of the number of car electronic control unit, if a data network is built by according to the traditional data transmission, it will be a huge one

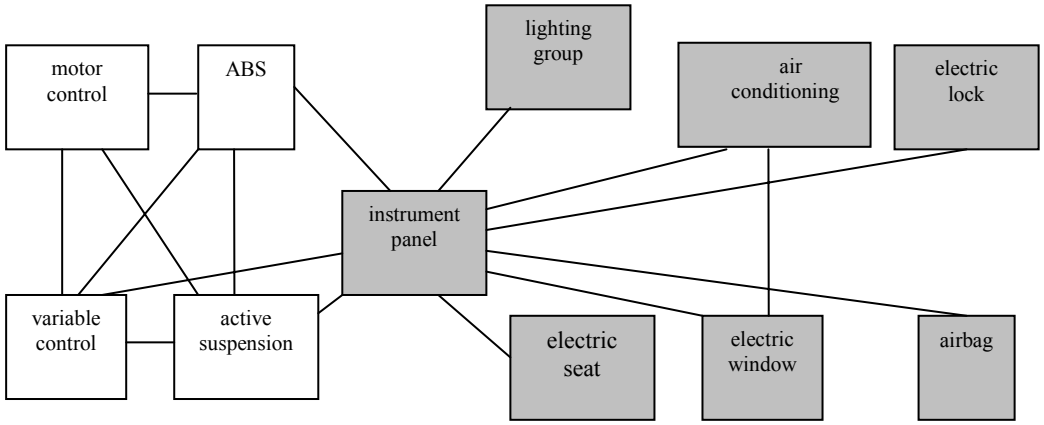


Figure 4 traditional vehicle routing net diagram

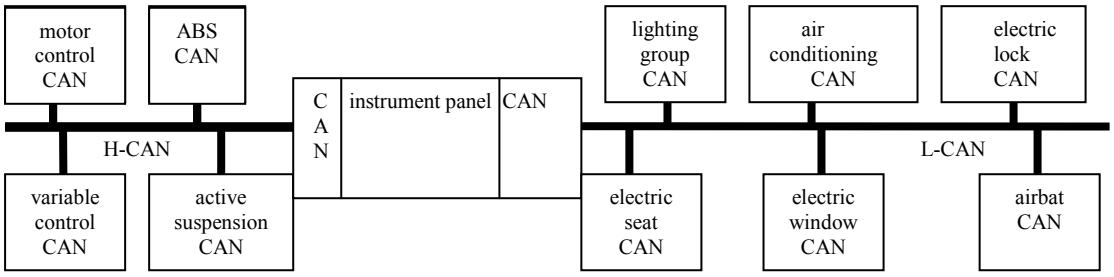


Figure 5 Automotive CAN-bus routing net diagram

III. EASE OF USE INFLUENCE OF CAN BUS TECHNOLOGIES ON TRADITIONAL VEHICLE CIRCUIT

A. Changes in power system configuration Changes in power system configuration

In the circuit of the car, the bus technology is used; the electric equipment is controlled by modular, so the using quantity and relay fuse are greatly reduced in the power system. If there is a fault diagnosis output function, 18 input (9 logic input, and 6 analog input and 3 pulses input, half or one bridge output and pulse width modulation output, load plug is very convenient, if some special requirements are needed, they need to increase a lighting devices in front of the car, we just need control to output terminal access at the unit of front lighting , the corresponding controlling switch as the dotted line showed, the input signals can be realized, as the figure 7 shows, its power wiring is not need to change. Visible, it is obvious that bus technology brings simply in the circuit of the car.

B. The sharing information between the control units

Figure 6, 7 shows that, after using a CAN bus technology, acquisition of the signal of each control unit realize CAN the information sharing. A sensor can be multiplexing, it don't have to repeat to set sensor and in the corresponding control unit to repeat and add signal processing system. That makes the circuit of the car simple. For example, getting the brake signal of automobile, engine, transmission, cruise system, ABS/EDL and so on, that these control units are getting on the brake from the data transmission lines, improving the system signal the utilization rate of and reducing design and production cost. In addition, because information communication is with each other, that can make the control parameters of the vehicle to control more fine for complete vehicle, That is extremely benefit for the improvement of the performance, and dramatically simplify and optimizing the car circuit

C. The role of components is changing

Different controlling units are used in the electrical equipment, As various control switches those control the electric equipment work or not are no longer in series circuit, but as a switch signals sent out, and through the input/output unit receiving, and then controlling the electric equipment work or not. Due to the decrease of the current switch work, the manufacturing cost of the switch is decreased, and also made the working durability to get bigger ascension.

D. The increasing service life of the components

It is also improving the service life of the components by using CAN bus in the car. Such as when electricity equipment load is increasing, the system can discover the problem in time and automatically make it out of work of the state, which is really active protection, and eliminating the only single fuses passive protection way, so the elements are effectively prevented to damage and prolong the service life of the components, avoiding the accidents.

IV. CONCLUSION

It holds enormous potential that bus technology is using for the optimization of the automobile and the whole performance vehicle controlling. It is a necessary developing direction of car circuit that the network controlling car circuit instead of traditional car circuit system. The network development of car circuit, causes the role of components to change in auto, and also causes enough attention,.

REFERENCES

[1] The automobile and automotive chip bus technology[M]. Beijing: The Institute press of Beijing University,2005

[2] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73. Weijun Yang. How to repair automotive vehicle network system[M]. Beijing: The Press of Mechanical Industry,2006

[3] Renyun Sun,Baixue Fu. Automotive electrical and electronic technology[M]. Beijing: The Press of Mechanical Industry,2007

[4] Cuirong,Qiu. The applications of bus technology in the automotive electrical system[J]. Beijing Vehicle, 2010.

[5] The match application on CAN bus technology in the electronic control diesel engine and ABS / ASR system[J]. Diesel engine design and manufacturing,2007