Gateway Node Design of Window Control System based on CAN / LIN Hybrid Network

Anyu Cheng, Bingyang Chen [a], Ting Chen

School of Automation, Chongqing University of Posts and Telecommunications, Chongqing 400065, China

[a]chenby@sumarte.com

Abstract

With the growing number of automotive network nodes, only the use of CAN network high cost, low reliability. In this paper, the CAN / LIN hybrid network is adopted to design the window node of the window control system for the real-time window nodes in the vehicle network. The hierarchical network control of the vehicle window nodes can be realized, which can reduce the vehicle communication cost and improve the vehicle communication cost. Real - time network communication. Finally, CANOE, a professional CAN analysis tool, tests the data processing and the window control function of the window gateway node, and obtains high performance index.

Keywords

Window Control ,CAN / LIN, Gateway.

1. Introduction

With the continuous development of intelligent automotive electronics, people on the car comfort and safety requirements began to improve. Bus technology as the direction of development of vehicles, can be a good alternative to traditional wiring harness, to achieve the electronic control of the car. As an important part of the vehicle comfort module, the automobile window is very important to realize the electronic control of the vehicle window. As a bus network with high communication speed, the control speed and update rate are relatively slow because of the manual operation of the windows. If all the communication is done by CAN bus, the communication cost is high and the network congestion will occur. The LIN is a switch, sensors and other equipment connected to the low-cost network, as a vehicle bus, can be applied to lights, windows, mirrors and other communication speed and reliability is not high occasions, while LIN Bus low cost, and only one line to achieve the control of the windows, no special controller, the network is simple.

Considering the communication load, communication speed and real-time, this paper adopts CAN / LIN hybrid network to realize the networked control of the window, which not only solves the huge problem of traditional control harness, but also reduces the control cost [1].

2. Window Control System overall Structure Design

The system includes a gateway node and four slave nodes, the gateway node through the CAN bus and CAN network connection, through the LIN bus and four slave nodes connected. The overall structure of the window control system shown in Fig. 1. When the gateway node receives the window control command on the CAN bus, the gateway node is awakened, and then the gateway node to wake up the entire LIN sub-network, through the LIN bus control instructions will be forwarded to the corresponding window LIN nodes to achieve the control of the window . At the same time, each LIN

node returns the real-time status of the window to the gateway node. The gateway node feeds back the status of each window to the CAN network, and realizes the status of each window for fault diagnosis and instrument display. The entire network, LIN bus as a CAN bus auxiliary network, combined with the CAN bus to form a hierarchical network of vehicles [2-3].

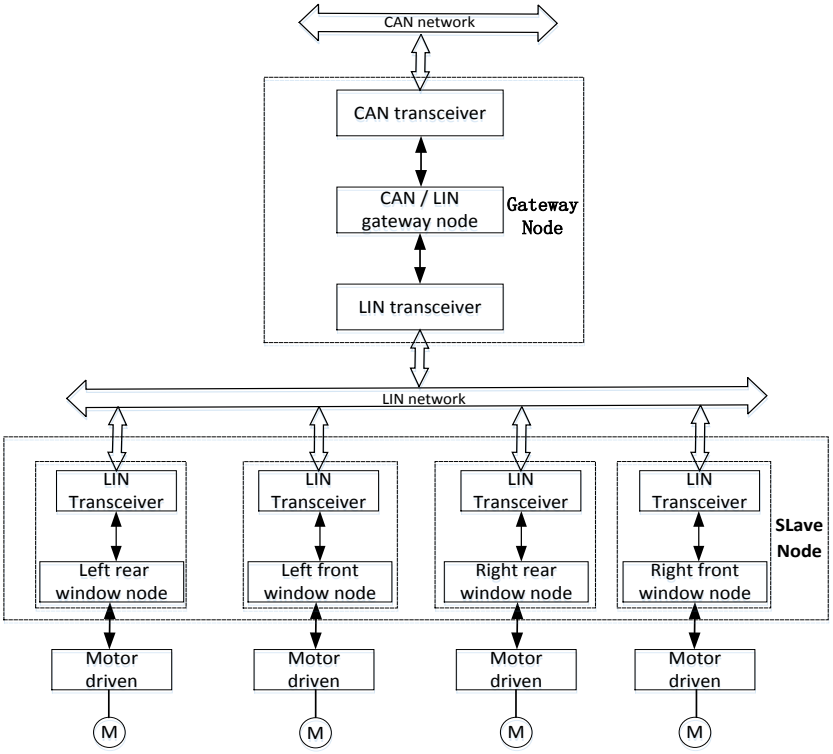

Fig. 1 The overall structure of the window control system

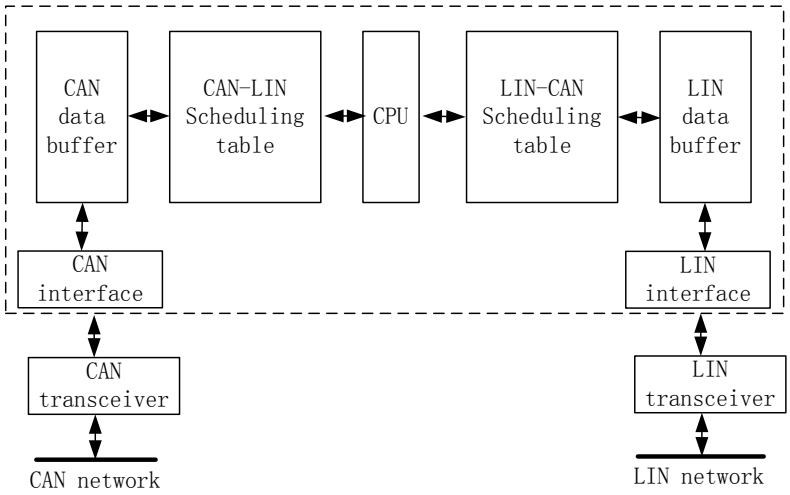

Fig. 2 Window controller CAN / LIN gateway model

3. CAN / LIN Network Design

3.1 CAN / LIN Gateway Model

The CAN / LIN gateway node is both a node in the CAN network and a master node in the LIN network. CAN / LIN network node from the role of the entire network positioning can be seen, CAN / LIN network node is the main task of CAN / LIN packet conversion.

CAN bus and LIN bus are two very different protocols, to achieve the transfer of information between the two, you need through the CAN / LIN gateway to the two protocols conversion. The specific work

flow is as follows: The source network node sends the packet to the gateway interface. After filtering the packet, the gateway stores the data in the corresponding data buffer. When the gateway node is idle, the network packet is converted according to the network schedule. Processing, at the same time will need to forward the data through the gateway interface to send to the target node in the network.

The window controller gateway model is shown in Fig. 2.

3.2 Window Control System Network Topology

Window control system The CAN / LIN hybrid network consists of a gateway node and four window nodes. Gateway node to achieve CAN / LIN protocol conversion, to achieve the message forwarding function. Each window LIN node realizes the control of the window and feedbacks the state information of the window at the same time. Which CAN network communication rate of 250kb / s, LIN network communication rate of 20kb / s. Network topology shown in Fig.3.

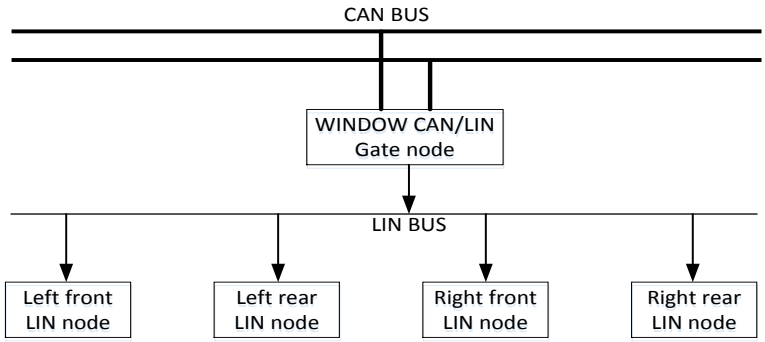

Fig. 3 Windows CAN / LIN gateway topology

3.3 CAN / LIN Message Frame Format

CAN protocol and LIN are very different, the agreement of the message identifier and frame format are very different definitions. To realize the protocol conversion, it is necessary to split the ID and message data of the CAN and LIN message frames and then reassemble the new message to the destination node. In this paper, the window control system is designed as a gateway node and four slave nodes [4-5]. It is assumed that the gateway node is 0x01 and the other four windows are respectively 0x03, 0x04, 0x05 and 0x06. Here, the first 6 bytes of the first byte of the CAN network message frame are used as the identifiers in the frame format of the LIN network message, and the other bytes are filled in the packets in the original order. According to the conversion rules to define CAN network message frame format shown in Table 1.

Table 1. CAN network message frame format

Symbol	Priority	Source Address	Target Address	Byte Length	Data byte		
					1(LIN Identifier)	2	3
LFL_CAN	0x01	0x02	0x01	8	0x03	0x01	0xFF
LRL_CAN	0x01	0x02	0x01	8	0x04	0x10	0xFF
RFL_CAN	0x01	0x02	0x01	8	0x05	0x11	0xFF
RRL_CAN	0x01	0x02	0x01	8	0x06	0x10	0xFF

The LIN network sends information to the gateway node. The first byte of the LIN message frame is used to store the CAN / LIN gateway address. The other bytes of the data are filled into the message in the same order. When the gateway node receives the window sub-node sent the message, the first LIN message contains the destination address byte is extracted, by comparing the resolution of which window nodes to send the status information. And then encapsulates the data information carried in the message into a CAN message, and sends the data message to the 0x02 node through the CAN bus for

data display and fault diagnosis. In accordance with the above processing, the definition of LIN message frame format shown in Table 2.

Table 2. LIN network message frame format

Symbol	Synchronization frame	ID field	Data byte		
			1(Target Address)	2	3
LFL_LIN	0x55	0x03	0x02	0x00	0xFF
LRL_ LIN	0x55	0x04	0x02	0x03	0xFF
RFL_ LIN	0x55	0x05	0x02	0x20	0xFF
RRL_ LIN	0x55	0x06	0x02	0x30	0xFF

4. CAN / LIN Protocol Conversion

4.1 LIN to CAN software design

After the LIN node sends a LIN message, it enters the LIN data buffer of the gateway node. When the gateway status is idle, it can directly read the destination address of the LIN message frame. If the destination address is changed from LIN to CAN In this paper, the destination address and data of the LIN packet are extracted and encapsulated into a CAN message according to the LIN to CAN message scheduling table, and then sent to the CAN network target node[6]. This window LIN node through the CAN / LIN gateway node protocol conversion, the formation of a virtual CAN node, CAN network through the body can read the status of the window information and fault information. LIN transfer CAN software flow chart shown in Figure 4.

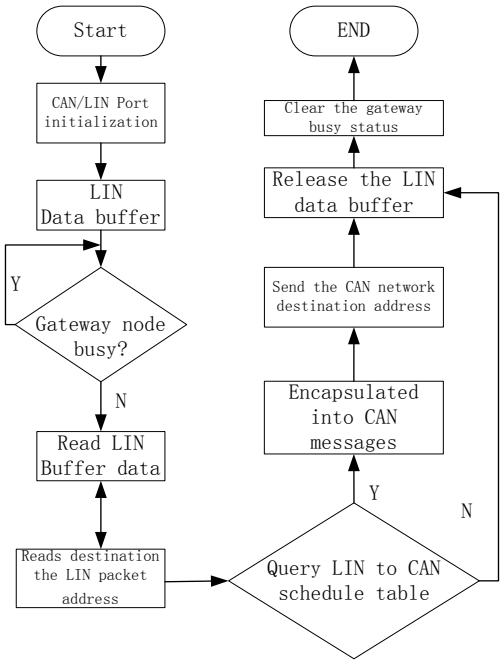

Fig.4 LIN transfer CAN software flow chart

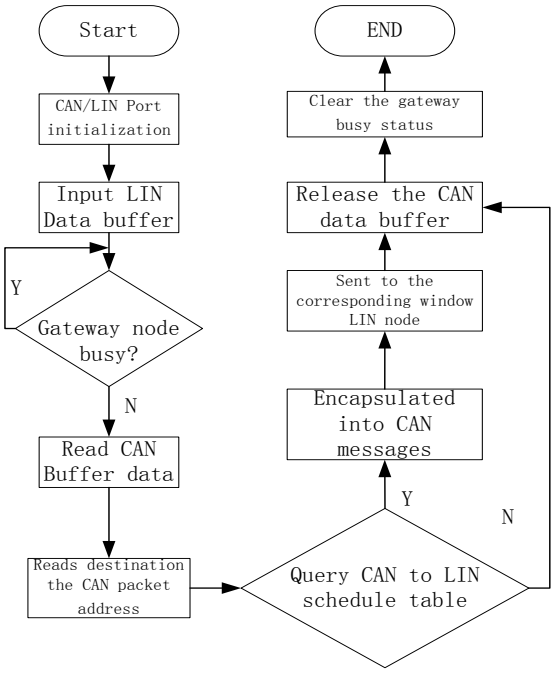

Fig. 5 CAN transfer LIN software flow chart

4.2 CAN to LIN software design

Protocol conversion is bidirectional, when the vehicle CAN network window control command issued, the instructions into the gateway node CAN data buffer. When the gateway status is idle, CAN data from the CAN data buffer to read the data, and then from the CAN to LIN packet scheduling table for the CAN message for the existence of ID, and then determine whether the CAN data LIN reported Text conversion [7]. After clearing the gateway busy state after converting to LIN message, the CAN data buffer is released, and the conversion of CAN message to LIN message ends.

5. Tests of Gateway Node

In order to verify the correctness of the gateway data conversion, the test with the help of CANOE bus testing tool designed for the gateway function test. By building a single CAN network window control system, each node communication rate of 250kb / s, and the design of CAN / LIN hybrid network, CAN bus communication rate of 250kb, LIN bus communication rate of 20kb / s (Figure 3) comparing. The average utilization rate of the single CAN network communication bus is 29.98%, as shown in Fig. 6; the average utilization rate of communication bus of CAN / LIN hybrid network is reduced to 16.27%. From the experimental data can be seen using the CAN / LIN hybrid network window control system to achieve the window control while effectively reducing the network traffic load rate.

Statistic	Current ...	Min	Max	Avg
Busload [%]	30.00	29.91	30.00	29.98
Min. Send Dist. [ms]	3.500	n/a	n/a	n/a
Burst Time [ms]	-	-	-	-
Bursts [total]	0	n/a	n/a	n/a
Frames per Burst	-	-	-	-
Std. Data [fr/s]	200	199	200	200
Std. Data [total]	1165	n/a	n/a	n/a

Fig. 6 A single CAN network communication load rate

Statistic	Current ...	Min	Max	Avg
Busload [%]	16.65	14.88	16.65	16.27
Min. Send Dist. [ms]	0.000	n/a	n/a	n/a
Bursts [total]	345	n/a	n/a	n/a
Burst Time [ms]	0.000	2.184	3.564	2.705
Frames per Burst	0	2	4	3
Std. Data [fr/s]	124	99	124	119
Std. Data [total]	3849	n/a	n/a	n/a

Fig.7 CAN / LIN hybrid network communication load rate

And then the window sub-nodes through the LIN bus control command to achieve the window up and down functions, the test results shown in Fig.8.

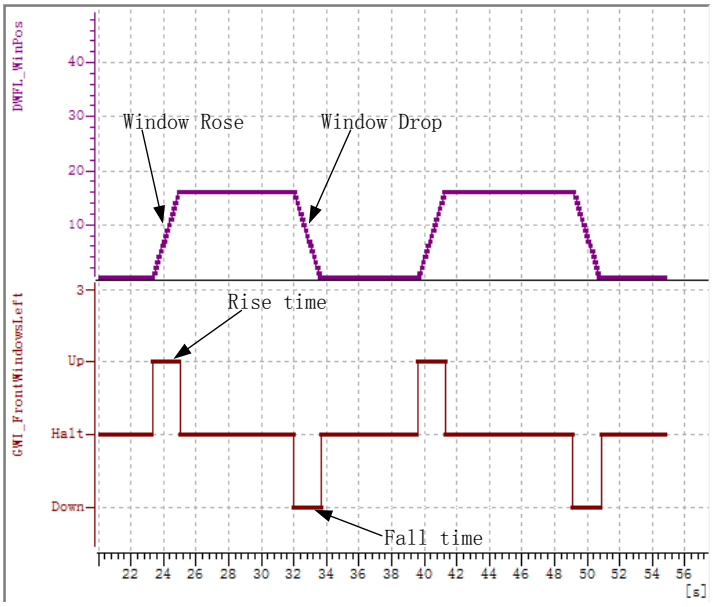

Fig. 8 Test results of the window lift process

Through the gateway test data can be seen that the contents of the CAN message sent after the conversion and the LIN message data, and the lift operation of the window is the same, that is to say, The CAN / LIN hybrid network control of the window is realized.

6. Conclusion

In this paper, the window bus CAN / LIN hybrid network control scheme is designed in view of the high control cost of the window bus. Through the CAN / LIN layered network structure to solve the traditional bus-type wiring difficulties, poor electromagnetic compatibility, and effectively reduce the vehicle cost of the vehicle. In this paper, CAN / LIN protocol data processing and forwarding process of gateway node is introduced in detail. CAN / LIN gateway design can realize the sharing and interaction of CAN nodes. At the end of this paper, the design of the window gateway node through the CANOE data test to verify the design of the window CAN / LIN gateway rationality in the realization of window control at the same time, reducing the network traffic load ratio, effectively avoid the network The nodes increase the network congestion caused by the problem, the practice has proved that the gateway node has a good application prospects.

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