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Hardware Software Codesign for Bus Monitoring System

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Abstract-presently, public traffic system mainly depends on driver's manual operation, which will inevitably encounter many problems such as punctuality of the bus's arrival on bus station. Paper proposes a supervisory system based on GPRS and ZigBee technology, to improve the operation efficiency of bus monitoring system and realize intelligent transportation system. Paper introduces the bus monitoring system from the aspect of both hardware design and software design, System takes it into accounts for the respective advantages and disadvantages of GPRS and ZigBee, and designs a feasible solution successfully, of practically significant.

Index Terms- ZigBee; GPRS; bus monitoring system; hardware design; software design.

1. INTRODUCTION

Buses are provided by the government as a public service, quality of which will directly determine the convenience of public travel. It is an important criterion for qualify of service standards that bus reaches the station on time and reports which station it is located accurately. Presently at the original station and terminal station, punctuality cannot be guaranted because of dedicated staffs on duty there. However, for most of the middle stations, punctuality cannot be guaranted and also, it is difficult to be assessed. It might be a good idea using the GPRS system for monitoring the bus when moving, but to expand the scope of GPRS usage is actually difficult due to the high cost of GPRS system. For the time being, reporting bus station is to rely on driver's manual operation, so making a mistake and misleading passengers is inevitable when driving the bus. To solve that, paper provides a solution; it develops a system of bus monitoring and management based on ZigBee and GPRS technology. ZigBee wireless communication technology is an emerging technology with low power, low data- rate, low cost, low-complexity [1]. GPRS is short for General Packet Radio-Service; GPRS uses packet switching technology, especially suitable for intermitted, sudden and frequent, small amounts of data transfer [2]. The system paper designed bases on a combination of ZigBee technology and GPRS technology will play a good effect from many aspects.

2. SYSTEM STRUCTURE ANALYSIS

To monitor the moving bus, the firstly important solution of that is to detect the time of every bus's arrival on station in time. After that, the information shall be sent to the monitoring center. According to the information, evaluation of driving process will be helpful for improving the punctuality of bus's arrival on each middle station and for improving service quality. System will be designed based on the characteristics of ZigBee network technology and GPRS network technology respectively, to solve the problem of monitoring the time of bus's arrival on and leaving station and the problem of automatically reporting bus station accurately. to be specific, one station monitor shall be set on each station and for every bus, one wireless identification device with ZigBee network function shall be put in it. The station monitor contains ZigBee network coordinator and GPRS module [2][3]. On the one hand, the station monitor receives signal sent by wireless identification device from bus, detects the bus's identification number and identifies which bus comes up to station; then the station monitor sends the information of bus's arrival time and identification number to monitoring center through the GPRS network. On the other hand, the station monitor sends its own station identification number to the bus coming up clear, and thus the bus reports bus station information according to the station identification number. Since each station and each bus has its own identification number, no error will occur. Since then, the station monitor continuously detects the intensity of wireless signal sent from that bus. If the signal intensity decreases to a certain extent, we consider the situation as that the car has left this station, and then the station monitor will send information to monitoring center. Thus, the monitoring center could accurately grasp the operation of each bus to assess the punctuality. Low-cost is one of the ZigBee technology's characteristics, besides that the cost of wireless identification device installed on bus is also very low; and the number of

station monitor is much less, the overall cost of this system will be quite low. Figure 1 presents the structure of bus monitoring system based on ZigBee and GPRS. As it shows, the system consists of three parts: Monitoring center, ZigBee coordinator-station Monitor, Device-wireless Terminal or wireless Identification Device [3].

3. HARDWARE DESIGN

As mentioned before, the system consists of monitoring center, station monitor and wireless identification device. The following describes hardware structure and the corresponding implementations of the system design process.

3.1. Station Monitor

The structural framework is shown in figure 2, the station monitor consists of MCU, GPRS module, ZigBee transceiver and so on. Station monitor chooses free scale's MC9S08GB60 as MCU, free scale's MC13192 as ZigBee transceiver and Motorola's G20 as GPRS module. The resources required for ZigBee coordinator to support multiple connections of ZigBee devices might be relatively more; however, the number of ZigBee devices that establish connection with ZigBee coordinator at the same time will not be large, less demanding on the network layer functions of ZigBee network. So MCU using 8bit is enough and MC9S08GB60 is component [4] [5].

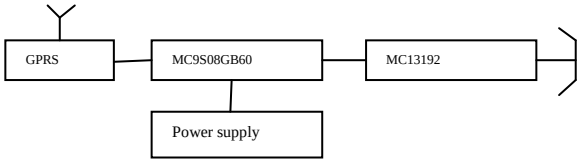

Fig. 2. The structure framework of station Monitor

Figure 3 presents the application framework structure of MC13192 connected with MCU-MC9S08GB60.

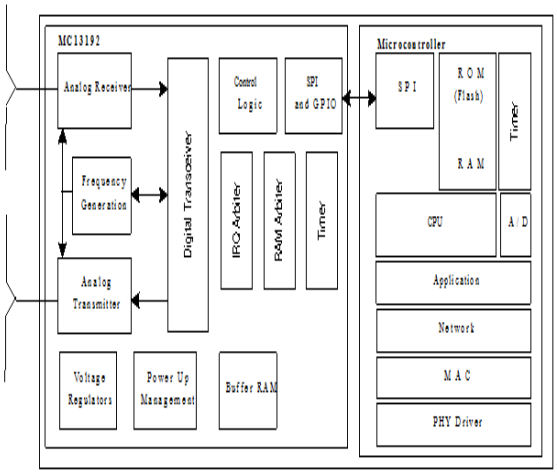

Figure 2. System Level Block Diagram

Fig. 3. The structure framework of station Monitor

3.2. Wireless Identification Device

As it shown in figure 4, the wireless identification device contains free scale's MC90S08GT60 and MC13192 to be a basic ZigBee device. The MCU internal Flash memory of Free scale, can be used as program memory, also to save data. Therefore, it is suitable for writing the unique identification number of each device while initialization, eliminating the need for an external non-volatile memory. Then the overall structure will be simplified; the cost will decreased. The structure of MC90S08GT60 is very similar to that of MC9s08GB60; to know more information, refer to figure 3.

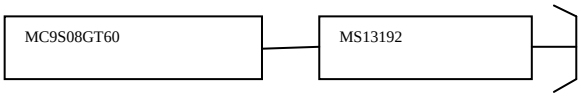

Fig. 4. The structure of wireless identification device

3.3. Monitoring Center

Monitoring center contains data center, client, router and physical line hardware; the structure of monitoring center is designed in distributed form, referring to figure 1 for more details of monitoring center. Data center consists of four parts: GPRS communication server, monitoring and management server, SQL data server and WEB server. Data center is responsible for receiving the data collected and transmitted by station monitor. When received the data, data center will restore data according to the data transmitting format and store data in database of data server [5].

Actually, the monitoring center internal forms a local area net; any computer in this LAN can visit the current real-time data to some special communicating rules and observer the archive historical data of station monitor.

4. SOFTWARE DESIGN

Software design includes application software design and ZigBee protocol software design. Station monitor itself is a Zig Bee network coordinator, plus GPRS module. After power-on, the MCU of station monitor first initializes GPRS module and ZigBee protocol stack. The next step for MCU is to scan the channel and assess the idle channel. According to the analysis of channel state, MCU will select appropriate operating channels and select the right network identifier. Then KCU starts the ZigBee network and sends data frames up to network, waiting for the connection request from some one ZigBee device. If MCU has received one message of connection request, it will certify whether the ZigBee device is legal. If yes, MCU can now issue a command to allow

ZigBee device connecting with it and establish connection.

When connection established, station monitor will obtain the information of ZigBee device's identification number which is on behalf of one bus where the ZigBee device is installed. MCU will register the identification number and at the same time, send one message about what time the bus will arrive in this bus station. Station monitor can connect with not just only one ZigBee device one time, so will it with information registration.

During the time that the bus is leaving bus station, the special signal intensity will decrease continuously. If the signal intensity decreases to some degree, the connection between bus and station monitor will automatically be eliminated. And corresponding, the information of identification number in registration table will be removed. Then the MOU of station monitor send one message that the bus has left the bus station. The work flow of station monitor is shown in figure 1-a.

For ZigBee device-wireless identification device, which is installed on bus, it first initializes the ZigBee protocol stack after Power-on. Then wireless identification device starts scanning the channel to find the nearest ZigBee coordinator. When it detects the data frames sent from ZigBee network coordinator and meanwhile, wireless identification device sends one message of establishing connection request if the signal intensity is stronger than a certain degree. Once connection is established, the wireless identification device will obtain the identification number of ZigBee coordinator, and be aware of which station the bus is located; so the bus can report bus station information according to the station identification number, to achieve the purpose of automatically and accurately reporting station.

Fig.1. The structure framework of station Monitor When the bus is leaving the bus station, the special signal intensity will decrease continuously. If the signal intensity decreases to some degree, wireless identification device will send one message when the bus is leaving the bus station, the special signal intensity will decrease continuously. If the signal intensity decreases to some degree, wireless identification device will send one message of request for disconnecting the network which it has joined and, the connection will be eliminated. The Workflow of station monitor is shown in figure 1-b.

Acknowledgment The application of GPRS and ZigBee Technology to the bus monitoring system can solve many problems. In this way, bus service quality and operational efficiency will improved a lot. So the solution can play a great effect, of practically significant. GPRS technology and ZigBee technology used in the system can implement their respective advantages and disadvantages such kind of system model is also suitable for many other applications of industrial site.

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