A Design Mode of Streaming Media Transmission and Access in Wireless Video Sensor Network

Mengxi Xu, Chenrong Huang, Shengnan Zheng and Jianqiang Shi

Abstract Wireless video sensor network, acquired by urban road traffic flow information, is composed of several sensor network nodes with traffic flow information video detection, process and wireless communication capacity. Wireless digital camera sensor network cooperatively senses the traffic flow information (traffic flow, vehicle length, vehicle type, etc.) in each location by the means of each node. Network nodes transfer data to information convergence nodes (base station, SINK) by wireless multi-hop relaying mode. Meanwhile, adopting 2.4 G wireless communication, the convergence nodes analyze traffic flow video detection information and converge into MAN/WAN, Gigabit Ethernet, and the control center can do the query, record and other operations by reverse IPTV (interactive network television). This paper focuses on a design mode of streaming transmission and access application in wireless video sensor network.

Keywords Multimedia sensor network · Streaming media · Image communication · Intelligent traffic

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1 Introduction

Logical information world is fused with real physical world by wireless sensor network, which deeply changes the interaction mode between human beings and natural. At abroad, WSN (Wireless Sensor Network) is originated from military application. From year 2002, WSN has been applied in environment, agriculture etc. and now it is expanded into monitoring, location and tracking, and environment sensor oriented intelligent computation in industry, electricity power, construction, intelligent traffic and so on. At present, one of the important aspects of WSN research is how to introduce image, audio, video and other media with abundant information into detection activities based on sensor network. Therefore, multimedia sensor network emerges as the time requires [1].

Recently, the research for multimedia sensor network technology has attracted scientific researchers. Some scholars do the exploratory researches on multimedia sensor network, meanwhile, they proposed some important research results in IEEE conferences (such as MASS, ICIP, WirelessCOM), ACM multimedia and sensor network conferences (such as ACM Multimedia, ACM MOBICOM, ACM WSNA). From year 2003, ACM specially organizes international video monitoring and sensor network seminar for communicating research results. University of California, Carnegie Mellon University, University of Massachusetts etc. has researched multimedia sensor network and set up video sensor network groups beginning with corresponding scientific plans. Meanwhile, domestic scholars also pay much attention to multimedia sensor network research.

In the research of multimedia sensor network, since the limitation of network resources, streaming media data need not to be transmitted in network in many applications, critical semantic information is abstracted to transmit by analyzing audio and video streaming data. Therefore, in one hand, the transmission burden of network is reduced, while the working lifetime can be extended, in the other hand, processing ability of nodes can be completely utilized to improve distribution of multimedia information processing in the whole system, which eases the burden of converging nodes, and improve the information processing rate of the whole system. Thus, intelligent multimedia information processing technology has an important affect for reducing network consumption, and improving the monitoring performance and quality. Two factors in intelligent multimedia information processing technology of multimedia sensor network need to be considered. One of the factors is complexity degree of processing, for the computational ability of multimedia sensor nodes is limited, it is not suitable for much complex processing technology; the other factor is the characteristics and application requirements of multimedia sensor network, traditional multimedia information processing technology needs to be improved to adapt multimedia sensor network.

In intelligent traffic application, traffic flow information includes: traffic flow, vehicle length classification, motorcade length, time occupied rate, space occupied rate, headstock distance, instant velocity, average velocity of time, average velocity of space and so on. Earlier traffic flow information detection mainly relied on labour

count and investigation table, such as touch-tone labour count and inhabitant trip investigation table, which are still practical until now. In the end of the 1980', the detection technology of microwave radar, video image and light beacon began to be developed and utilized [2, 3].

Traffic flow video detection technology based on computer vision can take the place of traditional detectors and supply more status parameters of vehicles and traffic flow which can not be completed by other detectors. Traffic flow video detection technology is the key point researched both at home and abroad, which provides an effective method of traffic flow information acquisition for the development and practice of advanced traffic flow control system and intelligent vehicle system. The advantages of video detectors are: can be easily set up, can not damage the road surface, can not affect the traffic when constructing, can detect in a large area, the installation of the camera are convenient, flexible and easily maintained. The disadvantage is that it is limited by environmental factors such as image processing algorithm, atmosphere, light and shade. With the development of CCD technology and computer vision technology, video detectors can acquire large traffic flow information, which has a development potential.

Real-time traffic flow information acquisition is one of the weakest links in intelligent vehicle systems (IVHS) and advanced traffic management systems (ATMS). Present traffic flow detectors are insufficient in information acquisition, communication and reliability. With the development of CCD technology, computer vision and information processing technology, it can be fixed by wireless video detection. Wireless video detection has the abilities of more layout and wireless detection, meanwhile, it can acquire important traffic flow parameters of vehicle density, queue scale and park times, vehicle size which can hardly achieved by routine detectors. The development tendency of wireless video detection technology has an obvious advantages, good perspectiveness, and can represent the development tendency of traffic information detectors [4–7].

Wireless video detection technology occupies an important position in modern traffic systems, which is the development foundation of future intelligent vehicle systems. However, the present problems are low real-time, high error rate in image processing, and the detection accuracy is limited by software/hardware of the entire system. For utilizing the video image to acquire the complexity of the traffic flow information, wireless video detection technology is still continuously improved. Nevertheless, with the development of computer vision, image processing technology and microelectronics technology, wireless video detection technology needs to be continuously improved and widely applied.

2 Overall Design of Wireless Video Sensor Networks

Wireless video sensor network acquired by urban road traffic flow information is composed of several sensor network nodes with traffic flow information video detection, processing and wireless communication capacity. Wireless digital camera sensor

network senses local traffic flow information (vehicle flow, vehicle velocity, vehicle length, vehicle types and so on) by the distributions of each node, while network nodes transmit data to information convergence nodes (base station, SINK) by wireless multiple hop relay. By 2.4 G wireless communication, traffic flow video detection information is analyzed by convergence nodes and converged to MAN/WAN and Gigabit Ethernet. Thus, master control center can do the query, record and other operations according to reversal IPTV. The architecture of wireless video sensor network acquired by traffic flow information is shown in Fig. 1.

The wireless video sensor network acquired by traffic flow information can realize IP broadband accessing network in the core of microwave transmission technology, networking conveniently, without excavating roads to interrupt traffic, which can achieve detection and management sharing the same wireless broadband network, being compatible with wired IP network and optical fiber, supporting multi-layer management integration, easily expanding intelligent wireless video system, and supporting one level to multilevel control center. Meanwhile, it can make each center detect multi-section multi video flows, call multi video flows of each section to conduct by grading and separation of powers. At the same time, it can operate safely and steadily in a large area, and easily maintain.

3 Data Management Mode of Wireless Video Sensor Network

The Data management mode of wireless video sensor network acquired by urban road traffic flow information is mainly supported by protocol design. The system protocol design adopts the frame of Fig. 2, and the sensor nodes use improved protocol based

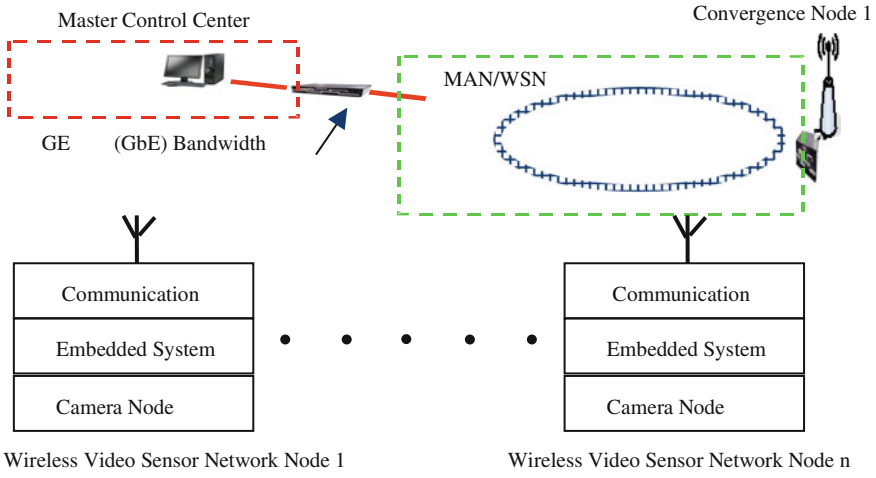

Fig. 1 The architecture of wireless video sensor network acquired by traffic flow information

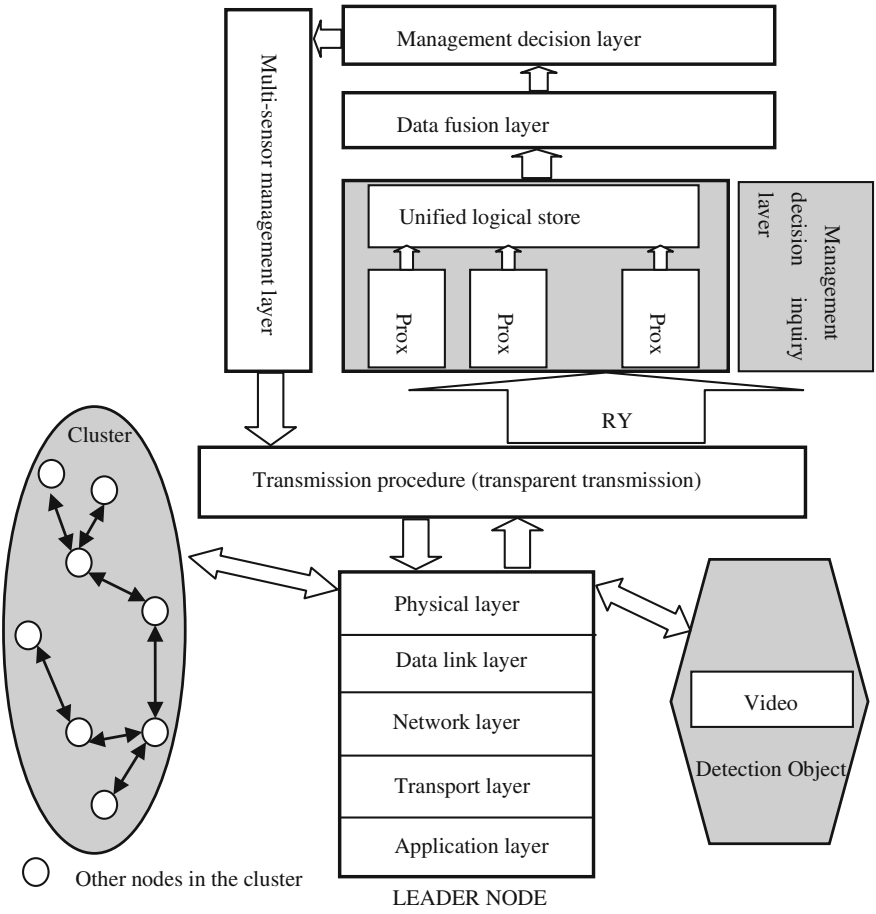

Fig. 2 Protocol design frame of the system

on cluster. The cluster LEADER includes application layer, transport layer, network layer, data link layer and physical layer. The cluster LEADER node comprises self-organizing network with other nodes in the cluster, meanwhile, the communication with communication infrastructure is in a transparent status [8–10].

Above the transparent procedure, they are mainly responsible for the data inquiry management, fusion, decision making, and management for each parameter of the sensor nodes in the detection area according to the decision making. Data inquiry and management layer is divided into normalization logical storage and each inquiry agent according to specific division of labor, and they transfer users' inquiry commands to nodes by normalization, where they obtain needed information. After that, information got from the data fusion layer is fused in accordance with decision making, then, the results are delivered to management decision making layer.

Multi-sensor management layer configures each parameter of the sensors in each area judging by the results and the requirements of the decision making in order to satisfy the next detection demands. Meanwhile, the commands are delivered to LEADER node by transmission network, and executed in the cluster based on specific situations [10, 11].

4 Streaming Media Transmission and Access Applications in Wireless Video Sensor Network

The design and realization of the hardware system of the traffic flow video detection node based on wireless sensor network and wireless streaming media technology adopt the self-design platform combing high-end ARM embedded system with programmable logic device FPGA (field programmable gate array). Using 2.4 G wireless communication, high-end ARM embedded system designs three functions:

A. Control function: it controls video image data acquisition unit, which includes initializing set up of acquisition, the choice and adjustment of the characteristic parameters in the acquisition procedure, the streaming rates in the acquisition procedure and so on.

B. Data exchange function: After successfully gathering the image data of the video image data acquisition unit, CPU provides data exchange function. The high speed read characterized by DMA (Direct Memory Access) reduces the participation of the CPU to the lowest level, which makes the read to the image data no longer need to occupy the resources of the CPU.

C. Data processing function: it is used to non-DSP related IP network processing, which provides IP communication related processing capacity and function. Its performance is to effectively and rapidly process network related affairs, which provides IP exchange conditions for digital camera hardware system.

The programmable logic device FPGA platform can achieve the function, that is, the quick channel of the high-speed image acquisition system unit and CPU need to be built. At present, there is no IC chip of no glue logic interface technique at home and abroad, the interface based on FPGA can be effectively set up, while the high-speed image acquisition system unit and CPU can be established. Such data channel concludes two main data flow: first, it is the data flow after image acquisition with black and white, color information, related timing signal and so on. Second, it is working status information of CPU control data and image acquisition sub-system, which reduces unnecessary soft processing work of CPU, and makes system work more effectively and fast. Third, FPGA platform can process data and connect with ARM effectively.

The design and realization of wireless sensor network streaming media transmission and access adopts three-level system structure. Where, multi-capacity IP broadband multichannel video network in the core of wireless sensor network and wireless transmission technology are researched and realized, while the networking

is convenient, monitoring and management are sharing the same wireless broadband network. The three-level structure is as following: no wired work of intelligent compound-eye digital camera system and the fusion of wireless detection sensor are the first level, the design and realization of wireless network bridge is the second level, which achieves wireless connection of multimedia data flow, interconnection with one or multi-block roads, where the data can be transferred, command instructions are unobstructed. The IP access technology is the third level, which is compatible with wired IP network and optical fiber, and it supports multi-layer management integration and achieves easily extended intelligent wireless video system, meanwhile, it supports one-level to multi-level control centre which can detect multi-channel multi video flow, and transfer multi-channel video flow of each channel in order to realize grading and separation of powers, and run safely and steadily in a large area to meet the requirement of easily maintain [3, 12, 13].

In the view of wireless communication, the design used in this paper adopts up-to-date international standard IEEE802.11n and related compatible standard (Backward Compatible IEEE802.11b/g) to realize the second and the third level wireless communication, meanwhile, according to the domestic actual condition, streaming media transportation uses IP protocol (TCP/IP, UDP/RTP/RTCP, etc.) by improving and choosing WiMAX standard. In the design of the base station, the open system structure is used as main structure, and the compatibility with the current system is emphasized to achieve smooth transition and system improvement. The design and the realization of the system adopt the advanced technology that is researched by ourselves, which provides advantages for preliminary design work, and effective platform for sustainable development of media and long term design work.

5 Conclusion

With the development of micro electronics, computer vision and image processing technology, as a traffic flow information acquisition method with development potential, video detection can acquire traffic flow information such as traffic flow, vehicle length classification, time occupied rate, space occupied rate, headstock distance, comparing to other detection methods such as induction coils, ultrasound, microwave, infrared and laser.

This paper introduces recently new developing wireless multimedia sensor network technology, carries out key technology researches of video detector with new large field of view, illumination adaptive well, real-time, high detection rate and easy to install and deploy. Meanwhile, it proposes a design mode of streaming media transmission and access application in wireless video sensor network, which provides a guide and reference for solving traffic flow information acquisition.

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