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Traffic Characteristics Research in Wireless Multimedia Sensor Networks

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Abstract: With the detection of the complex and changeable environment, wireless multimedia sensor network is therefore arise, as a new information processing and access to technology, wireless multimedia sensor networks compared to traditional sensor network its more attention with video, images, and other large amount of information and high density of data collection and processing, also therefore in the commercial, civil nuclear military field has broad prospects. We pass on the measurement of network traffic in recent years, found that the communication model to subvert the traditional Poisson theory. The self-similarity phenomenon of data traffic in modern networks has been fairly well studied in the literature. However, the statistical characteristics of the wireless multimedia sensor network traffic we have a lot of phenomenon worthy of study. In order to help these technical staff related with some useful references, we have mainly analyzed the traffic characteristics in the multimedia wireless sensor networks in this paper. *Copyright © 2013 IFSA*

Keywords: Wireless multimedia, Sensor, Network communication, Statistical characteristics.

1. Introduction

Multimedia sensor network is generally consists of a set of storage, computation and communication capabilities of multimedia sensor node. Has the perceptual characteristic of distributed network which is mainly through multimedia sensor node to peripheral environment of various multimedia information, such as image, video, audio and other digital information etc. Multimedia sensor network on the data transmission is through multiple hops relaying mode sends the data to the information center. And the data center to carry on the analysis and some other processing of these data, so as to achieve the purpose of environmental monitoring. So a full understanding of the media sensor network for us to design more efficient communication protocols and the network system structure and performance prediction of network will be a very important theoretical and practical significance. We combine Fig. 1 to focuses on the analysis of wireless multimedia flow characteristics.

2. Architecture of Multimedia Sensor Network [1]

A typical multimedia sensor network is usually consists of the sink node, multimedia sensor node, control center and other parts. Sensor nodes in multimedia sensor networks are required to distribute in the designated area. The main purpose of doing so

is to let the data acquired along other multimedia sensor nodes hop-by-hop transmission, through the "multi-hop" routing mode, finally the data are generally through the communication satellite or Internet network to the control center. Then the user through the control center to sensor network configuration and management. Publication of the monitoring requirements to monitor environmental data [2].

Control center: the duty is responsible for monitoring data query and collection of multimedia sensor network, also can release information monitoring multimedia sensor network, and provides the appropriate interface for users of monitoring information analysis, mining and decision-making.

Multimedia sensor node: integrated with data processing, sensor unit and communication module embedded micro-nodes and through the built-in style sensor to the real-time monitoring of the surrounding environment where the sonar image, heat, infrared, audio, video and other events of interested in. But it is not omnipotent, its data processing ability, communication ability and storage ability is relatively weak, and only through the limited energy battery - powered. Multimedia sensor node main function is to emphasize the acquisition of video, audio, images and other environmental information, and some simple processing, but also on the other nodes to forward over the data fusion and forwarding operation again.

The sink node [3]: either a strong function of the multimedia sensor nodes, there is enough energy to supply more memory and computing resources, it can be no monitoring ability, only special gateway devices with communication ability. The sink node processing power, storage capacity and communication ability are relatively strong, responsible for connecting to external network such as multimedia sensor network and the internet, publishing monitoring task of the management node, and forwards the data to an external network.

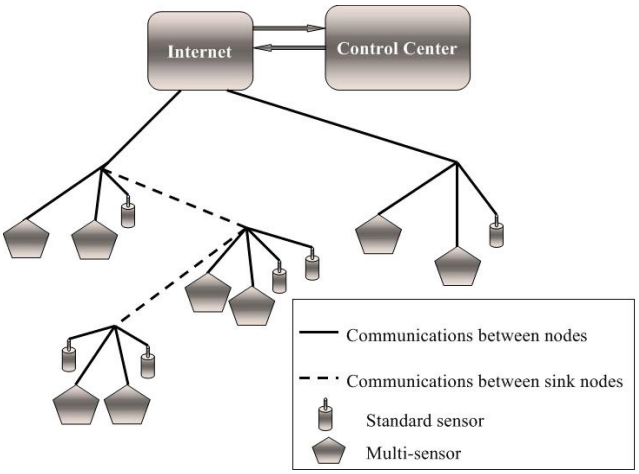

Fig. 1. Wireless multimedia sensor network structure.

3. Traffic Self-Similarity of Wireless Multimedia Sensor Network

Attention to self similarity (self-similar processes) is from the middle of the last century, and this study was applied to many fields. When carries on the analysis to the present network data, we usually like this to self-similarity:

The mathematical formula is in a wide-sense stationary random process, we want to meet the $\{X_n\}$ n=1, 2, 3, 4, 5...., set X_{nj} has a constant mean, which is able to satisfy the following equation u=E (X_n) and finite variance formula 2=E[(X_{n-2})], and the self correlation coefficient of which is R (=E[(k) (Xn+k-) (X_{n+k}) / (k=0,1,2,3,4 •,....), and its value is only related to K, here we can reach the number X_n can be understood as the number of the business entity network as the unit of time in n [4]. At the same time, we assumed that the autocorrelation coefficient Xn satisfying a range: R (k) --k- θ Ll (k), which we assume that Ll (k) is a slowly varying function, when the autocorrelation coefficient can meet on the type, we refer to this process as self-similar processes;

The Self-Similar Parameter H is also known as the academic community was known as the Hurst parameter, and this parameter is the only parameter to describe the self-similarity. We assume that a random sequence of self-similar, then its H range should be in (0.5, 1). And if the H value is greater, reflecting the random sequence similarity degree is also bigger [5].

4. The Key Technologies of Wireless Multimedia Sensor Networks

4.1. The Routing Protocol

Routing protocol is one of the focuses of research on wireless multimedia sensor networks, its main

purpose is to any need of communication between two nodes in the network to establish and maintain the data transmission path [6]. But the wireless network node resources are severely limited in speed does can not keep up, present situation and the network topology often changes, and network communication means more data-centric, so many domestic and foreign researchers have designed a lot of routing protocol, which is more common, there are LEACH, PEGASIS, TEEN, SPIN, DD, CADR, SMECN, GEAR etc.

4.2. The Multimedia Information Processing

A multimedia information processing is an important aspect of the study of wireless multimedia sensor networks, which is the key point to solve the bottleneck of how the single node processing power, storage and severely limited energy situation still can able to efficiently realize the compression coding and transmission of image, video and other multimedia information, the more feasible solution mainly is so two categories: more nodes "distributed" image compression method and distributed source coding method [7].

4.3. The MAC Protocol

The media access protocol (MAC protocol), the main work of the second layer of the Internet and its main function is highly competitive with each other between the sensor nodes, scientific and rational allocation of limited resources of the radio channel, in order to ensure the normal data communication, its design is reasonable or not will directly determine the use of wireless channel utilization and network performance, is the user feel network performance is an important indicator of good or bad.

4.4. Cross-layer Design

A traditional wireless sensor network protocol stack, and each layer of multimedia streaming strategies often have a common problem, are confined to separate a layer and ignore the interaction relationship between layers. But in fact the physical layer, MAC layer and network layer of the three is mutual restriction for the actual allocation of network resources; for example, the physical layer can be affected by interference on the receiving end of multi-channel wireless access, while the MAC layer can be based on the allocation of bandwidth to the forwarding nodes to influence the monitoring node of useful signal; of course, the network layer can also let the transmission scheduling leads to low bandwidth and delay to force the routing changes the diameter, and the routing will change a series of link scheduling. But how to say, is not to say that the application layer can be isolated, it is not completely cut off from the bottom, when we applied filtering, compression, encoding mechanism can enhance the performance of network transmission. Therefore, needs to cross layer cooperation to improve overall system performance in wireless multimedia sensor networks, such as energy consumption, QoS, channel utilization etc.

4.5. Node System

First we have to clear a concept is the sensor nodes constitute the basis of wireless multimedia sensor networks, wireless multimedia sensor network node in the world have design or production can be divided into two categories: one is the use of ASIC, FPGA and other special device design platform, such as we know that the Mult-Radio, Pico Radio, WSN platform etc.

The other is the most of the current node using general purpose microprocessor as the core components, the similar to the embedded system design of the node in this way, such as the more common of Mica, Gainz etc.

5. Analysis on Self-Similar Characteristic of Wireless Multimedia Sensor Network Communication

5.1. Simulation Experiments by NS2

Here we will through NS2 simulation methods to produce wireless multimedia sensor network traffic data sequence and analysis the bursty nature of the network. Here I assume that the number of nodes is 500 (see the Table 1 below). In the experiment, a randomly selected multimedia sensor nodes to Multimedia node x, assuming that we detected in sonar, image, audio, video and other thermal infrared, many other data of interest. And we assume that the data source for the United States of America a large a fragment. The GOP structure of the MPEG encoding of the video is IBBPBBPBBPBB (N= 12, M= 3).

Video transmission (play) frame rate of 25 frames per second. Then, all the data are sent to the sink node. So basically single-hope radio frequency coverage of each node can be guaranteed within 150 m, channel bandwidth is basically determined in the 1 Mbps. We analyze the characteristics of multimedia sensor networks, assuming that the state of the node is stationary. Then we take the communication between two nodes as the object of study, in each experiment, we record the Δt (Δt:t statistical time interval is 0.9 s), multimedia sensor nodes and aggregation nodes communication between the throughput.

Table 1. Parameters setup.

Parameters	Value
Simulation time	3600 seconds
Number of sensors	500
Topology size	800 × 800
Communication source	MPEG-4 video
Data packet	512 bytes
MAC protocol	IEEE 802.11

5.2. Brief Analysis Traffic Self-similarity

Here we assume that number of sensor nodes is still 500, the statistical interval is still 0.9 s, NS2 simulation experiment statistical analysis of the situation. The following figure we can end-to-end throughput of wireless multimedia sensor networks in different time scales for comparison.

Obviously we can see that, on different time scales, wireless multimedia sensor network flow burst has obvious characteristics of the autocorrelation. From the comparison in Fig. 2 has been very clear, wireless multimedia sensor network traffic on different time scales, the data with a strong burst.

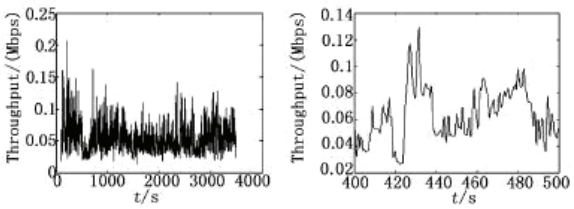

Fig. 2. Different time scales end-to-end throughput.

6. Main Application Areas of Wireless Multimedia Sensor Networks

The multimedia sensor network has a very broad application prospects in the military, civil, commercial. In order to distinguish with traditional sensor network applications, we mainly research on the current active audio and video sensor network applications to summarize. The following specific areas have paid lots of attentions.

6.1. Real-time Monitoring in Battlefield

Application prospects in this field, do not tell us that we also understand.

6.2. Traffic Monitoring on Roads Real-time Monitoring

This is a very promising application areas such as the ring road, traffic hub and highway layout, we can do for the implementation of traffic monitoring, statistics as well as by the number of cars, the illegal target docked, whether there is a fault vehicle, etc., by human is more difficult to do it, also can provide information about the road give your driver update congestion, but also can recommend the best route for drivers and remind the driver to avoid traffic accidents.

6.3. Real-time Monitoring to Security Sensitive Regions

The most common place is the effective real-time monitoring of power plants, mines, coal mines and other security-sensitive work environment.

6.4. Applications in Intelligent Household

This is a countries have attached great importance to the field, through the construction of wireless multimedia sensor networks can do kindergarten intelligent, timely monitoring of the children's environment to be educated, tracking the trajectory of a children's activities, so that the parents at ease and the teachers do not worry.

6.5. To Ensure Public Safety

Multimedia sensor networks can be widely applied to the customs, stadiums, airports, train stations, parking and other personnel mobility, crowded public places to do these areas of security and timely monitoring and emergency situations (such as fire, earthquake), occurs when the data statistics.

7. Energy-Saving Strategies for Wireless Multimedia Sensor Network Communication Module

7.1. Reduce the Communication Flows

Communication with the flow rate and the transmission distance is directly proportional to the energy consumption of the communication of multimedia nodes. And reduce the communication traffic will directly reduce the sending and receiving data bits, thereby directly reducing communication energy overhead. At present more popular methods mainly are:

1) Increase the error detection and correction mechanisms.

Increasing the error detection mechanisms can be found as early as possible due to invalid transmission errors, reduce the waste of energy consumption caused by the ineffective communication (such as packet loss and retransmission); while the correction

mechanism can be corrected to small number of bit errors packets, so that measures can be avoided retransmitting data amount of bandwidth occupancy, for the non - key frame transmission continuous multimedia error frame is very important, but the important key frames in the event of error does not apply to this method.

2) Reduce the probability of conflict.

The direct consequences of the conflict are caused jam retransmission and data packets. For multimedia information continuous flow, packet retransmission means huge overhead, thus wasting a lot of energy. Therefore, we urgently need to establish an effective, reasonable, suitable for wireless multimedia sensor networks conflict avoidance mechanism, of course this is also an important means to reduce the communication energy consumption and strategies.

7.2. Taking More Pieces of Short-range Wireless Communication for Data

In wireless sensor networks, the relationship formula between the communication energy consumption and the amount of distance as shown in equation (1).

$$E = k \times d^n , \quad (1)$$

where the values of n is greater than two and smaller than 4.

By the formula we can know, along with the increase of communication distance, the needed energy consumption in communication will be followed by a rapid increase, therefore, a feasible way to shorten the communication distance is to reduce energy consumption, this are the main types of specific ways: one is to reduce the transport distance of each hop. Two is to reduce the total transmission distance.

7.3. Choosing a Good Modulation Mechanism

In general, we select the 16 hexadecimal QAM (Quadrature Amplitude Modulation). The selection of this modulation been able to achieve the modulation mode of transport energy consumption is minimized. However, the selection of this high-level modulation will greatly increase the manufacturing cost of the nodes of wireless transceiver. Therefore, alternative means basically is to choose the 4 hexadecimal QAM modulation mode. When the transmission data volume reduction, we can properly reduce the modulation level, in order to achieve a balance between the communication and computation overhead.

8. The Advantages and Disadvantages of the Communication Structure in Wireless Multimedia Sensor Network

It is mainstream that the communication structure in wireless multimedia sensor network analyzed in this paper.

The main advantages: gathered nodes are the realization of the function of multimedia sensor node control center, more integrated modular specialization is more accurate and fast processing, the network communication higher stability and safety in operation and daily maintenance to effectively reduce the cost.

The main disadvantage: high content of science and technology, in the daily maintenance cost reduction, but also lead to trace defects existing in the system is difficult to eliminate in a timely manner in the daily system maintenance; Exception module running in network communication structure, because of its integrated with more functions, for network communication is a broad and deep impression, often to replace when replacement of maintenance module in the network structure is given priority to, not only have a single maintenance costs rise, but also improve the degree of dependence on related maintenance company.

On the whole, the advantages are much more than the disadvantages, this communication structure is worth using widely when people design the wireless multimedia sensor networks.

9. Conclusions

Multimedia sensor network is a new kind of information acquisition and processing technology. There is not a very long time, and compared with the traditional sensor network technology, it is more attention as the video, images, audio etc., these large amounts of data, large amount of information media collection, transmission and processing. So the multimedia sensor network has great application prospect in civil, commercial and military. In this paper, we introduce the concept and characteristics of multimedia sensor networks, multimedia applications, components and key technologies, and summarized the focus in the field of energy saving and communication in recent years, and look forward to further research directions, through the brief introduction of this paper is to promote attention and research on this emerging technology.

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