A Survey on Enhancement of Energy Efficiency in Wireless Video Sensor Networks

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Abstract: In the fast growing image application, the regular sensor networks will provide the text data. In the monitoring applications the video data provide the better information than the text data. Therefore it is necessary to receive video and image data. Thus Wireless video sensor networks are used to implement in a remote geographical areas for monitoring forests, mountains, deserts, border areas where the other networks do not exist. Even though the sensor networks limited by battery, memory, computing power and bandwidth. In order to satisfy the requirements proposed a few methods to overcome these limitations like video compression method, path planning, data aggregations. Video transmission via WSN is difficult because video data is inherently enormous in size, and transmission of video data necessitates a greater bandwidth, as well as additional memory and power for processing. This paper reviews the three parameters in different directions and figure out the more challenges in this research area.

Keywords: WMSN, Energy Efficiency, H.264

I. INTRODUCTION

In the networking field the wireless sensor network plays important role of grouping of sensor, data sharing, and data transmission. The Wireless sensor networks are infrastructure fewer networks in which deployed randomly in the entire environment based on the requirement of the application. The nodes are attached with sensor, processor, and power unit. In addition the fast development of sensor application capturing the real time image data is necessary rather than the raw data. As a part of this requirement, Wireless Multimedia Sensor Network (WMSN) is introduced and the sensor nodes are connected with cameras, microphones using these two devices can able to provide the live video streaming.

Sensor nodes with several sensing units make up Wireless Multimedia Sensor Networks (WMSNs). WMSNs, unlike standard wireless sensor networks, gather multimedia data including video and images. Data aggregation is a crucial enabling technology for WMSN, as it is required for it to be reusable and cost-effective. The process of collecting and aggregating meaningful data is known as data aggregation. Data aggregation is a good technique to preserve limited resources in the WSN. The main objective of aggregation of data algorithms is to capture and assemble data in an efficient manner in order to increase network lifetime. Figure 1 illustrates the process of aggregating the sensor dat. The method then aggregates sensor data from sensor nodes using aggregation algorithms such as the centralised approach, LEACH (Low Energy Adaptive Clustering Hierarchy), TAG (Tiny Aggregation), and so on.

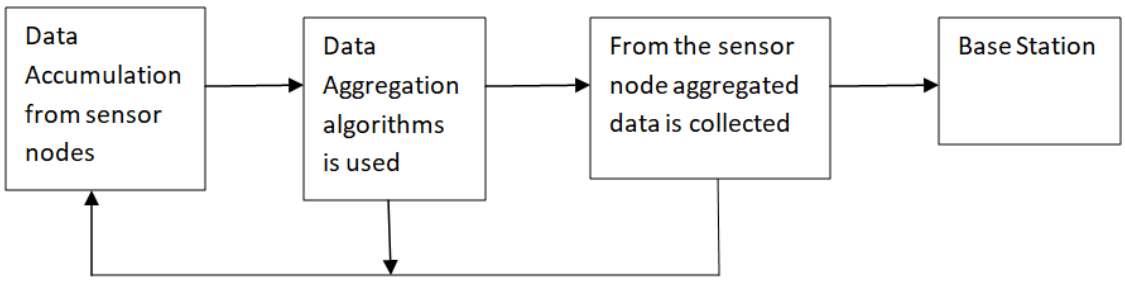

Figure 1: Architecture Diagram for Process of Data Aggregation

II. Strategies for Data Aggregation in Wireless Sensor Networks:

The data aggregation features employed in this work, such as energy efficiency and data aggregation rate, are listed below:

Energy Efficiency: In an ideal circumstance, every sensor in a Wireless Sensor Network should spend the same amount of energy throughout each data collection round. In practice, however, sensor nodes use varying amounts of energy during data transmission. In Wireless Video Sensor Networks, we can consider a data aggregation strategy to be energy efficient if it gives the most functionality with the least amount of energy usage. The ratio of the amount of data

successfully conveyed in a wireless sensor network to the total energy consumed to transfer those data is known as energy efficiency. Equation 1 is used to compute the energy efficiency.

$$\sum_{i=1}^{n} \frac{\text{In a sensor network,the amount of data that has been successfully sent}}{\text{The total amount of energy used to transport those data}} \quad \text{- - - - - Eq.1}$$

Data Aggregation Rate: Data aggregation is the technique for acquiring and aggregating key information in a specific region of interest in Wireless Video Sensor Networks. The primary method for reducing energy usage and consuming limited resources is data aggregation. The data aggregation rate is defined as the ratio of the volume of data successfully aggregated to the total amount of data detected as (Equation. 2).

$$\text{Data Aggregation Rate} = \frac{\text{Ratio of the volume of data successfully aggregated}}{\text{Total amount of information gathered}} \quad \text{- - - - - Eq.2}$$

Different Energy-Efficient Data Aggregation Techniques:

Secure Data Aggregation Using Polynomial Regression:

Polynomial Regression Based Secure Data Aggregation is a system in which sensor nodes describe their perceived data using polynomial functions. This method is used to ensure that the data being aggregated remains private. It's a new data aggregation system that uses polynomial regression on sensor data to achieve data privacy. The basic idea behind this protocol is to do data aggregation utilizing sensor data represented by polynomial coefficients.

Aggregation Tree with Clustering Based Lifetime Maximization:

The major goal of this algorithm, which is used to generate aggregation trees, is to reduce energy consumption by minimizing the cost of energy consumption and lowering the distance covered. The node with the most energy is regarded the parent node in the Clustering Based Lifetime Maximizing Aggregation Tree. The goal is to create the best aggregation tree feasible while minimizing energy consumption, lowering costs, and so maximizing network Data Aggregation in Wireless Sensor Networks. The aggregation tree that is derived utilizing the above-mentioned parameters shows to be the best for extending the network lifetime.

III. Compression Techniques:

The notable coding efficiency of Advanced Video Coding (MPEG-4 AVC), H.264 or MPEG-4 Part 10, the technology used for video compression opens a wide range of new applications over a variety of media for streaming video. It is a block-oriented motion-compensation-based video compression standard.

The H.264 standard provides optimized algorithms to estimate the motion, transforms, inter-prediction and spatial intra prediction. The H.264 standard supports motion estimation on blocks from 16×16 to 4×4 pixels. The H.264 uses multiple reference frames, smaller macro blocks and wider search ranges when compared with its predecessors to estimate the motion .The video transport over IP will be facilitated easily by H.264 standard and furnishes a hefty compression ratio.

Encoder processes:

The video in a compressed format is acquired by encoder and a decoder is used to get the uncompressed format by recouping the compressed video. The macro blocks are individual blocks of 16pixels by 16 lines that was obtained by breaking down the video consists of a stream of individual pictures. At each stage in the compression algorithm this process makes the operation very simple which needs to be done. In order to identify and remove the temporal redundancies the motion estimation is used that appears between individual pictures. When searching for a picture which is motion relative to a previous picture is encoded as “P-picture”. The B-picture is one which searches a previous picture and a future picture. The current block is calculated by predicting surrounding pixels from adjacent blocks in a well-defined range of directions. After then, the difference between the actual and predicted blocks is coded. The methods used for prediction in H.264 are more pliable when compared with other standards provides excellent video compression and accurate predictions.

A block of transform coefficients, nothing but the transformed output is **quantized**, i.e. Dividing the individual coefficient by an integer value. The precision of the transform coefficients is reduced by the quantization process, according to a quantization parameter (QP). The end output is a block with few non-zero coefficients and most or all of the coefficients being zero. The high compression is achieved by setting a high value to the quantization parameter at the outlay of poor decoded image quality this means most of the coefficients are set to zero. The low compression is achieved by setting the quantization parameter to a low value at the outlay of better decoded image quantity this means after quantization more non –zero coefficients remain.

Decoder processes

Bit stream decoding

On the other end, the video decoder obtains the compressed H.264 bit stream and extracts the information specified above by decoding each of the syntactic elements (quantized transform coefficients, prediction information, etc). This information is utilised to reproduce the video images in sequence and reverse the coding process.

Reconstruction

The decoder creates a prediction for each macro block that is comparable to the one made by the encoder. The decoder adds the prediction to the decoded residual to reconstruct a decoded macro block, which can subsequently be presented as part of a video frame.

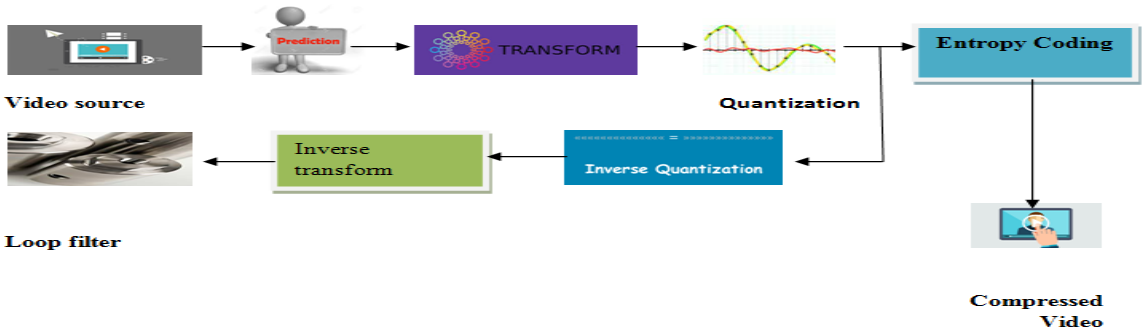

Figure 2: H.264 compression

The video is transformed and quantized at the encoder side and the uncompressed video is obtained at the receiver side by applying inverse transform.

The WMSN consist of nodes, it is interconnected to the base station. There are two types of architecture in sensor networks such as layered network architecture and clustered architecture. In the layered architecture where the entire design is divided into small portion and lower layer will provide the services to higher layer. In this clustered architecture the nodes are forms as group, the group of nodes transmit the data to the nodes which is selected as head and head cluster finally transmit the data to the base station. By this network architecture it shows layouts and how the nodes connected together.

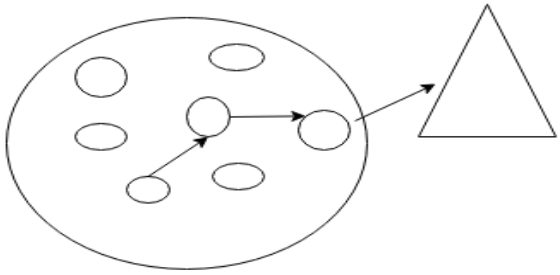

Figure 3: Layered Architecture

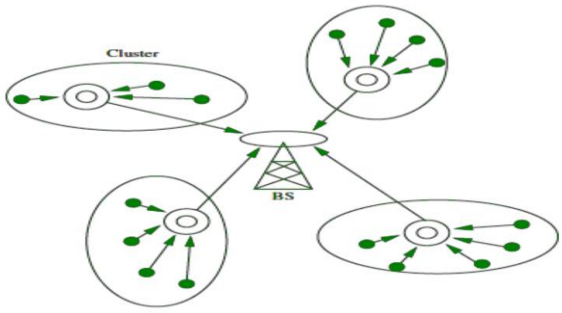

Figure 4: Clustered Architecture

The Fig: 3 shows the deployment of sensor node without any architecture and Fig: 4 shows the clustered architecture where data transmission done by cluster head. According to the design, the nodes are deployed because deployment of sensors node will be main issue in the sensor networks. The requirement of the application has to meet out by sensor

networks like, network connectivity issues, maximizing the sensing field and effectively utilize the energy of the sensor nodes.

IV. Cluster Based routing protocols:

In this routing method the nodes having high energy are selected as head, the data is received from the low energy nodes and head will transmit the data to another head located in the specific region. The cluster plays major of collecting the data from the nearby sensor nodes. The features of the cluster based routing protocol is enhancing the lifetime of the sensor, scalability; maximize the energy efficiency of the nodes the main drawbacks of this methods as additional overhead to cluster head, it will follow the direct transmission so that it will consume more energy, if the cluster head die then will not communicate with each other. Each probability of round the cluster head is selected based on the equation given below:

$$Pi(t) = \frac{K}{N - k(r * \bmod \frac{N}{k})} \quad \text{------ Eq. 3}$$

K is number of nodes, N is number of nodes in the cluster, r is the communication range.

V. Hierarchical routing protocol:

This routing method follows the 'Divide and Conquer' strategy. The entire region is divided into equal sized region and each region has own domain and router. Thus, the network is viewed at two levels: in the first level all the node having the information about the neighbor node and other routing regions have local algorithm to implement the routing method and the second level each section is considered as the single network , it is connected to network interfaces.

The Sensor nodes are arranged in hierarchies of different levels; For example, a city's local networks at one level, a country's cities at a higher level, and finally the network of all nations. Advantages of Hierarchical Routing:

- Storing of routing table size is less.
- Significantly fewer routing table calculations and changes.

Disadvantage:

- If network is designed based on the hierarchy method there is possibility to ignore the direct path from source and destination.

Location based routing protocol:

Location based routing protocol is the method of identifying the location of nodes using GPS and signal strength of the nodes. Facts about Location based routing protocol, first each node should know its own location, second node aware of the neighbor node and last source node find the shortest path to reach the destination node[3]. The two main algorithm proposed for location based algorithm one is GAF (GEOGRAPHIC ADAPTIVE FIDELITY) and second GEAR (GEOGRAPHICAL AND ENERGY AWARE ROUTING).The main advantages is cost value of each is less because it use location information of each node, it require less maintenance, it need less memory.

Meta-heuristic algorithm

The common physical-world problems have more risk, discontinuous process, interrelationship amongst variables and a large solution space. To overcome this issues introduced new method called Metaheuristic algorithms. The algorithms are called as optimization methods and are can able to produce best solution among the valuable amount of time. The purpose of optimization is to determine the best value for a set of variables in order to minimize (or maximize) an objective function while adhering to a set of constraints. This method plays important role in all aspects like financial and business planning, from industrial to automatic designing methods etc.

Energy Consumption of the node for transmitting k bits as follows:

$$P_{Tx}\, d = e_{amp}\, d\, 2k \quad \text{----- Eq. 4}$$

k bits is energy consumption of received bits from a node is proportional to the receiver electronics energy per bit.,

Energy receiving of the node for transmitting k bits as follows:

$$P_{Rx} = e_{elec}\,(k) \text{ - - - - - - Eq. 5}$$

Table 1: Shows Different types' algorithm in each routing protocol.

Cluster Based routing protocols Algorithms	**Hierarchical routing protocol Algorithms**	**Location based routing protocol Algorithms**	**Meta-heuristic algorithm**
LEACH	APTEEN	GAF	Bat
HEED	PEGASIS	GEAR	Cuckoo
UCS			Jelly fish
TEEN			Ant colony
			Swarm intelligence

VI. Conclusion:

Compare to all networks, wireless multimedia sensor networks implemented for particular applications like military applications, radio signal tracking, chemical industry but this are not limited. The requirement of each application gets different features. The features and requirements are differing in all the applications. New communication protocols, algorithms, architectures, and services are required to accommodate this wide range of applications. In this paper surveyed the different methods to solve the issues in WMSNs. Here underline the feasible improvements method in research in each area. Many concerns surrounding WSN applications, including as communication architectures, security, and management, remain unresolved. In order to fill the gap between technology and application discussed all the methods to solve the issues in sensor networks.

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