Saichand Amirishetti, Sanjib kumar .Nayak/International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 1, Issue 3, pp.1182-1188

Survey on Collaborative Methods of Image Transmission in WSN

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Abstract—
Image Trasmission applications of WSN such as monitoring and surveillance may require image sensor array to conduct collaborative image transmissions . The large size image transmissions cause bottlenecks in WSN due to the limited energy resources and network capacity.
In this paper we have explored different image transmission methodologies that are used in WSN

***Index Terms*—Wireless sensor network , lifetime, sensor correlation.**

1. INTRODUCTION

Recent advances in embedded systems and wireless communications have led to the creation of (*WSNs*), consisting of low-cost, low-power, multi-functional sensor nodes (*SNs*), that are small in size and communicate over short distances [1]. These tiny sensors have sensing, data processing and communication components and are able to communicate wirelessly over multiple hops with the help of their neighboring SNs. They can be used for continuous sensing, event detection, location sensing, and local control of actuators. These nodes run algorithms to self-organize into a network and communicate among themselves and the BS(s). A WSN is composed of a large number of SNs, deployed densely and most times randomly in the area being monitored. In general, the SNs in a WSN sense data and convey them to one or more high power nodes called the *sink* or the base station (*BS*) which do most of the complex processing. The sink (or BS) might be the final destination of the data or might act as a hub from where the data is sent to users over the wired network.

2. APPLICATIONS

- Multimedia surveillance sensor networks.

Video and audio sensors will be used to enhance and complement existing surveillance systems against crime and terrorist attacks.

- Trafic avoidance, enforcement and control systems.

WSNs are used in Big cities or highways and deploy services that provide trafic routing advice to avoid congestion.

- Advanced health care delivery.

Telemedicine sensor networks [2] can be integrated with 3G multimedia networks to provide ubiquitous health care services. Patients will carry medical sensors to monitor parameters such as body temperature, blood pressure, pulse oximetry, ECG, breathing activity.

- Automated assistance for the elderly and family monitors.

Multimedia sensor networks can be used to monitor and study the behavior of elderly people as a means to identify the causes of illnesses that a.ect them such as dementia [3].

- Environmental monitoring.

Several projects on habitat monitoring that use acoustic and video feeds are being envisaged, in which information has to be conveyed in a time-critical fashion.

For example, arrays of video sensors are already used by oceanographers to determine the evolution of sandbars via image processing techniques[4].

- Person locator services.

Multimedia content such as video streams and still images, along with advanced signal processing techniques, can be used to locate missing persons, or identify criminals or terrorists.

- Industrial process control.

Multimedia content such as imaging, temperature, or pressure amongst others, may be used for time-critical industrial process control.

3. Network architecture

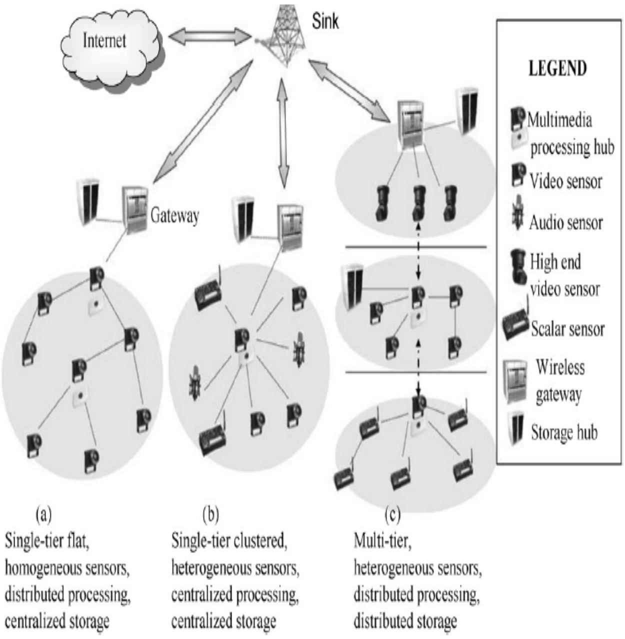
The problem of designing a scalable network architecture is of primary importance. Most proposals for wireless sensor networks are based on a .at, homogenous architecture in which every sensor has the same physical capabilities and can only interact with neighboring sensors. Traditionally, the research on algorithms and protocols for sensor networks has focused on scalability, i.e., how to design solutions whose applicability would not be limited by the growing size of the network. Flat topologies may not always be suited to handle the amount of traffic generated by multimedia applications including audio and video. Likewise, the processing power required for data processing and communications, and the power required to operate it, may not be available on each node.

3.1. Reference architecture

In Fig. 1, we introduce a reference architecture for WMSNs, where three sensor networks with different characteristics are shown, possibly deployed in divergent physical locations. The first cloud on the left shows a single-tier network of homogeneous video sensors. A subset of the deployed sensors have higher processing capabilities, and are thus referred to as processing hubs. The union of the processing hubs constitutes a distributed processing architecture. The multimedia content gathered is relayed to a wireless gateway through a multi-hop path. The gateway is interconnected to a storage hub, that is in charge of storing multimedia content locally for subsequent retrieval. Clearly, more complex architectures for distributed storage can be implemented when allowed by the environment and the application needs, which may result in energy savings since by storing it locally, the multimedia content does not need to be wirelessly relayed to remote locations. The wireless gateway is also connected to a central sink, which implements the software front-end for network querying and tasking. The second cloud represents a single-tiered clustered architecture of heterogeneous sensors (only one cluster is depicted). Video, audio, and scalar sensors relay data to a central cluster head, which is also in charge of performing intensive multimedia processing on the data (processing hub). The cluster head relays the gathered content to the wireless gateway and to the storage hub. The last cloud on the right represents a multi-tiered network, with heterogeneous sensors. Each tier is in charge of a subset of the functionalities. Resource-constrained, low-power scalar sensors are in charge of performing simpler tasks, such as detecting scalar physical measurements, while resource-rich, high-power devices are responsible for more complex tasks. Data processing and storage can be performed in a distributed fashion at each divergent tier.

3.2. Single-tier vs. multi-tier sensor deployment

One possible approach for designing a multimedia sensor application is to deploy homogeneous sensors and program each sensor to perform all possible application tasks. Such an approach yields a flat, single-tier network of homogeneous sensor nodes. An alternative, multi-tier approach is to use heterogeneous elements [5]. In this approach, resource-constrained, low-power elements are in charge of performing simpler tasks, such as detecting scalar physical measurements, while resourcerich, high-power devices take on more complex tasks. For instance, a surveillance application can rely on low-fidelity cameras or scalar acoustic sensors to perform motion or intrusion detection, while high-fidelity cameras can be woken up on-demand for object recognition and tracking. In [6], a multi-tier architecture is advocated for video sensor networks for surveillance applications. The architecture is based on multiple tiers of cameras with different functionalities, with the lower tier constituted of low-resolution imaging sensors, and the higher tier composed of high-end pan-tilt-zoom cameras. It is argued, and shown by means of experiments, that such an architecture offers considerable advantages with respect to a single-tier architecture in terms of scalability, lower cost, better coverage, higher functionality, and better reliability.



(a) Single-tier flat, homogeneous sensors, distributed processing, centralized storage

(b) Single-tier clustered, heterogeneous sensors, centralized processing, centralized storage

(c) Multi-tier, heterogeneous sensors, distributed processing, distributed storage

Fig. 1. Reference architecture of a wireless multimedia sensor network.

3.3. Coverage

In traditional WSNs, sensor nodes collect information from the environment within a pre-determined sensing range, i.e., a roughly circular area determined by the type of sensor being used. Multimedia sensors generally have larger sensing radii and are also sensitive to the direction of data acquisition. In particular, cameras can capture images of objects or parts of regions that are not necessarily close to the camera itself. However, the image can obviously be captured only when there is an unobstructed line-of-sight between the event and the sensor. Furthermore, each multimedia sensor/camera perceives the environment or the observed object from a divergent and unique viewpoint, given the divergent orientations and positions of the cameras relative to the observed event or region. In [7], a preliminary investigation of the coverage problem for video sensor networks is conducted.

4. IMAGE TRANSMISSION

The image data transmissions in WSNs can drastically degrade the network performance and sensor lifetime [8]-[9]. research topic. Most existing image compression methods only take advantage of the intra-image data redundancy, which is within a single sensor's measurement. On the other hand, although a large amount of data redundancy may exist among images sensed in a sensor array, a comprehensive joint image compression for the images collected by correlated sensors would be impractical, unless these image data reach an aggregation point. This is because such joint compression would require simultaneous availability of image data from multiple sensors, involving great network overhead for comprehensive data exchange. Therefore, it is difficult to increase communication energy efficiency of correlated image sensors and extend overall WSN lifetime. The redundancy of data transmission among correlated image sensors may not be easily exploited to save energy through traditional image compression methods.

4.1. SENSOR CORRELATION

In the literature, the research on utilizing sensor correlation is focused on either collaborative methods [10]-[12] or predictive methods [13]-[17]. The former heavily involves inter-sensor communication overhead, which could be prohibitively high in the case of image transmission. The latter must use the prior knowledge of sensor constellation.

4.1.1. COLLABORATIVE METHODS:

A)Distributed Data Compression and aggregation

In this method[10] they have addressed optimal arrangement of distributed compression subject to aggregation costs. aggregation cost is the energy associated with gathering sensor information.

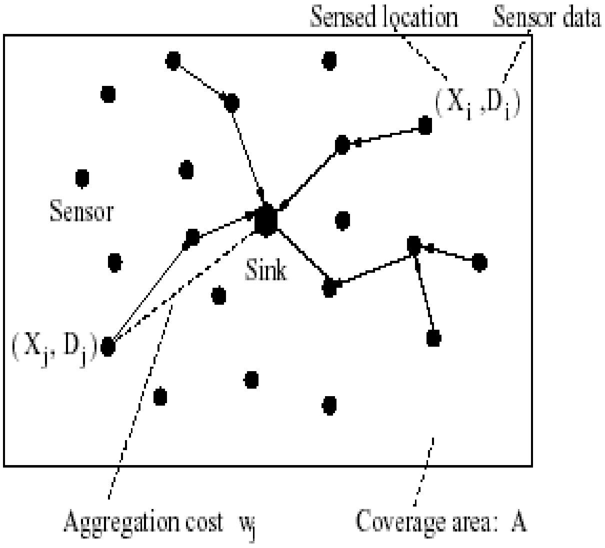


fig2:illustration of sensoer reporting

As illustrated in Fig.2, consider a set of sensors U = {1,2,...n} at different locations within a coverage area *A* and sink placed at the origin. We model information obtained by these sensors as a random vector , and suppose the sink coordinates and aggregates the information from the sensors. Since sensors are located at different positions, they may incur different aggregation costs in forwarding their data to the sink. We use a vector to model these costs .ensor *i* is proportional to its distance (a rough estimate for the number of hops) to the sink. The information collected by the sensors is likely to be correlated and thus it is possible to jointly compress the data .objective is to jointly compress the sensed data while minimizing the overall aggregation cost. they formally stated the problem as follows.

For a set of devices U sensing an information vector , and an associated aggregation cost vector determine the rate vector that minimizes the overall aggregation cost subject to joint data compression constraints

B)spatial Correlation On Routing With Compression

In this work[11], They shown the existence of a simple, practical an static correlation-unaware clustering scheme that satisfies a min-max near-optimality condition The implication for system design is that a static correlation-unaware scheme can perform as well as sophisticated adaptive schemes for joint routing and compression. In order to understand the space of interactions between routing and compression, we study simplified models of three qualitatively divergent schemes(fig3).

In *routing-driven compression* data is routed through shortest paths to the sink, with compression taking place opportunistically wherever these routes happen to overlap.

In *compression-driven* routing the route is dictated in such a way as to compress the data from all nodes sequentially - not necessarily along a shortest path to the sink. Our analysis of these schemes shows that they each perform well when there is low and high spatial correlation respectively. As an ideal performance bound on joint routing-compression techniques,

In *distributed source coding* in which perfect source compression is done a priori at the sources using complete knowledge of all correlations.

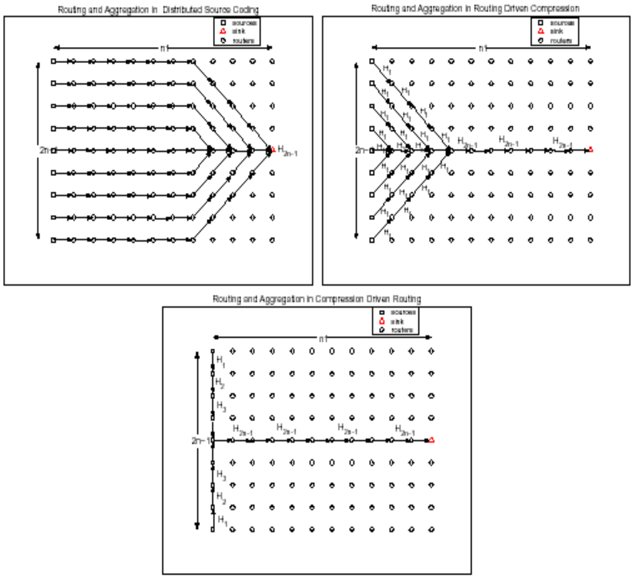

Routing and Aggregation in Distributed Source Coding
Routing and Aggregation in Routing Driven Compression
Routing and Aggregation in Compression Driven Routing

Fig. 3. Illustration of routing for the three schemes: DSC, CDR, and RDC. Hi is the joint entropy of i sources.

C)Data Aggregation

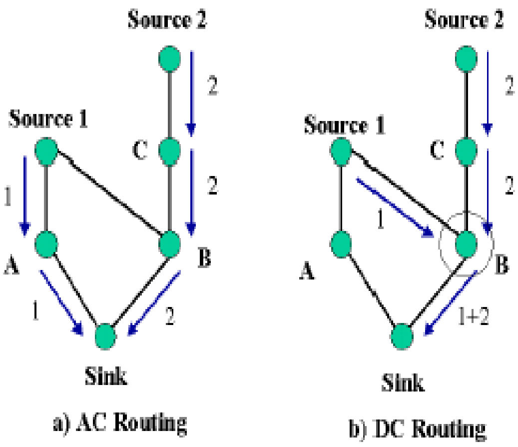
Data aggregation[12] has been put forward as an essential paradigm for wireless routing in sensor networks . The idea is to combine the data coming from different sources enroute – eliminating redundancy, minimizing the number of transmissions and thus saving energy. This paradigm shifts the focus from the traditional *address centric* approaches for networking (finding short routes between pairs of addressable end-nodes) to a more *data centric* approach (finding routes from multiple sources to single destination that allows in-network consolidation of redundant data). In this method they studied the energy savings and the delay tradeoffs involved in data aggregation and how they are impacted by factors such as source-sink placements and the density of the network. We also investigate the computational complexity of optimal data aggregation in sensor networks.

Routing Models

considering a single network flow that is assumed to consist of a single data sink attempting to gather information from a number of data sources. Which use data aggregation (which we term data-centric), and schemes which do not (which we term address-centric). In both cases we assume there are some common elements the sink first sends out a query/interest for data, the sensor nodes which have the appropriate data then respond with the data. They differ in the manner the data is sent from the sources to the sink:

Address-centric Protocol (AC): Each source independently sends data along the shortest path to sink based on the route that the queries took (“end-to-end routing”).

Data-centric Protocol (DC): The sources send data to the sink, but routing nodes enroute look at the content of the data and perform some form of aggregation consolidation function on the data originating at multiple sources. Figure 4 is a simple illustration of the difference between AC and DC schemes. In the address-centric approach, each source sends its information separately to the sink (source 1 routing the data labeled “1” through node A, and source 2 routing the data



a) AC Routing b) DC Routing

fig4:illustration of AC versus DC Routing-

compression labeled “2” through nodes C and B). In the data centric-approach, the data from the two sources is aggregated at node B, and the combined data (labeled “1+2”) is sent from B to the sink. The latter results in energy savings as fewer transmissions are required to send the information from both sources to the sink.

D)Collaborative Image Transmission

a collaborative transmission scheme [18]-[19]for image sensors to utilize inter-sensor correlations to decide the transmission and security sharing patterns based on the path diversities. Our proposed approach for secret image sharing on multiple node-disjoint paths for image delivery is to achieve high security without any key distribution and management, and thus the key management related problems do not exist. The energy efficiency is another major contribution made in this paper. This scheme does not only allow each image sensor to transmit optimal fractions of overlapped images through appropriate transmission paths in an energy-efficient way, but also provides unequal protection to overlapped image regions by path selections and adaptive bit error rate (BER) requirement.

Let us consider a cluster-based heterogeneous wireless image sensor network. Given a random deployment of image sensors and relay sensors to cluster heads along with the corresponding energy on each sensor, we want to find an optimal transmission pattern in terms of single hop or multiple hop paths to the cluster head. As shown in fig5 the images can be separated into overlapped (OVL) regions and non-overlapped (N_OVL) regions. We use $x_{i,j}$ to denote the fraction of the overlapped region $OV L_j$ that is to be sent by sensor i. All $x_{i,j}$ forms a matrix X called distribution ratio of OVL region transmissions. To save communication energy, it

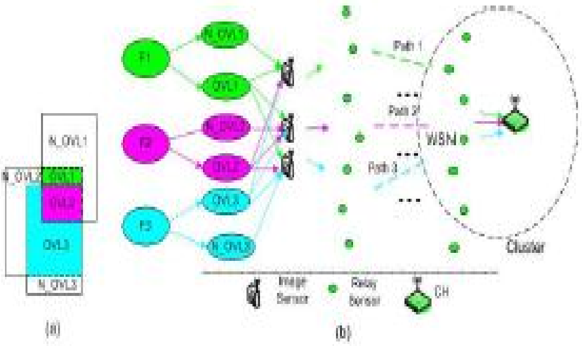
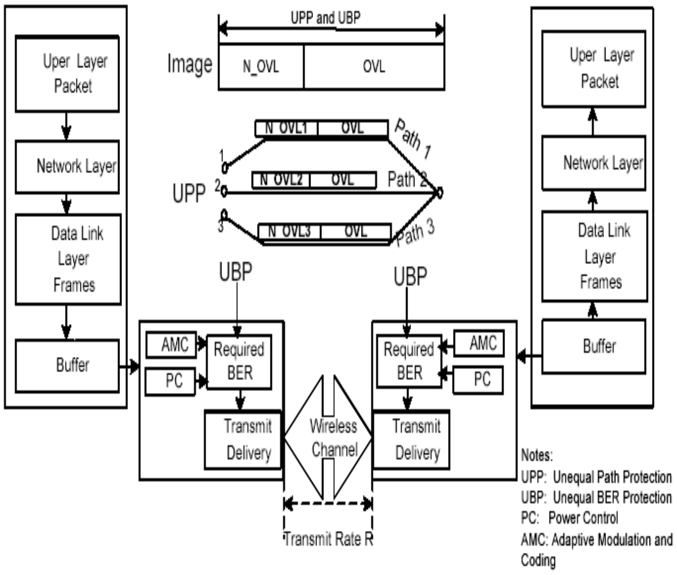


fig5:Sensor Network Moderl of Image Transmission

will be important for each source sensor to send its own N_OVL region and not to send the portion of OVL region that has already been sent by another source sensor which shares the same portion of OVL region. We also assume that the OVL image region has higher importance than the N_OVL regions. The overlapping regions (i.e., OVL) usually and naturally are important field view and N_OVL region could be the background with less importance. The importance of OVL region from several sensor measurements becomes obvious compared to one sensor measurement. It is necessary to provide unequal protection in transmitting OVL and N_OVL image regions to achieve expected image quality. This kind of diversity could potentially provide energy efficient image transmission over multiple paths. OVL regions demand higher image distortion requirement, more error resistant path transmissions and higher security level than N_OVL regions. depending on the number of paths selected to deliver the message, the maximum security can be achieved when we allocate N portions onto M paths, such that the adversaries must intercept all M paths to compromise the whole message. We extend this idea in image transmission scheme due to correlated image sensors sharing OVL regions and transmitting them with appropriate distribution ratio via multiple paths as shown in fig6. The security level in the proposed approach is defined as the compromise probability of image regions, which mainly depends on the security compromise probability on each path. The optimal secret sharing scheme is to provide optimal security protection on a certain amount of image regions that are transmitted by multiple paths so that the required security level can be achieved. In this method, goal is to find an image region distribution pattern and secret scheme for OVL image region and transmit its shares to cluster head via *M* node-disjoint paths so that the security level is guaranteed.



Notes:
UPP: Unequal Path Protection
UBP: Unequal BER Protection
PC: Power Control
AMC: Adaptive Modulation and Coding

fig 6: Path selection and unequal path protection and BER protection.

5. CONCLUSION

In this paper we have studied different techniques for collaborative image transmission. for each method we have given basic insight we specified the significancy of correlated methods over predictive methods and we have discussed wide variety of applications of wire less sensor networks in real-time environment.

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