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APPLICATION LAYER OF MULTIMEDIA PROCESSING IN WIRELESS SENSOR NETWORKS: A STUDY

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ABSTRACT

Multimedia processing in Wireless Sensor Networks (WSNs) has turned into a promising innovation. It can possibly empower an enormous class of applications, a large portion of them identified with reconnaissance and finding (for example target discovery and tracking, outskirt insurance, patient and old help, individuals and article distinguishing proof, environment observing, fire recognition, mechanical control,). To accomplish a successful Quality of Service (QoS) in multimedia applications, exceptional node, and network capabilities are required. For instance, contrasted with ordinary WSN nodes, multimedia nodes need extra hardware resources for memory, processing capacity, transmission rate, and energy. In this research, we diagram the plan difficulties of WMSNs, give an extensive dialog of the proposed structures, algorithms and protocols for the various layers of the communication protocol stack for WMSNs, and assess the current WMSN hardware and proving grounds. The field of Wireless Sensor Networks (WSNs) is getting much attention in the networking research community and as an interdisciplinary field of interest. WSNs are winding up progressively low-cost, low-power, multi-practical, and feasible because of the advances in micro-electro-mechanical systems (MEMS), low power and highly integrated digital electronics, and multiplication of wireless communications.

Keywords: ***Wireless Sensor, Network, Multimedia, Applications, Communications***

1. OVERVIEW

A Wireless Multimedia Sensor Network (WMSN) is a unique WSN comprised of a few multimedia sensor nodes, exceptionally intended to recover multimedia substance, for example, video and sound streams, still images, and scalar sensor data from the environment. The Heterogeneous Networks, where multimedia and non-multimedia nodes convey data. In this situation, the non-multimedia node requirements must be considered to convey multimedia data through multi-hop ways. By and large, communitarian processing looks bad for this situation. At present, research difficulties in structuring multimedia applications on WSNs incorporate, however, are not restricted to the following[1-5]:

- QoS requirements. Streaming media, system snapshots, audio/video store and playback applications have different requirements with respect to delay, jitter, and loss tolerance.
- Bandwidth. WMSNs require a bandwidth that is orders of magnitude higher than that supported by currently available sensors.
- Power. Compared to traditional WSNs, power consumption is greater in multimedia applications because of high volumes of data, high transmission rates, and extensive processing.
- In-network processing support, to efficiently extract relevant information from multimedia data (e.g. panoramic image fusion, target identification and location).
- In-node processing support, to compress data, signal analysis and features extraction (singular points, region segmentation, object detection)
- Cross-layer design. An effective optimization of all the above parameters involves crosslayer protocol design ranging from Application to Physical Layer.
- New hardware design to better manage the energy with high QoS (i.e. power supply, microcontroller (MCUs) architectures and energy harvesting)

The nodes of a WSN exhibit resource constraints in terms of CPU processing capacity, memory, bandwidth and energy. Figure 1 shows a node hardware structure, and table sums up a comparative study of popular MCUs, RF chips, and platforms

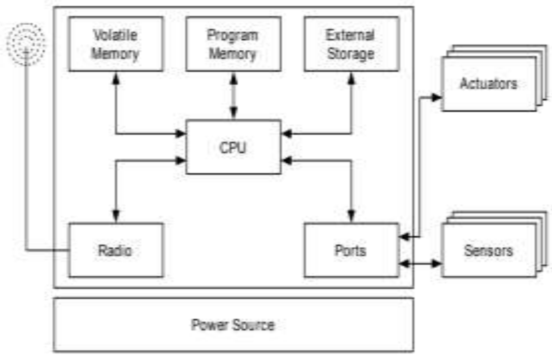

Figure 1: Node hardware architecture

2. MULTIMEDIA COMMUNICATION IN WIRELESS NETWORKS

Many operating systems and explicit program languages have been proposed. NesC language for TinyOS is the most well-known. Options incorporate SOS, Mantis, LiteOS, t-Kernel, or NANOrk. A portion of the above-operating systems (e.g., SOS, LiteOS, and Contiki) likewise give dynamic connecting capabilities, i.e., new code modules can be added at run-time to the application running on a node. Dynamic connecting is especially significant in supporting wireless reinventing of the WSN. System Services are projects intended to support claims. Normally, an application requires Location, Time Synchronization, and Storage, Communication and Data securing/processing services.

High bandwidth demand

Real-time multimedia applications are well known with their high bandwidth requirements and stringent delay constraints, which may be hard to satisfy even on wired links. In the design of multimedia WSN, high bandwidth requirements of multimedia traffic should be taken into account. For example, the size of a typical uncompressed video sample, i.e., frame, in QCIF format (144x176) is approximately 25 Kbytes.

Multimedia coding techniques

Since sensor nodes in a multimedia WSN capture and compress multimedia signals, processing and communication efficiency of the compression algorithms is clearly a design constraint, which needs to be carefully addressed.

Processing efficiency: Predictive encoding is known to be an effective way of obtaining good rate-distortion performance for signals with temporal correlation which is inherent to multimedia. However, computational complexity of these algorithms is unacceptably high for power constrained sensor nodes. On the other hand, using all intra frame coding is efficient in terms of energy spent on processing; however, it is inefficient in terms of communication cost due to its low rate-distortion performance.

Communications efficiency: Predictive coding can reach high compression ratios and dramatically reduce the bit rate of a source signal. Many techniques are proposed in order to tackle with this problem, all of which are based on adding some redundancy with the cost of increased bandwidth demand reducing the communication efficiency. Using channel codes is inefficient for the cases where losses exceed the correction capacity of the code, e.g., burst losses, and cause a cliff effect.

Power consumptions

The extreme power limitations of sensor nodes require sensor structure with low-intricacy and high compression productivity so as to delay the lifetime of a wireless sensor node. Along these lines, both processing and communication power consumption can be diminished to worthy levels which make the multimedia transport over WSN attainable. Power consumption because of communication in WSN has been generally researched. Consequently, here, we, for the most part, center on the energy proficiency issues identified with the multimedia processing at sensor nodes.

Production cost

By and large, sensor nodes are low limit devices furnished with simple sensing hardware which may have seismic, attractive, warm or acoustic data capture capabilities. Notwithstanding the low profile hardware of a sensor bit, use of previously mentioned simple sensing gear empowers to diminish the costs. Be that as it may, for the instance of multimedia WSN, sensing hardware turns into a sound, image, or video capturing hardware, e.g., camera, which is a considerably costly device.

3. APPLICATIONS LAYER

In a multimedia WSN, application layer ought to speak to the captured signal appropriately to transport over lossy channels by utilizing algorithms that limit both procedure and communication power. While there is a lot of research on multimedia compression and transmission, these techniques don't fit well to the unique qualities of the WSN paradigm. For instance, the new video coding standard H.264/AVC generally give excellent rate-distortion performance because of advanced techniques it incorporates to abuse the signal insights, e.g., spatial forecast for intra coding, multiple reference edges movement pay, little and variable block-size intra/inter block coding, and advanced entropy coding schemes.

Be that as it may, prescient encoders are intended to chip away at high-end systems which don't have any energy and processing limitations. This is for the most part because while the advanced techniques incorporated in prescient encoders help increment the coding productivity; they likewise present inordinate processing and energy prerequisites. Thusly, they don't remain as a handy application layer answer for energy and limit restricted sensor bits. So as to accomplish the circulated sensing in a WSN, compacted bitstream ought to be imparted over lossy channels.

4. TRANSPORT LAYER

In order to realize efficient multimedia communication in WSN, a reliable transport mechanism is imperative. In general, the main objectives of the transport layer are

(i) To bridge application and network layers by application multiplexing and demultiplexing;

(ii) To assure reliable data delivery between the source and the sink according to the specific reliability requirements of the application layer;

(iii) To perform congestion control by regulating the amount of traffic injected to the network.

Reliable multimedia delivery over WSN: In multimedia WSN applications, the data gathered from the field may contain multimedia information such as target images, acoustic signal, and even video captures of a moving target. However, the multimedia traffic has significantly different characteristics and hence different reliable transport requirements compared to conventional data traffic. Therefore, new transport layer solutions which address the requirements of multimedia delivery over WSN must be developed.

Real-time communication support: Despite the existence of reliable transport solutions for WSN as discussed above, none of these protocols provide real-time communication support for the applications with strict delay bounds. Therefore, new transport solutions which can also meet certain application deadlines must be researched.

Relation between Multimedia Coding Rate and Reliability: The success in energy-efficient and reliable delivery of multimedia information extracted from the phenomenon directly depends on selecting appropriate coding rate, number of sensor nodes, and data rate for a given event. However, to this end, the event reliability should be accurately measured in order to efficiently adapt the multimedia coding and transmission rates. For this purpose, new reliability metrics coupled with the application layer coding techniques should be investigated.

Cross-layer optimization: Due to the severe processing, memory and energy limitations of sensor nodes, it is imperative that multimedia communication must be achieved with maximum efficiency. With this respect, cross-layer optimization of multimedia coding, transport, link and physical layer algorithms must be investigated and the theoretical results must be applied to develop new cross-layer communication protocols for reliable and efficient multimedia transport in WSN.

5. NETWORK LAYER

Network layer is basically in charge of steering packets, both in fixed and versatile networks it is possible that it is wired or wireless. In any case, wireless versatile specially appointed networks or WSNs require infrastructure communication just as the application communication alluding to the fundamental packet directing undertaking. Infrastructure communication alludes to the network layer communication expected to discover starting courses or fix bombing courses because of evolving topology.

As of late, various researchers have proposed energy effective steering answers for WSN. Multimedia conveyance in WSN has the following limitations and qualities, which ought to be considered during the plan of a directing protocol.

Data Delivery model: According to data delivery strategy WSNs are classified into three main groups, namely continuous, event-driven, and query-driven (observer initiated). Continuous delivery model requires continuous transmission of sensor data generated at a specified rate independent of the existence of an event or a user query emanating from the sink.

Source aggregation: Some routing solutions are based on aggregation of sensed data from a locality according to a certain aggregation function. A possible aggregation function may be joint encoding of the incoming multiple correlated video signals at an aggregator node.

Quality of services: Multimedia data delivery is bound to the QoS requirements discussed in Section II-E such as high bandwidth and low error rate. Direct communication from a sensor node (a cluster head) to the sink in a single hop results in the usage of low bandwidth and high error rate communication channel (due to fading and multipath).

Data centric and flat architecture protocols

This class of directing protocols accumulate or course data based on the quality of the data, i.e., data driven, as opposed to utilizing courses based on the unique identities (ID) of nodes in the sensor network.

6. WIRELESS MULTIMEDIA SENSOR NETWORKS: CURRENT TRENDS AND FUTURE DIRECTIONS

Wireless Multimedia Sensor Networks (WMSNs) have developed and moved the concentration from the regular scalar wireless sensor networks to networks with multimedia devices that are skilled to recover video, sound, images, just as scalar sensor data. WMSNs can convey multimedia content because of the accessibility of cheap CMOS cameras and microphones coupled with the huge advancement in dispersed signal processing and multimedia source coding techniques.

7. ROUTING LAYER IN WMSN

Routing layer in wireless sensor network aims to deliver the sensed data from the sources to the sink node taking into account several design considerations, such as energy efficiency, link quality, fault tolerance, and scalability. Although there are many routing protocols proposed for the traditional WSN, the design of routing protocols for WMSN is still an active research area.

We believe that the new characteristics and constraints due to the multimedia content handling over the network make the proposed routing protocols for WSNs not directly applicable for WMSNs. The multimedia nature of the collected information (video streaming, still images, audio) adds more constraints on the design of the routing protocols in order to meet the application-specific QoS requirements and network conditions. There are many traffic classes in WMSNs and can be categorized into three main classes or services depending on their QoS requirements:

1) Event-driven service which is delay intolerant and error intolerant but it requires less bandwidth, so a path with a little traffic and high signal to noise ratio is attractive for this kind of service.
2) Data query service is error intolerant but query-specific delay tolerant applications, so a path with significant congestion and a high signal to noise ratio may be used for this service.
3) Stream query service which is delay intolerant but query-specific error tolerant application (in a sense packet losses can be tolerated to a certain extent), so a path with less traffic and relatively lower signal to noise ratio is better for this type of service.

8. CONCLUSION

In the subsequent one, the nodes demand and reinvent a packet powerfully. Data securing isn't constantly considered and modified as a service. In any case, it is particularly important in multimedia applications. In the testing stage, a calibrated set of sensors are examined, and the column data are time stepped, if important. Sensor alignment is a significant issue. Traditional approachs can't be connected due to the cost of a manual and node-by-node modifying. The examining procedure is terminated by either an occasion or periodically. Following the Nyquist information theory, inspecting rate depends on marvels elements. Increasingly modern speculations, as compressive sensing, allow the reduction of the examining rate for explicit signals (e,g images).

WSNs have wide and changed applications, for example, real-time tracking of items, checking of environmental conditions, observing of wellbeing structures, and setting up a universal figuring environment, and so on. The previously mentioned attributes force a lot of confinements on the WSNs structure, for example, adaptation to non-critical failure, versatility, production costs, network topology, operating environment, hardware imperatives, power consumption, and so forth. These difficulties have prompted intensive research in the previous couple of years that tends to the potential coordinated effort among sensors in data assembling and processing. In many applications, the organization area has no current infrastructure for either energy or communication. In this research, an essential necessity for sensor nodes is to have the option to get by with a restricted source of energy which is generally a small battery. The network should remain alive and dynamic for length of time that depends on the application of the conveyed network, and that may last from a little while to a couple of years.

In this research, to meet the quality of service (QoS) necessities and to utilize the network rare resources in a reasonable and proficient way, these attributes of WMSNs alongside other research issues, for example, coverage and security become a worry, and ought to be considered most likely at the various layers of the communication protocol stack. We diagram and talk about these issues in detail in the following sections. Moreover, given the moderately high repetition in the visual sensor data, WMSNs have extra prerequisites, for example, in-node multimedia processing techniques (e.g., conveyed multimedia source coding and data compression), application-explicit QoS necessities, and multimedia in-network processing techniques (e.g., storage management, data combination, and aggregation).

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