A Routing Mechanism for Time Critical Applications in VSN

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Abstract: ***Visual sensor networks are emerging as a research technology and are deployed to get the visual data from the monitored field such as habitat monitoring, enriching monitoring and control applications. Set of camera are deployed to control sensor nodes to fetch the information from time critical monitoring and visual information such as images and video streams are sent to the destination node synchronously. Requiring a differentiated treating of the network when compared with non-critical visual data. In such way, we consider the source sensor nodes may have different sensing relevance mechanism for the application, based on the monitoring task and the current sensors' poses and fields of view, In this paper we propose a delay-aware multihop routing mechanism where higher relevant visual data packets are routed through paths with lower end-to-end delay. As sensor nodes are expected mainly depends on energy, transmitting only high relevant packets through shorter/faster paths may prolong their lifetime and assure longer time-critical delivering, with low impact to the overall monitoring quality. In simulation with NS2 we shown sending of high relevance data on delay aware sensor network..***

Keywords: Visual sensor network, routing, energy synchronous, sensor nodes..

1. Introduction

Visual sensor networks (VSNs) as shown in fig 1 are composed of resource constrained self-organizing nodes where some or all of them are endowed with a low-power camera for a series of innovative multimedia sensing functions. Visual information retrieved from the monitored field in the form of video streaming, conventional snapshots, infrared or thermal images can significantly enhance a large set of monitoring applications, besides fostering the development of new ones. City surveillance, tracking, disaster monitoring, home automation, industrial control, traffic management and battlefield surveillance are some of the applications addressed by by visual sensor networks.

The quality of visual sensor networks will be a function of how well an area of interest is viewed by the source nodes. And such quality depends on the actual application requirements, which dictate what, when and with which constraints a set of static or moving targets or even an area of interest must be monitored by the deployed source sensors.

Therefore, source nodes may have different relevancies for the application, according to the monitoring requirements and the current cameras' poses and fields of view. As visual source nodes follow a directional sensing model where redundancy is uncommon, source nodes can be directly mapped to a relevance level according to the importance of the retrieved visual information for the application.

Figure 1: Visual sensor networks

Characteristics of Visual sensor networks
Following are the characteristics of a visual sensor networks.

- **Resource Requirements**

The lifetime of battery-operated camera nodes is limited by their energy consumption, which is proportional to the energy required for sensing, processing, and transmitting the data.

- **Local Processing**

Local (on-board) processing of the image data reduces the total amount of data that needs to be communicated through the network. Local processing can involve simple image processing algorithms as well as more complex image/vision processing algorithms.

- **Real-Time Performance**

Most applications of visual sensor networks require real-time data from the camera nodes, which imposes strict boundaries on maximum allowable delays of data from the sources (cameras) to the user.

- **Precise Location and Orientation Information**

In visual sensor networks, most of the image processing algorithms require information about the locations of the camera nodes as well as information about the cameras' orientations.

- **Time Synchronization**

The information content of an image may become meaningless without proper information about the time at which this image was captured. Many processing tasks that involve multiple cameras (such as object localization) depend on highly synchronized cameras' snapshots.

- **Data Storage**

The cameras generate large amounts of data over time, which in some cases should be stored for later analysis. An example is monitoring of remote areas by a group of camera nodes, where the frequent transmission of captured image data to a remote sink would quickly exhaust the cameras' energy resources.

- **Autonomous Camera Collaboration**

Visual sensor networks are envisioned as distributed and autonomous systems, where cameras collaborate and, based on exchanged information, reason autonomously about the captured event and decide how to proceed.

Applications of Sensor Networks

- **Surveillance**: Surveillance has been the primary application of camera-based networks for a long time, where the monitoring of large public areas (such as airports, subways, etc.) is performed by hundreds or even thousands of security cameras.
- **Environmental monitoring**: Visual sensor networks can be used for monitoring remote and inaccessible areas over a long period of time.
- **Smart homes:** There are situations (such as patients in hospitals or people with disabilities), where a person must be under the constant care of others.
- **Smart meeting rooms:** Remote participants in a meeting can enjoy a dynamic visual experience using visual and audio sensor network technology.

In time-critical monitoring applications, visual information transmitted from high-relevant source nodes will need to reach the sink with minimal end-to-end delay. As more than one transmission path may be available from source nodes to the sink and a single node may route packets from different sources, we propose a delay-aware routing mechanism where the sensing relevance is considered when deciding the transmission path that visual packets must be forwarded to. Doing so, we achieve two distinct objectives: 1) the most relevant information for the application is transmitted with lower end-to-end delay and 2) energy is preserved over paths with lower delay since they will receive less average traffic. In the proposed approach, low-relevant packets will still be transmitted, but they will flow over the remaining “worse” paths. As such visual data packets are expected to have low impact to performed monitoring [7], the overall application quality is not warmed. Employing the proposed routing approach, the time-critical delivering capability of the network is expected to last for longer, keeping high accordance with the monitoring requirements of the application. We performed simulations to estimate the average end-to-end transmission delay and the energy consumption when the proposed mechanism is adopted.

The remainder of this paper is organized as follows. Section II presents the related works. The problem formulation is presented in Section III. Section IV brings the proposed routing approach. Some simulation results are presented in Section V, followed by conclusions and references.

2. Related Work

Different routing approaches have been investigated in recent years for visual sensor networks, addressing issues as energy-efficiency, delay constraints and data packet prioritization.

In D. Costa and L. Guedes. “Exploiting the sensing relevancies of source nodes for optimizations in visual sensor networks”. Wireless ad-hoc networks composed of resource-constrained camera-enabled sensors can provide visual information for a series of monitoring applications, enriching the understanding of the physical world. In many cases, source nodes may have different sensing relevancies for the monitoring functions of the applications, according to the importance of the visual information retrieved from the monitored field. As a direct result, high quality is only required for the most relevant information and, as it is expected that many visual monitoring applications can tolerate some quality loss in the data received from the least relevant source nodes, the network operation can be optimized exploiting this innovative concept. As a novel global QoS parameter, the sensing relevancies of source nodes can be considered for a series of optimizations in different aspects of the wireless sensor network operation, achieving energy saving or assuring high quality transmission for the most relevant data. This paper describes some approaches for the establishment of the sensing relevancies of the nodes and proposes a protocol to support them.

P. Leelapornchai, T. Stockhammer. “Progressive image transmission applying multipath routing in mobile ad hoc networks” The objective is to minimize the power consumption and end-to-end distortion when transmitting images. Therefore, a progressive image coding in combination with unequal erasure protection is used. There are two different scenarios, independent packet loss events and path loss events. For both cases, the expected distortion for progressive image transmission without error protection as well as for unequal erasure protection has been derived. Also, the expected power consumption for a certain path allocation pattern is obtained. The construction of operational distortion-power curves is presented by optimizing the unequal error protection and extracting the convex hull of all possible path allocation patterns. The profit of applying UEP to the progressively coded image bit stream in a multipath environment is shown. The presented error protection and rate allocation can be used as a framework for studying the allocation problem concerning the tradeoff between power and distortion for progressive image transmission in different multipath environments.

3. Proposed System

Some monitoring applications may require transmission of crucial visual information with minimal delay. However, packet transmission over the network consumes most part of energy, directly defining the network lifetime. In such way, transmission paths with lower end-to-end delay should only be used for transmission of high-relevant packets, potentially prolonging the time-critical delivering capability of the network. In this section we formulate the transmission delays and energy consumption issues in visual sensor networks , I order to facilitate the analyses of the proposed approach.

3.1 End-to-End Delay

The transmission delay may be originated from different aspects of wireless communications. Among these aspects, we can highlight the radio operation, the medium access mechanism, the congestion control, the error recovery and the transmission rate. The most usual radio hardware is equipped with a single wireless antenna, and thus the radio must be turned on to receive packets from neighbor nodes. In fact, it may be that the radio is turned on but no packet is being received, what is referred as idle listening. As idle listening may rapidly deplete the energy resources of the nodes, duty cycle protocols are employed to insert sleeping periods into the radio operation [14], but node sleeping may increase the communication delay. Besides this, medium access procedures may result in collision and additional delay, as well as when data corruption requires packet retransmission. At last, higher layer mechanisms for congestion control and error recovery also affect the perceived delay of the communication.

Architecture:

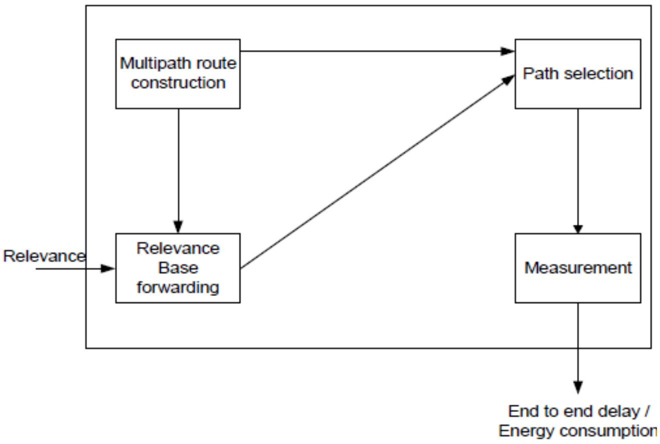

Figure 2: Architecture

System architecture as shown in fig 2 is the conceptual design that defines the structure and behavior of a system. An architecture description is a formal description of a system, organized in a way that supports reasoning about the structural properties of the system. It defines the system components or building blocks and provides a plan from which products can be procured, and systems developed, that will work together to implement the overall system.

3.2 Energy consumption

The actual energy consumption in each node due to communication depends on many factors, as the employed radio hardware, the transmission power and the physical and MAC protocols. As a result, mathematical formulations considering specific details of physical and MAC operations are very complex, pushing energy consumption models to incorporate some level of simplification [15][16]. We expect that the transmission rate in a routing path directly impact the end-to-end delay. But does it also impact the energy consumption over the path? Still images or videos produced by source nodes are expected to be transmitted in small data packets (reducing the error probability [17]) and with the same size, and typically many packets will be necessary to transmit even small pieces of visual data. In order to achieve minimal transmission overhead, full-size packets should be transmitted. We consider that every data packet has the same size in bits, k, corresponding to the entire packet (data payload plus physical, MAC, network and application layers protocol headers). The size in bits of all protocol headers in each packet is defined as z, resulting in an effective payload area of (k – z) in each data packet. For a network composed of S source nodes, we assume that each source node s, s = 1,…,S, will transmit Ds data packets in fs seconds. Considering either lossless or fully-reliable wireless links, each intermediate node in the path from the source s to the sink will have to relay at least (T/fs).Ds data packets, for a period of T seconds.

3.3 Delay-aware multipath routing

Multihop visual sensor networks are likely to be composed of several source nodes, which may be connected to the sink through more than one transmission path. A single intermediate node may belong to more than one transmission path, depending on the nodes positions after deployment and the available paths discovered by the routing protocol. Those router nodes may be used to route packets employing some policy depending on the adopted optimization approach. In many cases, source nodes may have different monitoring relevancies for the application, defining a novel global QoS parameter for optimization purposes. In [7], we defined that the sensing relevance of each source node is represented by a numeric value referred as the Sensing Relevance (SR) index, ranging from 0 to 15. As expressed before, the significance of the retrieved visual data and the corresponding SR depend on the application monitoring tasks and the network configuration after deployment. In [7] the sink is expected to compute the values of SR using some automatic or manual approach, associating each source node to a group of relevance. The final SR is locally computed by each source node considering such classification and some hardware characteristics as camera's resolution and processing characteristics. Source nodes transmitting packets over the network have to include their own 4-bit SR value in each transmitted data packet. Although such requirement may incur in additional energy consumption, the actual impact depends on the adopted MAC technology and wireless radio [19], and the inclusion of optimization information in data packets is a common approach largely adopted by the academic community [9]. We assume that a SR is already established to each source node employing any assignment approach defined in [7]. Additionally, we assume that the transmission paths are already created using some routing protocol [8] and that the available paths are known by router nodes. Some routing protocols as [20] can provide information of the number of hops of the path, and this information will be considered during routing since the end-to-end delay will be estimate based only on the number of hops of the paths.

4. Simulation Results

Scenario 1:

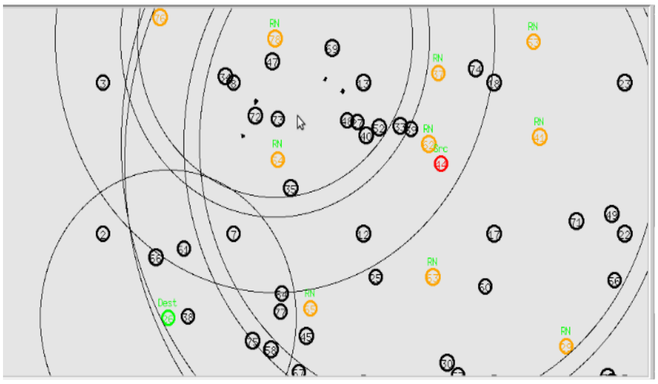

Figure 3: Forwarding the packet through different path.

Fig 3 shows the source node (44) forwarding the packets through the relay nodes 62-78-26

Scenario 2:

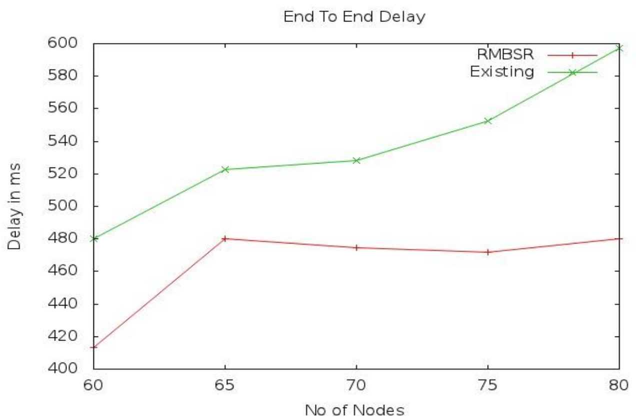

Figure 4: Comparison Graph

Fig 4 shows the comparison graph of end to end delay of the existing system and proposed system.

5. Conclusion and Future Work

In the project a SR-based delay-aware routing mechanism is used where high relevant packets are transmitted through the shortest paths in order to reduce the end-to-end delay. Doing so, the application monitoring quality is potentially enhanced, directly benefiting time-critical monitoring applications when the best paths are preserved. As intermediate nodes take their own decision about routing, some looping may be created if the network is not properly configured. More complex sensor network scenarios will be considered when assessing the proposed routing mechanism. Moreover, when better paths relating to end-to-end delay run out of energy, the routing node may change the current routing policy, reconfiguring the way packets are routed over the remaining paths. New simulations will be conducted considering such dynamical behavior of the network. Besides, future works will also consider the assessment of the monitoring quality of the application concerning the monitoring delay.

6. Acknowledgment

Abhishek Matmari, thanks to Mr. Sudhakar K N, who is always encouraging and motivating me to do research activities. I am also very thankful to my families and friends.

References

[1] D. Costa and L. Guedes. "The coverage problem in video-based wireless sensor networks: a survey". Sensors, vol. 10, pp. 8215-8247, 2010.

[2] I. Almalkawi, M. Zapata, J. Al-Karaki, and J. Morillo-Pozo, "Wireless multimedia sensor networks: current trends and future directions", Sensors, vol. 10, pp. 6662-6717, 2010.

[3] I. Akyildiz, T. Melodia, and K. Chowdhury, "A survey on wireless multimedia sensor networks", Computer Networks, vol. 51, pp. 921- 960, 2007.

[4] S. Qaisar, H. Radha, "Multipath multi-stream distributed reliable video delivery in wireless sensor networks", in Proc. Conference on Information Sciences and Systems, March 2009, pp. 207-212.

[5] V. Lecuire, C. Duran-Faundez and N. Krommenacker, "Energyefficient image transmission in sensor networks", International Journal of Sensor Networks, vol. 4, no. 1-2, pp. 37-47, 2008.

[6] Costa and L. Guedes. "Exploiting the sensing relevancies of source nodes for optimizations in visual sensor networks". Multimedia Tools and Applications, in press, 2011.

[7] J. Al-Karaki, A. Kamal. "Routing techniques in wireless sensor networks: a survey", IEEE Wireless Communications, vol. 11, pp. 6-28, 2004.

[8] D. Costa and L. Guedes. "A survey on multimedia-based cross-layer optimization in visual sensor networks". Sensors, vol. 11, pp. 5439- 5468, 2011.

[9] P. Leelapornchai, T. Stockhammer. "Progressive image transmission applying multipath routing in mobile ad hoc networks". in Proc. International Conference on Image Processing, Rochester, MN, USA, September 2002, pp. 553-556.

[10] H. Wang, D. Peng, W. Wang, H. Sharif. "Optimal rate-based image transmissions via multiple paths in wireless sensor network. in Proc. IEEE Multimedia and Expo, Beijing, China, July 2007, pp. 2146-2149.

[11] L. Zhang, M. Hauswirth, L. Shu, Z. Zhou, V. Reynolds, G. Han. "Multi-priority multi-path selection for video streaming in wireless multimedia sensor networks". Lecture Notes in Computer Science, vol. 5061, 439-452, 2008.

[12] L. Zhou, X. Wang, W. Tu, G. Mutean, and B. Geller, "Distributed scheduling scheme for video streaming over multi-channel multi-radio multi-hop wireless networks,"

IEEE Journal on Selected Areas in Communications, vol. 28, no. 3, pp. 409-419, 2010.
[13] T. van Dam, K. Langendoe. "An adaptive energy-efficient MAC protocol for wireless sensor networks", In Proc. SenSys, Los Angeles, USA, pp. 1-10, 2003.
[14] W. Heinzelman, A. Chandrakasan, H. Balakrishnan, "An applicationspecific protocol architecture for wireless microsensor networks", IEEE Transaction on Wireless Communications, vol 1, no. 4, pp. 660-670, 2002
[15] F. Bajaber, I. Awan, "Adaptive decentralized re-clustering protocol for wireless sensor networks". Journal of Computer and System Sciences, vol 77, pp. 282-292, 2011.
[16] J. Korhonen and Y. Wang. "Effect of packet size on loss rate and delay in wireless links". in Proc. IEEE Wireless Communications and Networking Conference, New Orleans, USA, pp. 1608-1613, 2005.
[17] D. Costa, L. Guedes, A discrete wavelet transform (DWT)-based energy-efficient selective retransmission mechanism for wireless image sensor networks, Journal of Sensor and Actuator Networks, vol. 1, no. 1, pp. 3-35, 2012.

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