International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Inference Framework for Smart Surveillance

Pooja Pande[1], T. Tamilarasi[2]

[1]Student at Department of I.S.E M.S. Ramaiah Institute of Technology, India

[2]Assistant Professor in Department of I.S.E M.S. Ramaiah Institute of Technology, India

Abstract: ***Video surveillance is rapidly growing in the area of public safety, facilities surveillance, and traffic monitoring. In visual sensor network, the visual information of the monitored field from any arbitrary point is provided to user. In a centralized system, video streams from different cameras are sent to a control system where human operator monitors it. This paper proposes enhancement in previously used algorithm to accomplish scalable smart video surveillance. Previous work relies on an algorithm for work-tree formation, which is designed to reduce the redundant data processing by maximizing the overlapping index [1]. The new approach takes account of battery and packet-drop at each node. This new approach when implemented will solve the problem of overloading at the base node, and loss of information in case of low battery and packet-drop.***

Keywords: Wireless Sensor Network, Visual Sensor Network, Smart Video Surveillance, Field of View (FoV).

1. Introduction

Sensor networks comprise a rapidly growing field of research with numerous applications for both military and civilian problems [1, 2].

In wireless sensor networks small devices having their own Sensing, computation and communication component and power source are connected. These networks are basically Distributed and ad-hoc and they usually used for the monitoring purpose and collect the related information. [3]

To make visual sensor networks (VSNs) suitable where temporary monitoring is needed, camera-nodes are powered by batteries. VSNs are used in wide range of applications like remote and distributed video-based surveillance, ambient assisted living and personal care applications, Virtual reality etc. With these new opportunities of VSNs, come the new challenges. In VSNs camera node generate a huge amount of data. Due to this huge amount of data, processing and transmitting such data is challenging because of computational and bandwidth requirements. A limitation on available power means that problems such as inference and estimation in sensor networks must be carefully considered. In particular, communication typically takes many times the amount of energy required for computation or sensing [4].

1.2. Related Work

A lot of research has been done in the area of camera selection in a camera-based wireless network. In case of camera sensors, the complexity of coverage issue increases as three dimensional coverage of space is required. Huang et al. [5], analytically verifies that 3D coverage can be done in polynomial time but they did not consider the issue of coverage optimization. The reason is that in VSNs the cameras that cover same area may be far from each other because of a camera's field of view (FoV) whereas in WSNs coverage and connectivity go hand in hand. In [6] Soro and Heinzelman applied DAPR, an application aware routing and coverage preservation protocol which is designed for traditional WSNs. The authors of [6] found that DAPR behaves differently for VSNs. In [7] Yongil Cho, Sang Ok Lim and Hyun Seung Yang propose a collaborative inference framework for visual sensor networks. In their work they present an algorithm to form a work-tree from semantic topology which is based on the common FoV of cameras.

2. Inference Problem in Sensor Networks

2.1. Inference Problem

In sensor networks, because of sampling and unexpected conditions combining the local measurements is required to have a globally consistent inference [8]. Now as the number of nodes increases in the sensor network, a multitier architecture became popular to overcome the inference problem [9].

In case of homogeneous sensor network, two problems are considered: how to cluster the sensor nodes and which node is responsible for the global inference of its cluster. As a multitier architecture is designed, which node to select as an anchorage node for global inferences comes into picture. The selected nodes of each cluster collects data and combines them and send the information to the upper tire.

In VSNs, as camera nodes have directivity and different sensing ranges, overlapping field of view is most effective criterion for forming clusters. The graph formed is referred to as a Semantic Topology or by a similar name such as Camera Topology, Vision Graph, or Scene Graph [10].

3. Global Inference in VSNS

3.1. Semantic Topology

Semantic topology is build based on the overlapping FOV of camera. In semantic topology two cameras are connected to each other via line, if there FOVs are overlapping. Every isolated subset graph is considered as cluster in the two-tire VSNs. Figure 1 [7] shows how the nodes can be clustered according to:

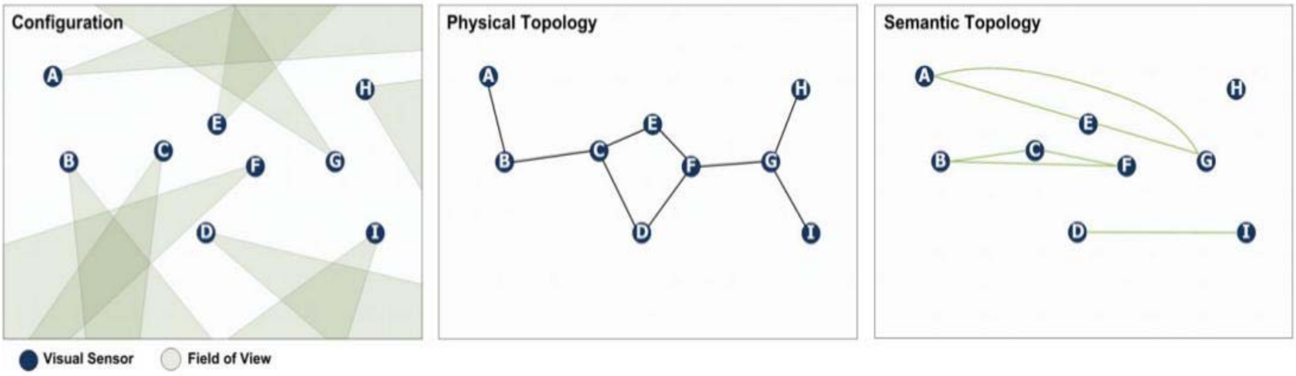

Figure 1: A visual sensor network configuration and topologies built according to different points of view. Physical topology shows the topology of the leftmost VSNs based on geometric proximity. Semantic topology shows the topology of the leftmost VSNs based on FOV overlapping constraints.

In the framework, sensor nodes in the network are grouped together into clusters using the overlapping FoV. Based on equation 2, anchorage node is chosen, which is responsible for global inference

Within a cluster, to form a work tree, the amount of overlapping between two nodes is used as the basis. The asymmetric weights of all the edges in the semantic topology is defined as [7]

$$\text{weight}_{src}(dst) = \text{overlapped FOV of Src with dst / FOV of src} \quad (1)$$

3.2 Work-Tree Formation

In VSNs, the passing of data from each node to a root node can be considered as message passing problem [9] [13]. This can be efficiently solved with the help of spanning tree. A work tree can be built from the semantic topology using breadth first search.

Algorithm 1 describes how to build wok-tree [7].In this approach, data is combined simultaneously within multiple nodes for distributed processing. Now for each node except leaf nodes, data transmitted from child nodes is combined and passed to parent node. As in VSNs, size of data tends to be very large; work tree is built in such a way that as many parent and child node pairs have overlapped views as possible, so that the size of the combined data at each node process is maximized.

For every tree, a root node is to be selected. To select a root node, stability factor is defined. Let us assume a work-tree that is composed of n nodes and for which the root node of the tree is R. The tree has the set of edges E = {(c1, p1)... (c_n, p_n)} ; The stability of the tree is defined as:

$$\text{Stability}(R) = \sum_{e}^{E} \text{weight}_{e.child}(e.parent) \quad (2)$$

If the tree with the root node R has the maximum stability according to (2) then we choose the node R as the anchorage node of the cluster.

Algorithm 1: Work Tree from Semantic Topology

Input: Root node r, semantic topology
Output: Work-tree structure

1. set r.parent = monitoring server;
2. set P := {r};
3. set C := {};
a. foreach node p in P do
b. foreach node n in neighbor of p do

i. if n.parent is null then
1. C += n;
2. if n.parent is null then
a. n.parent = p;

ii. else if n.parent is in P then
1. if weight(n to n.parent) < weight(n to p) then
a. n.parent = p;
4. if C is not empty then
a. P := C;
b. goto line 3;
5. end;

* neighbor: a set of connected nodes in semantic topology.

4. Proposed Concept

Now in the proposed algorithm the for work tree formation, factors like packet drop, load capacity, battery of each node is not considered. Suppose for the selected semantic topology, we can have five different works tress's each having its own stability factor. As per the proposed algorithm, the work tree with maximum stability factor has to be selected with the node R as the anchorage node of the cluster. But if for the selected work tree, if any of the parent node for this particular work tree has more of packet drop, the data loss will be more compared to other work trees even if the stability factor is less. In case of the more packet drop for any of parent node we cannot guarantee better coverage.

The given algorithm can be modified in such a way that it gives equal weightage to both stability factor and packet drop of node. The concept of equal weightage can be modified to any better ratio based on the scenario where the surveillance is done, for example if the surveillance area has more of noise then more weightage can be given to the packet drop and vice versa.

Further, matrix like battery life of each node, communication cost between nodes can also be included all the above mentioned factors can be combined to design load balancing matrix (in terms of maximum number of child any parent node can have).

The new algorithm will be more realistic as it will be considering all the real time factors that can affect the performance of VSN.

4. Conclusion & Future Work

In this article we have highlight the potential bottle neck of the proposed algorithm for the inference frame work and suggested a concept by which the algorithm can be enhanced for the better performance in real time environment.

References

[1] H. Gharavi and S. Kumar. Special issue on sensor networks and applications. Proceedings of the IEEE, 91(8):1151–1153, August 2003
[2] S. Kumar, F. Zhao, and D. Shepherd. Collaborative signal and information processing in micro sensor networks. IEEE Signal Processing Magazine, 19(2):13–14, March 2002
[3] CHALLENGING ISSUES IN VISUAL SENSOR NETWORKS YOUSSEF CHARFI, BELL CANADA NAOKI WAKAMIYA AND MASAYUKI MURATA, OSAKA UNIVERSITY
[4] R. Min, M. Bhardwaj, S. Cho, N. Ickes, E. Shih, A. Sinha, A. Wang, and A. Chandrakasan. Energy-centric enabling technologies for wireless sensor networks. IEEE Wireless Communications Magazine, 9(4):28–39, August 2002.
[5] C. Huang, Y. Tseng, and L. Lo, “The Coverage Problem in Three-Dimensional Wireless Sensor Networks,” *Proc. IEEE GLOBECOM ‘04*, 2004.
[6] S. Soro and W. Heinzelman, “A survey of visual sensor networks,” *Advances in Multimedia*, vol. 2009, pp. 21, Article ID 640386, 2009.
[7] Y. Cho et al.: Collaborative Occupancy Reasoning in Visual Sensor Network for Scalable Smart Video Surveillance
[8] M. Paskin, C. Guestrin, and J. McFadden, “A robust architecture for inference in sensor networks,” In Proc. of International Symposium on Information Processing in Sensor Networks, 2005.
[9] Y. Charfi, N. Wakamiya, and M. Murata, “Challenging Issues in visual sensor networks,” IEEE Wireless Communications, vol. 16, no. 2, pp. 44-49, 2009.
[10] R. J. radke, "A survery of distributed computer vision algorithms,” Handbook of Ambient Intelligence and Smart Environments, pp. 35, 2010.

Author Profile

Mrs. T. Tamilarasi obtained her M.E. degree from Anna University in 2005. Her area of interest is Sensor networks and internet computing. She is currently working as Assistant Professor in M.S.Ramaiah Institute of Technology in Information Sciences & Engineering.

Pooja Pande is from Bhopal M.P. She is currently pursuing M.Tech from M.S.Ramaiah Institute of Technology in Information Sciences & Engineering.