Maintaining Differentiated coverage for moving targets in directional visual sensor networks

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***Abstract*—**

I. Introduction

Wireless visual sensor networks (WVSN) consists of a set of (smart) visual sensors capable of self-controlling their orientations in order to monitor a set of target points. Directional Recently visual sensor networks have drawn considerable attention of researchers due to their enormous applicability in real-world scenarios like surveillance system, environment monitoring, smart traffic controlling system etc.

The coverage issue is a fundamental problem for wireless visual sensor networks. The way the targets are covered or monitored by the visual sensors or cameras in an WVSN is very important and the complexity of the coverage depends on whether omnidirectional or directional sensors are used. Directional sensor nodes work in a specified direction at a given time. They may adjust their working direction based on the requirements of the application.
Fig. 1 (a) shows how an omnidirectional sensor work and Fig. 1 (b) shows how a directional sensors work. A target is said to be covered by a sensor if that target lies within a active sensors sensing range and that active sensor is oriented towards that target. In the first case, an omnidirectional sensor covers three targets t1,t2,t4 wheares in the second case a directional sensor can cover either t1, or t2 or t3 but not all of them depending on its active pan. Therefore, coverage optimization in directional sensor networks has newly taken attraction of the research community. Since traditional sensor networks omni-directional sensing model, does not overcome difficulties of directional sensor nodes, such as field of view, directionality, etc.
Another fundamental issue faced by current sensor network deployment is to provide the required coverage efficiently which is known as differentiated coverage. Specifically, there is a question of how to guarantee that every point or location in the target region is continuously covered by a certain number of sensors, with the objective to prolong the network lifetime as much as possible. Moreover, tracking moving targets or points in network area is one the research issues in the literature till now. The task of multi-object detection and tracking is first to detect the location of multiple moving objects in video sequence and then to record their trajectory information for predicting their next position in the network area.

In this paper, our target is to provide a cooperative multiple target tracking system for differentiated targets in wireless directional visual sensor networks. Therefore, we focus on to handle the three major challenges of WVSNs in our single

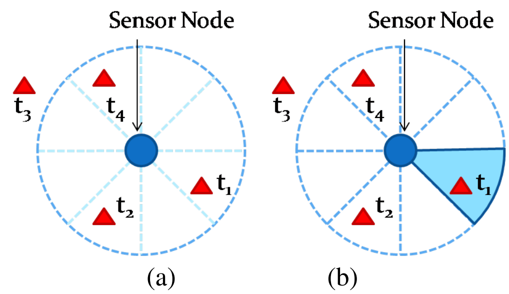

Fig. 1. Target coverage by (a) omnidirectional sensor and (b) directional sensor

work efficiently and effectively.

II. Literature Review

Over the past decade, a large number of researchers are exploring fundamental issues of visual sensor networks such as the optimal placement of sensors, energy efficient scheduling to extend network lifetime [1]. Ma and Liu [6] presented the concept of directional sensor network and primarily discussed coverage problems of DSNs. They also proposed a method to solve the connectivity problem for randomly deployed sensors under the directional communication model.
In paper [3] Xiaojiang Du et al. proposed an energy efficient differentiated coverage algorithm for heterogeneous sensor networks forming clusters and introducing uniform sensing schemes. Moreover, the authors tried to keep minimum number of sensors to work in order to reduce energy consumption and investigated load balancing among different sensor nodes.
Jun Lu et al. [5] proposed an enhanced differentiated surveillance system called EDS to maintain the required coverage for sensor networks by establishing working schedules of sensors for the purpose of energy saving. This system allows every sensor to establish its working schedule in a distributive manner, based on random reference times generated through integer hashing and a proposed coverage measurement rule. This EDS can be applied to sensors with different sensing ranges and extended to random mobile sensor networks, where sensors randomly roam and cannot control their movements.

On the other hand, a lot of researches have already been performed for tracking moving objects in a sensor network field. However, handling multi objects tracking is more challenging and are little explored in the literature till now. Bo Jiang et al. [4] proposed a completely distributed particle filter (CDPF) designed for target tracking in WSNs towards minimizing the communication cost. This approach works for single object tracking in WSNs.
In paper [**?**] Chu et al. proposed a cooperative multi-object tracking method for Wireless Video Sensor Networks.The

main contributions of this paper is the sensing model of a video sensor and utilization of Kalman filter to achieve optimal sensor selection. The authors employed Projective Invariants to integrate information from the related nodes.

In another paper [2] Chu et al. proposed a multi-object detection and tracking method in wireless video sensor networks. The authors used mobile agents to communicate among network nodes, so the objects are assigned correct labels after multi-object occlusion in WVSNs. For detecting an object, this paper used Gaussian Mixture Model for Background Subtraction to extract the foreground and then applied the method of binarization, median filter and removing isolated noise points to detect the object. Moreover, in this paper, the minimum Euclidean distance is used for object matching, which is to set the objects in each successive frame as the same one if their centroids are the nearest for tracking the objects.

A recent work on tracking objects in Underwater Wireless Sensor Networks (UWSNs) have been performed by Majadi et al. [**?**]. This paper proposed a target localization protocol for single target tracking in UWSNs incorporating local search based energy saving tracking method presented a metaheuristic based algorithm by keeping the minimum number of sensors active to increase the network lifetime.

However, all these works did not addressed differentiated coverage along with multiple target tracking in directional WVSNs which is our main concern in this paper.

REFERENCES

[1] Yanli Cai, Wei Lou, Minglu Li, and X-Y Li. Target-oriented scheduling in directional sensor networks. In *INFOCOM 2007. 26th IEEE International Conference on Computer Communications. IEEE*, pages 1550–1558. IEEE, 2007.

[2] Zheng Chu, Jing Zhang, and Li Zhuo. A multi-object detection and tracking method in wireless video sensor networks. In *Fourth International Conference on Digital Image Processing (ICDIP 2012)*, volume 8334, page 83343L. International Society for Optics and Photonics, 2012.

[3] Zheng Chu, Li Zhuo, Yingdi Zhao, and Xiaoguang Li. Cooperative multi-object tracking method for wireless video sensor networks. In *Multimedia Signal Processing (MMSP), 2011 IEEE 13th International Workshop on*, pages 1–5. IEEE, 2011.

[4] Xiaojiang Du and Fengjing Lin. Maintaining differentiated coverage in heterogeneous sensor networks. *EURASIP Journal on Wireless Communications and Networking*, 2005(4):565–572, 2005.

[5] Bo Jiang and Binoy Ravindran. Completely distributed particle filters for target tracking in sensor networks. In *Parallel & Distributed Processing Symposium (IPDPS), 2011 IEEE International*, pages 334–344. IEEE, 2011.

[6] Jun Lu and Tatsuya Suda. Differentiated surveillance for static and random mobile sensor networks. *IEEE transactions on wireless communications*, 7(11), 2008.

[7] Huadong Ma and Yonghe Liu. On coverage problems of directional sensor networks. In *International Conference on Mobile Ad-hoc and Sensor Networks*, pages 721–731. Springer, 2005.

[8] Nazia Majadi, Mahmuda Naznin, and Toufique Ahmed. Energy efficient local search based target localization in an uwsn. In *Wireless and Mobile Computing, Networking and Communications (WiMob), 2016 IEEE 12th International Conference on*, pages 1–8. IEEE, 2016.