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Coverage Problem in Directional Sensor Network Due to Overlapping

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Abstract: The wireless sensor network comes into prominence because they have the capability to change our economy and life. The design, implementation, and operation of a sensor network requires the confluence of many disciplines, including signal processing ,networking and protocols, embedded systems, information management, and distributed algorithms. As a stream of sensor network, Directional sensor network covers the specified angle at a given time. As the sensors are randomly deployed there sensing direction may overlap among each other. To reduce this overlapping several techniques have been applied previously among which the technique related to the motility are preferred.

Keywords: Wireless sensor network (WSNs), Directional sensor network (DSNs), overlapping, intersection, Motility.

I. INTRODUCTION

Recent advances in wireless communications and electronics have developed a low cost, low-power, multifunctional sensor nodes that are small in size, power and communicate in short distances. These small sensor nodes, which consist of sensing, data processing, and communicating components, leverage the idea of sensor networks. Sensor networks represent a significant improvement over traditional sensors. A sensor network is composed of a large number of sensor nodes that are densely deployed [1] either inside the phenomenon or very close to it. The position of sensor nodes need not be engineered or predetermined. This allows random deployment in inaccessible terrains or disaster relief operations. On the other hand, sensor network protocols and algorithms must possess self-organizing capabilities.

Networking together hundreds or thousands of cheap micro sensor nodes allows users to accurately monitor a remote environment by intelligently combining the data from the individual nodes. Such type of networks requires wireless communication protocol that can provide prolong network lifetime and reduced latency.

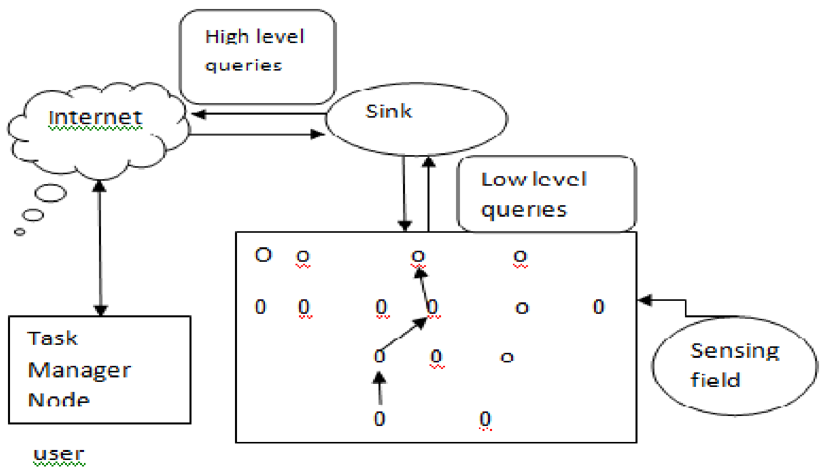


Fig 1:Architecture of sensor network

In figure 1, basic architecture of sensors is shown, it consist of sensing field where the sensors are deployed either randomly or in a deterministic fashion.WSN follows multi-hop communication to minimize the use of Power. Sensors deployed in sensing field can sense data in one of three possible case i.e. either in time driven fashion(they send data in a regular manner to the sink/base station) or in event driven fashion(sensed data has been sent only if some event occurs for example a fire detecting sensor would start alarming only if there is a fire) or in query driven fashion(when disseminate some query in the sensing field).Sink/base station with the help of many gateways transmit the data to user which is connected with an IP internetwork internet.

Network Architecture:

The network can be classified in two categories:

1. Homogenous/Flat: All the sensors nodes have equal role and responsibilities. But these type of network structure is not suitable for handling the data from multimedia application.
2. Heterogeneous: All sensor nodes have different roles and responsibilities. In such a network all nodes have different parameters.

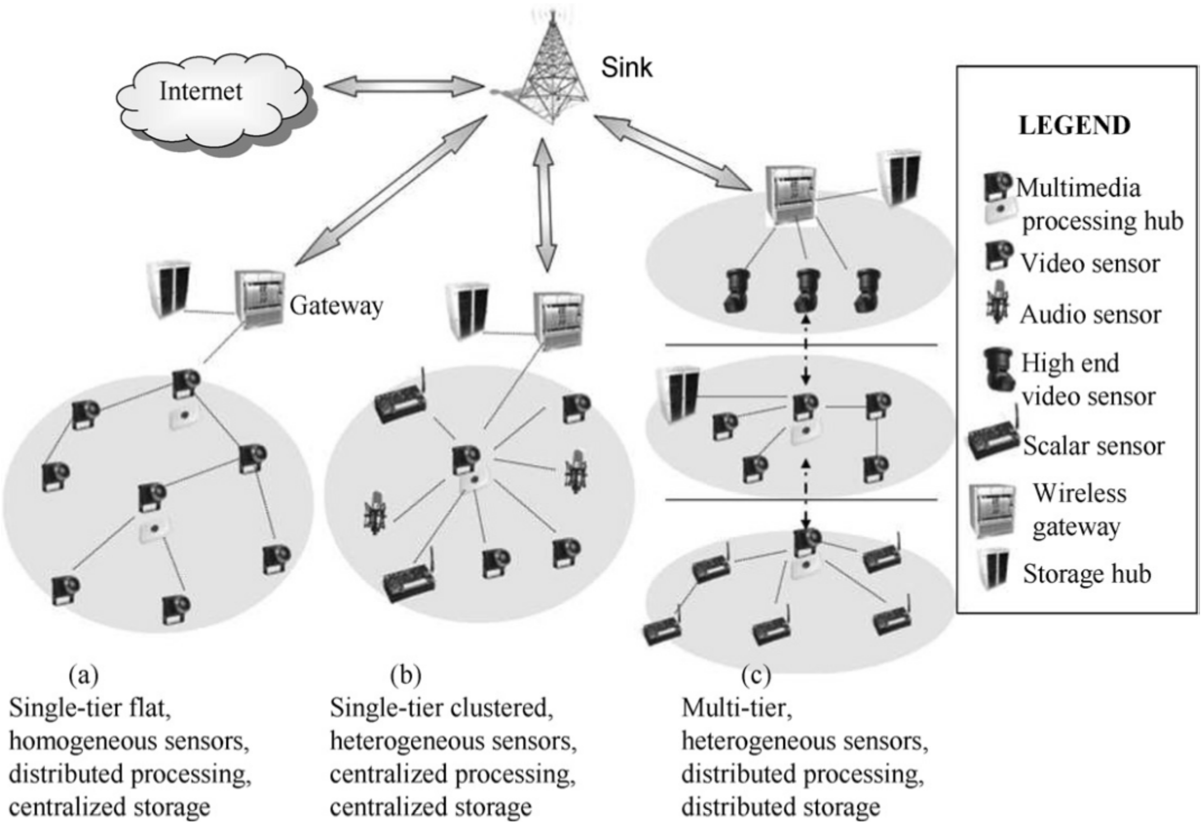


Fig 2: Network Structure

QoS of WSN is different from infrastructure network and adhoc network. Qos related to the sensor network is not fixed it varies according to the application. There are very few QoS providing routing protocol that provides a significant level of energy to ensure the network lifetime like sequential assignment routing protocol(SAR), SPEED, MMSPEED, Energy Aware QoS [2] routing protocol etc.

II. RELATED WORK

a) Energy estimation:

Sensor networks are basically application dependent but moreover densely deployed sensor network are preferred in most of the application because it improves SNR (signal to noise ratio) Ratio by decreasing the average distance of target from the sensors. Due to the unique attenuation characteristic of radio frequency signal (RF), a single hop communication network consumes more energy than the multi hop communication network. The strength of signal degrades as the inversely proportion of squared distance as presented in[3]. Say, distance between the hops is 'r'.

$$P \propto \frac{1}{r^2}$$

b) *Directional Sensors:*

Recently, in directional sensor networks, the coverage problem has been received a lot of attention from many researchers, not only in area coverage but also in target coverage as well. The difference between area coverage and target coverage is in the measurement of the coverage performance. In the area coverage problem, we are focused on the coverage performance on the covered region while in the target coverage problem; the coverage performance on the number of covered targets is considered. Therefore, we need to schedule sensors to face to certain directions to maximize the covered area of the whole network.

Directional Sensor Network (DSN) can be of three types i.e. ultrasonic, Infrared and video based sensors. The most common sensor is video based sensors. Before DSNs Omni-directional Sensors are used in which sensing directional is 360 °.

The main objective of Directional Sensor Network (DSN) is to have Maximum Coverage using Minimum Sensors. Directional Sensor Network (DSN) composed of various tiny, low powered match-box size sensors that have limited sensing direction unlike conventional sensors i.e. Omni-directional sensor. Main problem in DSN is to enhance the coverage area with prolong network lifetime and guaranteed connectivity. In DSNs coverage maximization is an important issue. In general the sensors are deployed randomly hence they might have overlapping sensing regions. Due to overlapping, coverage area is reduced and sensors may report redundant data. In the DSNs the coverage can be maximized by implementing the common mathematics to find the intersecting area of the sensing region then rotating the sensor to minimize the overlapping and maximize the coverage.

Wireless Multimedia Sensor nodes sense areas that are uncorrelated to the areas covered by radio neighbor sensors. Thus, node clustering for coordinating multimedia sensing and processing cannot be based on classical sensor clustering algorithms. Today, for random deployments, dense networks of low cost, low resolution and low power multimedia nodes are preferred than sparse cases of high cost, high resolution and high power nodes. Overlapping FoVs in dense networks causes wasting power of system because of redundant sensing of area. The main aim of the proposed work is to provide maximum coverage using minimum sensors method is energy conservation and prolonging network lifetime.

Need of directional sensors:

Traditional sensor is known as Omni-directional sensors having sensing angle of 360° i.e. it can sense in all directions. But due sensing in all direction causes following problems as:

1. Redundancy
2. Unnecessary power consumption.
3. Unnecessary processing
4. Sensors size becomes larger

Directional sensors differ from traditional Omni-directional sensor nodes with their unique characteristics, such as angle of view, working direction, and line of sight (LoS) properties.

Directional sensor nodes work in a specified direction at a given time t. They may adjust their working direction based on the requirements of the application. As sensors can be either static or rotatable, thus, in rotatable sensor whenever there is overlapping the sensors can change their direction.

To be clear, $\alpha R^2/S$ indicates that a directional sensor can monitor given area that is within its sensing region. Therefore, after N directional sensors are deployed, the probability that covers a given area is represented as[a]:

$$P=1-(1-\alpha R^2/S)^N$$

In other words, if the coverage rate of a given area is at least p, the number of deployed directional sensors should be represented by:

$$N= \ln(1-P) \;/\; \ln(S-\alpha R^2) - \ln S$$

Directional Sensors Coverage Problem:

The main objective of the Directional sensors is to maximize the coverage area by minimizing the energy consumption and the number of active sensor nodes.

Basically, the area coverage problem entails the following points:

1. Orient the sensors such that it covers the maximum area.
2. Minimize the overlapping problem.
3. Implement the MCMS policy i.e. maximum coverage with minimum sensors.

Problem Statement: To find a procedure to rotate the sensors to achieve the maximum coverage with minimum sensors and having a prolong network lifetime.

Overlapping Sensors:

From [b] it can be shown that, sensors S1, S2, S3, S4, S5 are deployed randomly .The arc formed represents the FoVs of the corresponding sensors. The overlapping area of the sensors is clearly visible in Figure 3. After rotating sensors by using certain specification or algorithms the overlapping areas can be reduced and the network can be represented as shown in Figure-4.

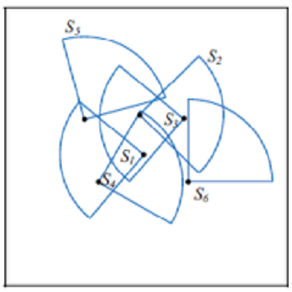


Figure 3: Before orientation

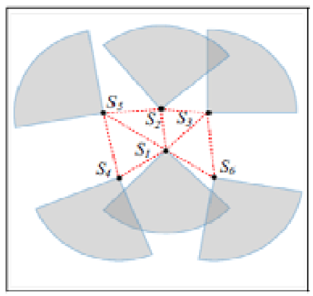


Figure 4: Before orientation

c) Comparative Study Between Static Sensors And Rotatable Sensors:

In Static sensors the following properties should hold:

1) Each directional sensor is homogeneous, such as sensing angle, sensing radius, communication radius.

2) Each directional sensor can sense only one limited angle of Omni-direction.

3) Each directional sensor have fixed sensing angle.

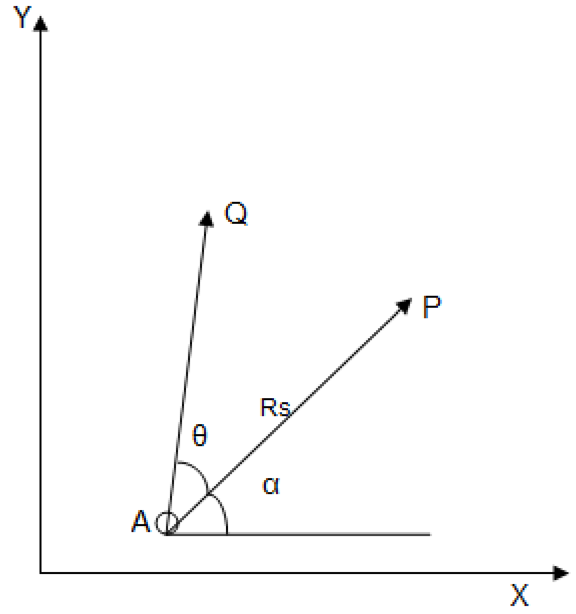


Figure 5: Features and architecture of directional sensors

In Figure 5:

A: Sensor node

α: Offset Angle or orientation angle

θ: Field of View(Sensing Region)

Rs: Sensing Radius

N: No. of Sensor

R_c : 2 *Rs (range of communication must be twice the range of sensing)

In static sensors, the sensing direction is decided by scheduling. In scheduling, two factors should be considered:

1) Size of covered region

2) Size overlapped region.

Scheduling is done on the basis of the priority and priority is decided as follows

1).least overlapped area first

2) Number of neighboring nodes i.e. the node have minimum neighbor will be scheduled first.

Whereas in rotatable sensors the following constraint should hold:

1) Each directional sensor is homogeneous, such as: sensing angle, sensing radius, and communication radius

2) Each directional sensor can sense only one limited angle of omni-direction

3) Each directional sensor is fixed and can rotate arbitrary angle in sensing region

4) The communication radius is twice than the sensing radius such that sensing neighbors can reliably communicate.

In this, each sensor have uses same scheduling process but to reduce overlapping sensor rotates the center line of sight of field of view to the largest angle bisector with its neighbors.

d) Overlapping Area between FoVs:

It is obvious that there is no overlap between FoV of two nodes if the Euclidean distance between them is more than 2Rs. Otherwise, as is done in [c] , calculate overlapped regions between their FoV depending on the orientation angles α. For calculating the FoV overlapping area of two nodes, first we survey intersection of the triangles that are the representatives of their FoVs. Second, if they intersect each other, we find the intersection polygon and at last, compute the area of the polygon. Hence, from Figure 5,

$$X_p = X_A + Rs\cos(\alpha)$$

$$Y_{p=}Y_A + Rs\ sin(\alpha)$$

$$X_Q = X_A \ + Rs\cos(\alpha + \theta)$$

$$Y_Q \ = Y_A + Rs\sin\,(\alpha + \theta)$$

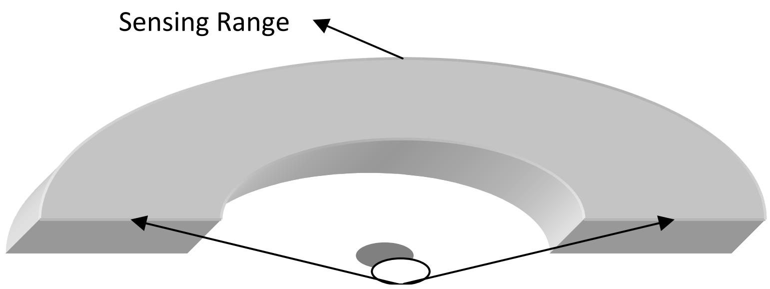


Figure 6: Sensing Range

Further finding equation of each lines and determining the intersection point of each side of each triangle to all sides of the other triangle. Furthermore, in the case of intersection, the vertices and also the sides of the overlapped polygon are found and accordingly a sensor can be rotated.

There are various cases of intersection:

Case 1: No interesting point

That is no overlapping FoVs.

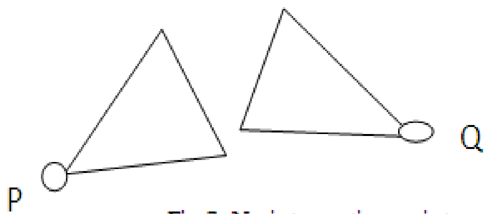


Fig 7: No intersection point

Case 2: one intersecting point on at least two sides of triangle

This case implies that lesser area is overlapped like

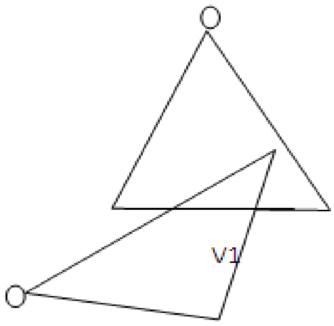


Fig 7: One intersection point

Case 3: Every side of triangle has 2 intersection point

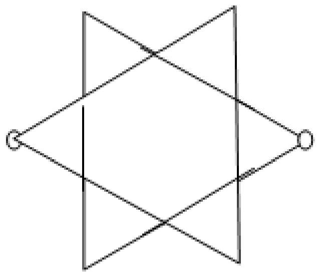


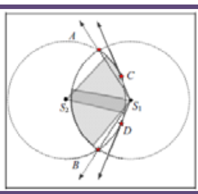
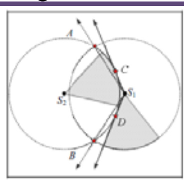
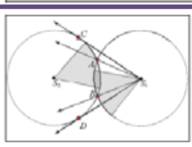
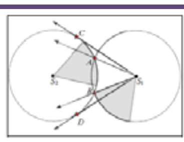
Fig 8: Two intersection point

That is wider area of sensing region is overlapped.

e) Methods to solve overlapping problem:

1. Sensors can be rotated on the basis of the intersection point and the distance between the sensors as explained:

TABLE 1: Study of various cases

S.no	Distance between the sensors	Before rotation diagram	After rotation diagram	Conclusion
2.	R<=Dist(s1s2)<$\sqrt{2}$ R			The one will move to the tangency point.
3.	R>=Dist(s1s2)			Move to the intersection point.

2. On the basis of the overlapped area(basically used in cluster formation)

To find the sensing region of any sensor first need to find the intersecting point and then the intersecting area of the polygon formed. The overlapped area is needed to identify so that the sensor having maximum area overlapped will be rotated especially in a case when more than two sensors sensing region is overlapped.

The procedure to compute the overlapping area is explained as:

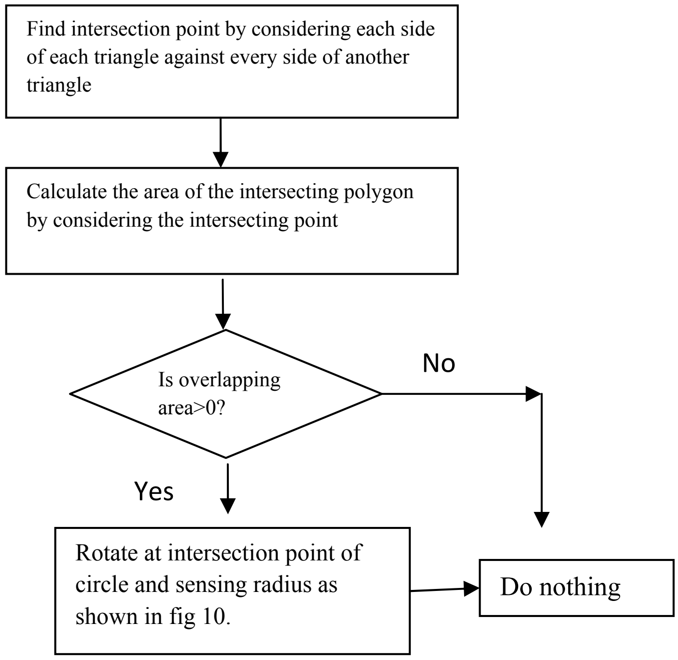


Fig 9: Flow Chart for checking intersection point

Major concern in this method is to enhance area coverage and reduce redundancy.

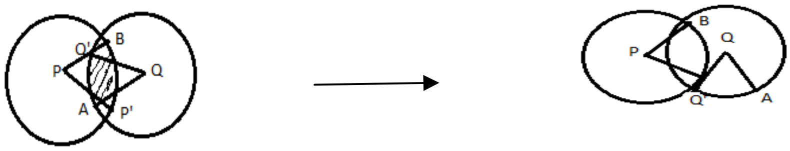


Fig-10 Reduced overlapping

By rotating the node Q at the intersection point of the circle of radius PB And line QA the overlapping area is reduced.

References

1. Ian F. Akyildiz, Weilian Su, Yogesh Sankarasubramaniam, and Erdal Cayirci ,"A Survey on Sensor Networks",published in 0163-6804/02/$17.00 © 2002 IEEE.
2. JAMAL N. AL-KARAKI, AHMED E. KAMAL**,"** ROUTING TECHNIQUES IN WIRELESS SENSOR NETWORKS: A SURVEY**",**published in 1536-1284/04/$20.00 © 2004 IEEE.
3. Chiu-Kuo Liang **,** Chih-Hung Tsai, Ting-Hao Chu Coverage "Enhancing Algorithms in Directional Sensor Networks with Rotatable Sensors", published in 2011 IEEE Asia -Pacific Services Computing Conference.
4. Mohammad Alaei, Jose M. Barcelo-Ordinas," Node Clustering Based on Overlapping FoVs for Wireless Multimedia Sensor Networks",published in IEEE Communications Society subject matter experts for publication in the WCNC 2010 proceedings.