Event Detection Techniques in WSN: Review

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Abstract— A Wireless Sensor Network (WSN) is a group of small sensor nodes. Sensor nodes are used to sense physical or environmental conditions. WSNs are mainly used in defense and military application. As the need to go into the physical world increases, the activation and sensing tasks become more complicated. WSNs suppose to aid more complex applications. Regardless of the particular application running on the network, sensor node should be able to individually or jointly provide various event services and also report that events The main function of WSNs is the event detection which helps to manage the disaster. Occurrence of certain phenomenon is called event. This paper aims to study, discuss and analyze the various techniques for the event detection in Wireless Sensor networks.

Keywords— Wireless sensor network, Event detection, Sensor Nodes

I. INTRODUCTION

Wireless sensor networks (WSNs) are constructed of many small devices, called sensor nodes, they are randomly distributed over a large location. The sensor nodes consist of a sensing unit, data communication unit, and processing units, which enable them to view the physical world, exchange and communicate the sensory data collected with other nodes. The sensed data are local processed and make decisions about the phenomena. This will results in the determination of unusual data and events in the environment. This feature is called as event detection. Event detection in WSNs has reached more attention in applications, such as wildlife monitoring, natural disaster relief, military and health care. The ability of sensor nodes in a WSN can vary widely, the simple sensor nodes may view a single physical occurrence, while more compound devices are used for different sensing techniques. They also vary in their communication ability with different data rates and delay. Simple sensors are used to collect and communicate information about the sensed environment, but more powerful devices are capable of complex processing and aggregation functions. Deployment of node is an important problem to be solved in WSNs. The complexity of problems in WSNs is reduced by choosing a proper node deployment scheme i.e. decrease in energy consumption and hence increases life time. The main goal is to find high-accuracy event detection at less energy cost in order to increase network lifetime[1]. There are certain parameters that should be needed in event determinations such as a low false alarm rate, timeliness and a high true detection rate.[3]. WSNs have limited resources such as battery, memory and computing capabilities. However, it is difficult to create an event detection with these resource scarcity. WSN suffers from certain challenges while determining an event[4]. The paper is organized as follows: section 2 problems faced in event detection, section 3 event detection techniques in WSN.

II. CHALLENGES IN WSN EVENT DETECTION

A. Situational Dependence

WSNs are used in a large number of applications. Different situation needs different event detection method. For instance, some measures that are used to detect an event in military application cannot be applied to the medical applications. The network controller must consider various aspects in environments. This include the network size, type of applications, and the area where sensor nodes are deployed. Thus, finding an event detection method which is flexible to different situations is a crucial task.

B. Criticality of Application

WSNs are used in various critical applications such as defence, military and forest fire. Event detection methods in such crucial applications must have a high degree of accuracy and detect particular event within a particular time limit. The location identification of node provides the base for routing, density control, tracking, and various other communication aspects. Thus, it is essential in critical applications that the location of each node should be reported accurately.

C. Numerous and Diverse Data Sources

WSNs consists of hundreds to thousands of sensor nodes and can be deployed in various location meaning that there is a large size of sensed data from different sources of data. Sensed data may contain video, images, text documents, audio, multivariate records, relational data, and spatio-temporal data. Thus, event detection method must be capable to handle different data types and formats coming from various data sources.

D. Network Topology

In WSN applications, it is necessary to design efficient network topology, hence reduce energy consumption and increases network lifetime. In some WSNs, the topology of network changes regularly due to mobility and lifetime of sensor node. There is heterogeneity among nodes due different residual energy, transmission speed, transmission range, and nodal traffic. Thus, in case of heterogeneities WSNs, event detection method must behave depending on the motion of sensor node outside the intended viewing area, power consumption, node failures and finite node lifetimes, and balance the energy consumption in sensors.
III. EVENT DETECTION METHODS

3.1 Terrestrial WSN
3.1.1 Distributed Event Determination method
A. Event Signature based: The event signature which is based on the application is distributed over the network. The event signature and the sensor readings are compared to find the nodes whose value matches with the stored event signature[6].

B. Fault tolerant distributed event detection: In this method an event is determined based on the Bayesian approach suggested for WSNs. Due to packet drop in the network, the outputs of the network may fail. Kalman estimators are added to the scheme to avoid this issue. To find the statuses of the neighbourhood in the decision of each sensing point a data fusion algorithm is used[5].

C. Fuzzy logic based: Detection is the main function of WSN in many of applications. This approach is considered for a network with homogeneous nodes. Each of the nodes consist of various heterogeneous sensors and send the data processed to a Fusion Center (FC). Data fusion takes place in two steps: 1. Fuse the data from each sensor node, 2. The FC takes the final decision by fusing this data. At the FC, the correlation among the decisions made by node can be solved by adding the logarithm of the sum of nodes' decisions to that of statistic of the FC[7].

3.1.2 Outlier Detection [8]
A. Nearest Neighbor based approach: The data is analyzed with its neighbor. The distance is calculated using Euclidean distance method. Outlier condition if the data sensed is different from the neighbor.

B. Clustering based: In this method similar data are combined. The size of normal clustering of data are large and dense compared to cluster formed by outliers. Outlier condition is the deviation from normal sensing range.

C. Classification-Based Approaches: Classification approaches are based on logical approaches. They are used in the machine learning and data mining. In this method the outcome is predicated and the algorithm is trained using training set. The set consist of attributes and the corresponding outcomes, mainly called predication attributes. The method provides certain set of outliers by making a classification model to classify.

D. Spectral Decomposition-Based Approaches: Principal component analysis (PCA) technique is used for outlier detection. PCA reduces the dimensionality and finds a new subset of dimension having the nature of the data before outlier detection. The top few principal components capture the build of variability and any data instance which violates this pattern for the smallest components is considered as outlier.

3.1.3 Collaborative Event Detection
A. Fuzzy Logic based: Fuzzy logic is used to check the credibility of the clusters. At the fusion center, not all the clusters are taken. Decisions are made based on the credibility. This method improves the decision making of WSN, hence improves the accuracy of event detection. The use of crisp value cannot handle the problem of imprecise sensor reading occurring more often. This includes modeling of the incorrect reading of data and combining decisions of multiple sensor node with same data. The main problem is that it requires large memory for storage of rules[11].

B. Stochastic Model Based: Event determination is based on count of sensors, losses in message, measurement errors. The approach consist of two orthogonal availabilities for improving the event determination. Each node performs imperfect local event determination and send the local decisions through a network to a sensor node which uses more voting to decide the occurrence of event. An optimal stopping retry mechanism are developed for this model to reduce the probability of error in event determination[9].

C. Markov Random Field: Each sensor node is observed from its own hypothesis. Markov Random field is used for modeling the spatial correlation of sensors and a fusion algorithm based on sensors reliability. The algorithm is based on weight of sensor and spatial data[10].

3.1.4 Composite event detection
A. Event detection tree based: This approach helps to reduce energy consumption, hence network lifetime increases. The concept of event relationship are used to reduce the number of data to be transmitted and reduce the distance in data transmission[12].

B. CSMA based: The method uses spatial relationship of sensor node to improve efficiency in event determination. A query tree is constructed to remove network flooding. When event determination queries with aggregated data then the query tree consumes less energy. In order to filter and send information for event determination a spatial partial aggregate technique is used in CSMA model. Different sets of data are used for empirical studies[13].

C. Type Based: Multiple primitive events with temporal and spatial relations present in composite events are difficult to direct. The major goal of this approach is the selection of sensor nodes as fusion points. To detect higher level composite events lower level events are fused at selected fusion points. A distributed randomized algorithm is used to determine event most efficiently[14].

3.2. Underwater WSN
A. Distributed Event detection
The base station collects information from multiple sensor nodes and the decision is made from the sensing reports but due to dynamics in water, there is unpredictable movement of this sensor node and affect the accuracy of event detection. This issue can be solved by sensor virtualization approach. The final decisions is made with reports of multiple virtual sensors at the base station, this method improve accuracy and reduces energy consumption[16].

B. Monitoring courses approach
The entire network is divided into different cycles. Each cycle is equal to the distance between sensor node and sink node with atleast one cycle. When an event occurs the location is reported in the form of cycles, where the event sensors are placed. Due to water dynamics the position of sensor node always changes, Hence the cycle of sensor node
should also be re-established. Prediction mechanism are used to find the location of sensor[15].

C. Sensory data gathering technique
An event is deviation from normal sensing range with respect to some of the neighboring nodes. A single sensor can cause high error on the system called outlier condition. Neighboring sensor node detect the occurrence of event by communicating with the sensor nodes in order to check whether the value of sensed data is beyond a threshold value. This method will prevent unwanted routing of data to base station and results in decrease in energy consumption and increases network capacity. The occurrence of event only when the normal sensing range deviate from corresponding set of its neighboring nodes. Anode is selected as relay node for collecting and routing data from sensor node to sink node. Event coverage and source is determined using weighted graph and barycenters in this graph[17].

D. Autonomous Underwater Vehicle based (AUV)
The sensed information from the sensor is collected using AUV through optical communication and they are periodically delivered to the base station located on the surface. Event is said to be occurred when the sensed data have large value compared to other sensor nodes. The path for the routing of data from sensor node to sink node should be chosen in such a way that delivery vale of information from the sink is maximum. The distributed heuristic method is used to determine the paths online[19].

E. Prediction method
The sensed data may vary periodically due to underwater environment. Sensed data may follow certain trend so that we can predict data for certain time duration. The data is predicated at the base station and are synchronized with real time sensed data by sensor nodes only when their value vary above threshold. This helps to avoid unnecessary routing of packet to the base station. This method is applicable only when the variation of network environment follows simple and certain patterns[18].

IV. CONCLUSIONS
Due to various restrictions in WSN in creating an event determination method incorporating with these resource limitations is difficult task and this sets lots of challenges. We have discussed about different event detection schemes implemented in both TWSN and UWSN.

REFERENCES