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Sink Level Detection Using Localization Algorithm in Ship Detection Using Wireless Sensor Networks

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ABSTRACT: Intrusion detection and border surveillance constitute a major application category for wireless sensor networks. A major goal in these applications is to detect intruders as they cross a border or as they penetrate a protected area. WSN is usually composed of small, low-cost devices that communicate wirelessly and have the capabilities of processing, sensing and storing. It typically consists of large number of resource-limited sensor nodes working in a self-organizing and distributed manner. Due to the ad hoc working style, once deployed, the inner structures and interactions within a WSN are difficult to observe from the outside. Intrusion detection using three-tier accelerometer sensors detect intrusion ships. The sensors deployed on the sea surface get tossed by ocean waves which makes them move randomly. This random movement of the node makes it difficult for most sensors to detect an intrusion. Network data processing with spatial and temporal correlations between nodes estimates the speed of a passing ship. Using signal processing and cooperative signal processing techniques the ocean waves and ship-generated waves are differentiated accordingly with their respective different energy spectrums. Though the algorithm detects multiple ships travelling along distances in different geographical areas it requires a relatively dense network especially to achieve a high detection ratio due to larger attenuation. To resolve such issues the proposed approach introduces the concept of Adaptive self-organizing localization algorithm. This is included in sink level detection to deal with invasion detection ships.

KEYWORDS: Three-tire accelerometer sensor, attenuation, correlation, temporal correlation, spatial correlation.

1 INTRODUCTION

The nodes communicate wirelessly and often self-organize after being deployed in an ad hoc fashion [1]. It is an infrastructure comprised of sensing (measuring), computing, and communication elements that gives the user the ability to instrument, observe, and react to events and phenomena in specified environment. Currently, WSNs are beginning to be deployed at an accelerated space. In a typical application a WSN is scattered in a region where it is meant to collect data through its sensor nodes. WSN are being used in many industrial, surveillance or military applications and civilian application areas including industrial process monitoring and control machine health monitoring, environment and habitat monitoring, healthcare applications, home automation and traffic control [1].

Detection, classification and tracking of targets are a basic surveillance or military application, and have hence received a considerable amount of attention in the literature. Recent developments in the miniaturization of sensing, computing, and communications technology have made it possible to use a plurality of sensors within a single device or sensor network node.

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Their low cost makes it feasible to deploy them in significant numbers across large areas and consequently, these devices have become a promising candidate for addressing the distributed detection, classification and tracking problem.[2]

To provide sensing coverage for a relatively large area, the network is usually comprised of a large number of densely deployed nodes. This imposes a challenge on efficient data propagation and reliable operation. The detection, classification and reporting must be performed in a timely manner. It is usually required that the network completes the detection and classification before the target travels out of the field so that the system can respond to the event. As a result, offline-style processing performed by base stations with global and relatively “complete” data is often not feasible in this context. To perform quality signal processing, the sensors often need to sample at a high sampling rate, stressing resource utilization. The sensing data is bursty and will be in large quantity. Thus surveillance networks are often deployed on rough terrains for a long period of time. Hence it must be adaptive to the realistic, ever-changing environment [3] .The algorithm tracks the target in real-time does not require time synchronization between sensor nodes and can be applied to targets moving in random directions and with varied velocities. Moreover, the algorithm is tolerant to sensing faults, when a sensor either fails to detect a target within its range as well as information loss caused by packet collisions.

WSN with three-axis accelerometer sensors measure the actual surface movement of ship-generated waves to exploit spatial and temporal correlations of an intrusion of ships which increases detection reliability.

2 RELATED WORKS

The fundamental function in wireless sensor networks is to sense the network using the nodes deployed randomly. The raw sensor data is often of low quality, that is they are not reliable. So it is necessary to use signal processing algorithms to provide precise, reliable and easy to use information. The group level classification is of special importance to the detection and classification performance. It not only controls the aggregation of member reports and reduces the network traffic, but also reduces the false positive rate of the system. The hierarchical architecture naturally distributes sensing and computation tasks at different levels of the system so that the sensor network can support high-quality sensing and reliable classification without involving special high-power nodes [4].Often sensor nodes within a geographical region will be grouped to form a local cluster so that a certain hierarchy of command and control over the entire sensor field can be established. Each local cluster will elect one or more sensor nodes as the cluster head where spatial decision fusion of sensors within a cluster will be performed. Individual sensors will need to be activated, and then periodically perform target detection algorithm to detect the presence of a moving vehicle in the neighbourhood of the sensor. Using spatial correlation with centralized approach the vehicle is detected [5].

3 SYSTEM DESCRIPTION

The detection of any passing ships by distinguishing the ship generated waves from the ocean waves can be calculated using Short Time Fourier Transform. This is because Ocean waves and ship generated waves have different energy spectrums.

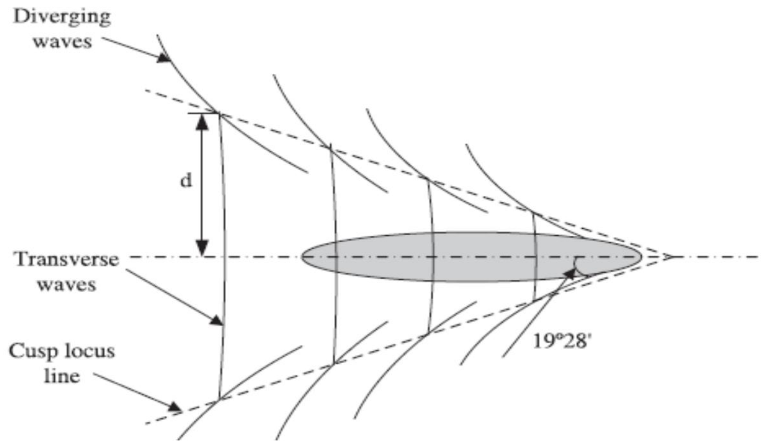

Fig. 1. Ship generated wave model

While ship moving in water, it generates waves which comprise divergent and transverse waves as shown in Fig. 1.

Algorithm: Node algorithm includes initialization of node, intrusion detection, and temporary cluster setup, correlation of spatial and temporal data processing. **Intrusion detection algorithm** includes node-level, sink-level and cluster-level algorithms.

3.1 NODE-LEVEL DETECTION

Once the node detects a target the extracted features are transmitted to the local head node or a sink for further signal processing and classification due to the energy constraints of the sensor node and the limitations of the communication bandwidth [6].

3.2 CLUSTER-LEVEL CLASSIFICATION

The clusters are formed according to the geographical locations of nodes or the migration of the external event after the network deployment. In each cluster, a local head node takes charge of the data fusion or other coordination tasks within the cluster.

3.2.1 CLUSTER-LEVEL DESCRIPTION

When a ship travels through the sensor networks, the waves generated by the passing ship disturb the sensor areas A1; A2; A3 in sequential manner. These areas have spatial and temporal correlations. By exploiting these correlations, we can improve the reliability of the detection system. In order to monitor the entire deployed area, the temporary clusters are combined with static clusters. The static clusters are formed according to the geographical location of the nodes, and temporary clusters are formed on demand when a node’s alarm is trigger. Since the nodes positions are fixed, they know where their neighbours are located. When a node discovers a ship intrusion, it initiates a temporary cluster, informs its neighbouring nodes and automatically becomes the temporary cluster head. If more than one node detects a ship intrusion before it receives detection signals from other nodes, it sends out their average detection energy, thus the node with the higher detection energy becomes the cluster head. If the nodes within the cluster also find the intrusion, they report the findings to the temporary cluster head. If the cluster head has not received any report within a certain period of time, it will cancel the temporary cluster because its positive finding may be a false alarm.

3.2.2 SINK-LEVEL DETECTION

Processes the data sent from local head nodes and the final decision will be reported to the external user via satellite or other means. Multitarget detection monitors several intrusion targets at the same time in different geographical areas over large distances [7]. It increases the reliability of the intrusion detection with reduced false alarms with respect to spatial and temporal correlations of detection. The self- organizing localisation algorithm which enhances the sensor nodes to be location-aware is deployed in our proposed system.

4 PROPOSED SYSTEM

The process of finding accurate location of any sensor node is called as localization. The issue of energy efficiency and efficient data transmission is critical due to limited battery power and limited storage capacity of sensors. Spatial correlation is more doubtful due to higher distance among sensors and long propagation delays.

Proposed algorithm

Adaptive self-organizing localization algorithm is developed in proposed system. It can able to operate under modes of parameters such as:

Temperature: Ranges 23to26 degrees centigrade within 33meters.

Distance: Node’s deployment distance D is within 40 meters.

The proposed localization technique uses only the distance estimation between the reference Nodes (RN) and Ordinary Nodes (OrN). RNs are able to detect their position by means of GPS to find the accurate location of OrNs. OrNs are those nodes which execute without any centralized control to make randomly deployed WSN to be location-aware. In order to perform collaborative sensing tasks the sensor nodes must estimate their position by means of a distributed positioning algorithm. Average Error (AE) is calculated to weigh the efficiency of proposed algorithm:

$$\mathrm{AE} = \frac{\sum_{i=1}^{500} \sqrt{((\mathrm{x_i}-\mathrm{x_i^*})^2+(\mathrm{y_i}-\mathrm{y_i^*})^2+(\mathrm{z_i}-\mathrm{z_i^*})^2)}}{500} \quad (1)$$

Where (x_i,y_i) is a real sensor position and (x_i^*,y_i^*) is estimated localization.

4.1 NETWORK MODEL AND NODE LEVEL DETECTION

An undirected graph G (V, E) where the set of vertices V represent the mobile nodes in the network and E represents set of edges in the graph, which represents the physical or logical links between the mobile nodes. Sensor nodes are placed at a same level. Two nodes that can communicate directly with each other are connected by an edge in the graph. Let N denote a network of m mobile nodes, N1, N2...Nm and let D denote a collection of n data items d1; d2; . . . ; dn distributed in the network. For each pair of mobile nodes N_i and N_j, let t_{ij} denote the delay of transmitting a data item of unit-size between these two nodes. The experimental system is with 30 nodes deployed in such a way that five nodes in a row and a total of six rows is kept. The node's deployment distance D is 25 m. The ship travels along one side of the deployed area with three different speed levels and with each speed the test runs some defined rounds.

4.1.1 NODE-LEVEL DETECTION

Sample the event and extract those features. Once the node detects a target the extracted features are transmitted to the local head node or a sink for further signal processing and classification due to the energy constraints of the sensor node and the limitations of the communication bandwidth. Sample the signal value at time t is a_i, the total number of sampling points in time period T is u. The average sample value of this period T and the standard deviation can be computed with threshold as

$$\mathrm{m}_{\Delta\mathrm{t}} = \frac{1}{u}\sum_{i=0}^{u} \mathrm{a}_{\mathrm{i},} \quad (2)$$

$$d_{\Delta t} = \sqrt{\frac{1}{u}\sum_{i=1}^{u}(a_i - m_{\Delta t})^2} \quad (3)$$

The threshold should reflect those changes. Thus design an environment adaptive threshold by moving the average value and the standard deviation with time. The moving average and the standard deviation is defined as

$$m'_T = \beta_1 \times m_T + m_{\Delta t} \times (1-\beta_1), \quad (4)$$

$$d'_T = \beta_2 \times d_T + d_{\Delta t} \times (1-\beta_2), \quad (5)$$

In other words the crossing of the threshold occurs several times within a short period of time. Thus anomaly frequency is defined as

$$a_f = \frac{NA_{\Delta t}}{N_{\Delta t}} \quad (6)$$

4.2 CLUSTER-LEVEL DETECTION AND SINK-LEVEL DETECTION

If more than one node detects a ship intrusion before it receives detection signals from other nodes, the nodes contend to become the temporary cluster head. To simplify the process, when the nodes try to set themselves up as cluster heads, they could also send out their average detection energy thus the node with the higher detection energy becomes the cluster head. If the nodes within the cluster also find the intrusion, they report the findings to the temporary cluster head. If the cluster head has not received any report within a certain period of time, it will cancel the temporary cluster because its positive finding may be a false alarm. However if it receives enough positive reports in a timely fashion it will process the received data using the spatial and temporal correlations of the ship waves. We define time correlations in row i. Because the cluster head knows the positions of each node, we arrange all reports according to their position and reporting time. If the number of ordered reports is N,

$$C_{rt(i)} = \frac{N}{n}, \quad (7)$$

The group's time correlations C_{Nt} defines as

$$C_{Nt} = \pi C_{rt(i)} \quad (8)$$

CNe describes the cluster's energy correlations. The correlation coefficient C measures the spatial and temporal correlations in a cluster and is defined as

$$C = C_{Nt} \times C_{Ne}\ , \tag{9}$$

Estimate the speed of the intruding ship using the equation:

$$V = \frac{D \sin(\alpha - 70^{\circ})}{(t_4 - t_3)\sin \emptyset}\ , \tag{10}$$

$$\alpha = arctan\left(\frac{t_2 + t_4 - t_1 - t_3}{t_2 + t_3 - t_1 - t_4} \tan 70^{\circ}\right) \tag{11}$$

4.2.1 Sink-level detection

The intruding ship will keep moving it will eventually move away from the monitored area. So it raises false alarm when several clusters are affected and disappears. It process the data sent from local head nodes and the final decision will be reported to the external user via satellite or other means. To distinguish between friend and foe ships add ID to friendly ships. When such ships come, the system will not sound intrusion alarms. Thus it increases the reliability of the intrusion detection with reduced false alarms with respect to spatial and temporal correlations of detection.

4.3 Node Location Estimation

The proposed localization technique uses only the distance estimation between the reference Nodes (RN) and Ordinary Nodes (OrN). RNs are able to detect their position by means of GPS to find the accurate location of OrNs. OrNs are those nodes which execute without any centralized control to make randomly deployed WSN to be location-aware. In order to perform collaborative sensing tasks the sensor nodes must estimate their position by means of a distributed positioning algorithm. Average Error (AE) is calculated to weigh the efficiency of proposed algorithm using the formula 1.

5 Analysis Of Proposed System

In order to improve energy consumption in efficient way, localisation algorithm is proposed. It analyse inconsistency caused due to erroneous depth which is calculated using pressure sensors and find the average error in calculated node location. It autonomously performs the assigned task without human intervention. The block diagram describes the overall methodology of the proposed system.

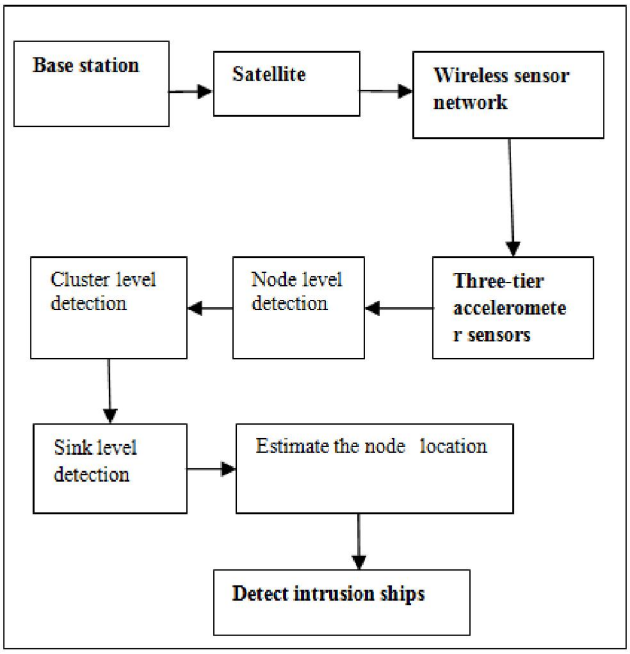

Fig. 2. Block diagram of the proposed work

The block diagram shown in the above fig. 2 describe the working methodology of the proposed system. Using the three-tier accelerometer sensor to detect the intrusion ship. We introduced four detection algorithms namely node level, cluster level, sink level and node location detection to detect the intrusion ship more efficiently and accurately. The following graphs in fig:3 and fig:4 shows the ship speed estimation and success detection in accordance with the intruder ship. The fig:3 shows that minimum, maximum and the average speed that the ship could attain, any ship that exceeds the ratio calculated is considered to be an intruder ship.

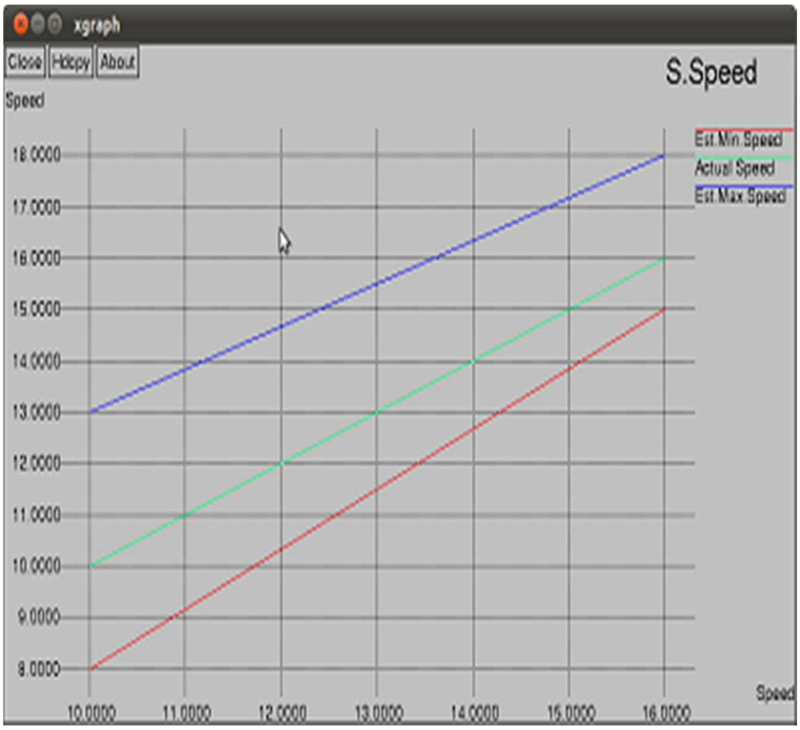

Fig. 3.   Ship speed estimation

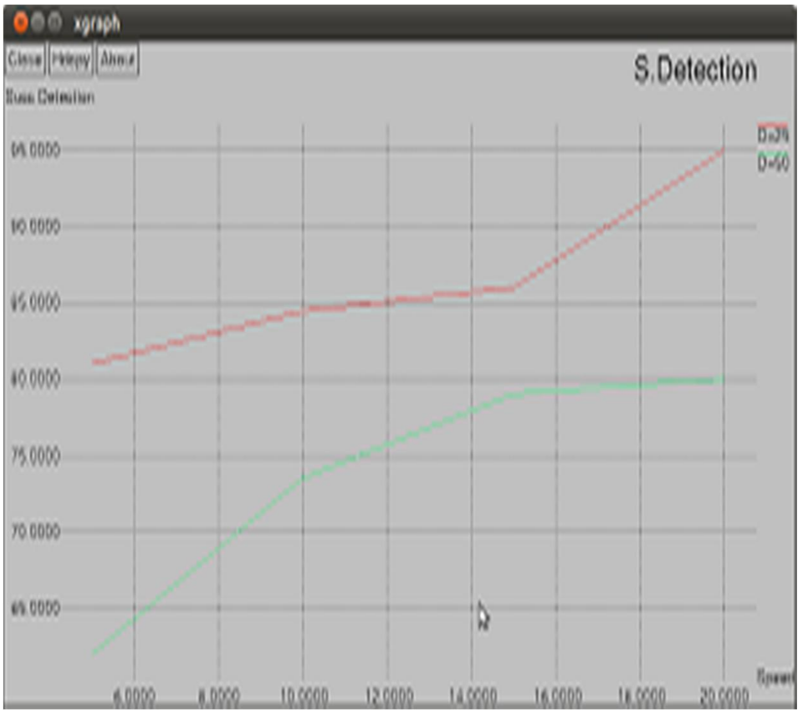

Fig. 4.   Success detection

6 IMPLEMENTATION

NS-2 is an open-source simulation tool running on Unix-like operating systems. It is a discreet event simulator targeted at networking research and provides substantial support for simulation of routing, multicast protocols and IP protocols, such as UDP, TCP, RTP and SRM over wired, wireless and satellite networks. It has many advantages that make it a useful tool, such as support for multiple protocols and the capability of graphically detailing network traffic. Additionally, NS-2 supports several algorithms in routing and queuing. LAN routing and broadcasts are part of routing algorithms. Queuing algorithm includes fair queuing, deficit round robin and FIFO.NS-2 started as a variant of the REAL network simulator. REAL is a network simulator originally intended for studying the dynamic behaviour of flow and congestion control schemes in packet-switched data networks. In 1995 ns development was supported by Defence Advanced Research Projects Agency DARPA through the VINT project at LBL, Xerox PARC, UCB, and USC/ISI. The wireless code from UCB Daedelus and CMU Monarch projects and Sun Microsystems has added the wireless capabilities to ns-2. NS-2 is available on several platforms such as FreeBSD, Linux, SunOS and Solaris. NS-2 also builds and runs under Windows with Cygwin. Simple scenarios should run on any reasonable machine; however, very large scenarios benefit from large amounts of memory and fast CPU's.

7 CONCLUSION

The developed architecture enables the system to conduct efficient information processing including detection and classification in a large-scale WSN. This architecture naturally distributes sensing and computation tasks at different levels of the system so that the sensor network can support high-quality sensing and reliable classification without involving special high-power nodes. With evaluation data collected from field tests in physical environments, the evaluation demonstrates excellent performance on the detection rate, classification result, attribute (velocity) computation accuracy and timely information delivery. The developed approach is further extended in future in many ways. Propagation of ship waves over large distances is not concentrated in existing system. Real sensor network system drop buoys from a plane rather than grid environment have to be analysed. Power management in sink level detection is another methodology to improve the performance of the detection system in efficient way. On the other hand seek solution for supporting online intrusion detection system.

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BIOGRAPHIES

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