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Energy Efficient Fast Forwarding in Event Driven Wireless Sensor Network (EWSN) using Route Discovery

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Abstract: In wireless Sensor Network Efficient event detecting protocol (EEDP) is used for event monitoring. In the event occuring area each node broadcasts its primary detection result to make a final decision. The final decision-made by a node will choose the next hop using the underlying routing protocol to forward a single alarm packet and the shortest path is also considered. For selecting a shortest path and broadcasting greedy algorithm is used. Further the decision packet is routed such that the node which has maximum battery power and which is closest to sink will be selected as the next hope. This minimizes the rate of failure of link due to node failure thus improved the life time of the network and efficient use of energy is achieved. The Multi copy scheme is used to improve the reliable transmission of the single alarm packet.

Keywords: Efficient event detecting protocol (EEDP), Energy efficient, wireless sensor network, event detection.

1. Introduction

Event-driven wireless sensor networks (EWSNs) are composed of large numbers of sensor nodes that are used to sense event (eg. fire detection by using temperature and smoke). The main purpose of EWSNs is the ac-curate notification of the events to the event decision-maker. In this paper, an efficient event detection protocol is used to monitor infrequent events. Thus, EWSNs will have the capability to transmit the sensor data and the location of an event to one a centralized sinks who is expected to perform real time processing and to make accurate decision quickly. We compress the sensed event raw data by analyzing the characteristics of event, thus the event is detected in a distributed and efficient way. Also, alarm messages which are the final decision will be delivered to users in an energy efficient and fast forward manner. EEDP has the following contributions:

- Decisions are locally made in the event area and then only particular conclusion such as the occurrence of an interested event is sent to sink.
- No significant amount of data is sent to the end users whether an event occurred or not. Thus, each node can naturally conserve more energy to extend network lifetime.
- A novel dynamic multi-copy scheme is used to ensure the reliability of the alarm packet delivery. Since there is only one packet to be transmitted, the multi-copy scheme will not bring serious storms and pro-vide a considerable improved performance in term of reliability and timeliness.

There are mainly three types of routing protocols in sensor networks: Pro-active (table-driven) routing, Reactive (on-demand) routing and Geographical routing. The Pro-active routing protocols maintain a fresh list of routes by periodically distributing routing tables throughout the network. The shortcoming of this type of routing is slow reaction on restructuring routes as after a link failure. The Reactive routing protocols establish a route on demand by flooding the network with route request packets, which would generally cost less energy when compared with the former one. However, this type of routing (Reactive/on-demand) will result in a high latency time due to route finding process, which cannot be tolerated for alarm delivery. Geographic routing is a routing principle that relies on geographic position information.

2. Related Work

For the event detection, Lige Yu et al. have a lot of research [8], [9], [10] using the conventional distributed detection theory [11]. In the work of [8], three detection schemes have been investigated: the centralized, distributed and quantized scheme. Traditionally, a centralized scheme requires each sensor node to forward all its observations to the fusion center, which results in large energy in communication.

A distributed scheme, allows each sensor node to make its own decision and then send out only its 1- bit decision. This reduces communication energy at the cost of increased processing energy and reduced detection accuracy. In a quantized scheme, each node processes observations data and sends a quantized M-bit quantity to the fusion center, and the control center makes the final decision based on the K quantized quantities. Considering a sequential detection strategy [12], a sequential probability ratio test (SPRT) at the fusion center is adopted in [10]. Based on the work of [10], Lige Yu proposed an energy-driven scheme where each sensor node sends out its 1-bit decision if that decision exceeds a predetermined detection accuracy threshold in [9], and sends out all its observations otherwise. The scheme sets a restriction for the maximum number of observations collected by each sensor, which avoids the potential delay at sensors and the consequent problem of asynchronism caused by large number of observations in the case of sequential detection. Event Detection protocol is used to detect the fire monitoring by considering the temperature and smoke. Depending the application scenario, the phenomenon could be classified into global phenomenon (GP) and local phenomenon (LP). In order to reduce the transmissions to minimize the power consumptions, each node makes a local decision considering its own observation and also the decision made by the previous node.

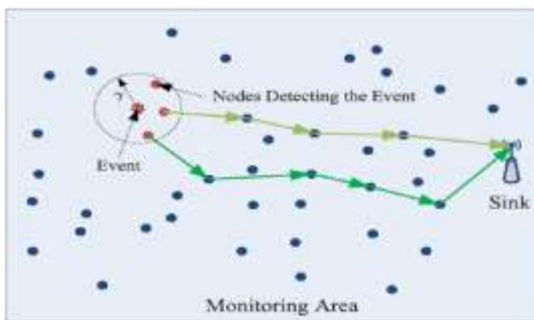

Figure 1: Example of a typical EWSN

In EWSNs, whether the event occurs or not is more of interest to users rather than the detailed event in-formation. However, an event should not be decided only based on one property of the event like the research mentioned above, but combining with other properties together. Composite event is first proposed in [14] to make accurate event detection. To ensure the quality of surveillance, some applications require that if an event occurs, it needs to be detected by at least one sensor.

Greedy Perimeter Stateless Routing (GPSR) [18] is very well-known routing protocol utilizing the positions of nodes and the destination to make packet forwarding decisions. According to the information about a node’s immediate neighbors in the network topology, GPSR makes greedy forwarding decisions. By keeping state only about the local topology, GPSR scales better than traditional routing protocols as the number of network destinations increases. However, GPSR is designed for the ad-hoc networks and does consider the characteristics in EWSNs, where the event decision should be made in the forwarding procedure to shorten the event information delivery delay.

[2]In this paper, proposed IQAR - an Information Quality Aware Routing protocol for event-driven sensor networks. IQAR considers the individual IQ contribution of each sensory data, and collects only sufficient data for a phenomenon of interest (PoI) to be detected reliably. Redundant data is suppressed for a time interval to reduce traffic load and alleviate medium access contention. This allows IQAR to achieve significant energy and delay savings while maintaining information quality in event detection.

The notion of event-to-sink reliability is necessary for reliable transport of event features in WSN. This is due to the fact that the sink is only interested in the collective information of a number of source nodes and not in individual sensor reports. This is also the reason why traditional end-to-end reliability notions and transport solutions are inappropriate for WSN. Based on such a collective reliability notion, a new reliable transport scheme for WSN, the event-sink reliable transport (ESRT) protocol, is presented in [6]. ESRT is a novel transport solution developed to achieve reliable event detection with minimum energy expenditure and congestion resolution functionality. ESRT has been tailored to meet the unique requirements of WSN. Its congestion control component serves the dual purpose of achieving reliability and conserving energy. The algorithms of ESRT mainly run on the sink and require minimal functionality at resource constrained sensor nodes. The primary objective of ESRT is to configure the network as close as possible to the optimal operating point, where the required reliability is achieved with minimum energy consumption and with-out network congestion. Thus, ESRT protocol operation is determined by the current network state based on the reliability achieved and the congestion condition [6].

This paper focuses on minimum energy for wireless sensor network (WSN) to perform a specific function. They consider wireless sensor networks that perform an event detection function. Each sensor node will repetitively collect a 1-bit information regarding whether the event occurs or not in its neighborhood. A fusion center will make the decision on whether the event occurs based on the information provided by individual sensor nodes. Traditionally, a centralized scheme requires each sensor node to forward all its observations to the fusion center, which results in large energy in communication. A distributed scheme, on the other hand, allows each sensor node to make its own decision and then send out only its 1-bit decision. This reduces communication energy at the cost of increased processing energy and reduced detection accuracy. They propose a hybrid energy-driven scheme where each sensor node sends out its 1-bit decision if that decision exceeds a pre-determined detection accuracy threshold, and sends out all its observations otherwise. This scheme provides WSN designers the flexibility to balance detection accuracy, sensor density, and energy consumption. We develop the optimal decision rules for this scheme. They also propose methods to calculate the detection accuracy threshold for individual sensor node to guarantee the overall detection accuracy at the fusion center. The simulation results show that the hybrid scheme consumes significantly less energy than both centralized and distributed schemes to achieve the same detection accuracy [7].

3. Programmer’s design

Proposed system

Energy efficient composite event driven protocol with multi copy scheme is used which will minimize the energy being used by nodes for broadcasting volume data. Further the decision packet is routed such that the node which has maximum battery power and which is closest to sink will be selected as the next hope using Greedy approach. This minimizes the rate of failure of link due to node failure thus improved the life time of the network and efficient use of energy is achieved.

- The nodes route the data to the hopes which have maximum energy remaining energy so that it should minimize the rate of failure of link due to node failure and which tends to improved life time of net-work. Failure of link causes the retransmission of the packet which may lead to the latency.

- And also select path which consume minimum energy.

- It improves the lifetime of the WSN

3.1. Mathematical Model

- Defining System:
  Consider a static EWSN with N sensor nodes S= {}
- Identifying input:

Identify input S1={N,P_r,P_s,T,R,SI}

S ={S1,.,...} {Ni|i=1,2,3,...} where,
N = Wireless nodes
P_r = Packets Received
P_s = Packet Sent
R = Rate of data transfer from node to sink
SI = Sink Node

- Communication Model:
  Forward Set (FS):

To indicate neighbour nodes which are closer to the destination node than the source forward set is used. Let, FS_i be the set of neighbour node which belong to N_i such that node jzFS_i if
$D(i,s) \leq D(j,s)$ $D(i,d) \geq D(j,d)$

Backward Set (BS):

To indicate those neighbour nodes that are closer to the source than the destination Backward set is used. Let BS_i be the set of neighbour nodes that belong to N_i such that node jzBS_i if
$D(i,s) \geq D(j,s)$ $D(i,d) \leq D(j,d)$
Where D(i,j) represents the distance between node i and j. And s,d denotes the source and destination node.

- Composite Event:

A set of predefined observation attributes and the corresponding predicates defined on the attributes is called as composite event E.

- Primary Detection Procedure:

For the composite event E, x^i_m be the observation of the mth sensor of node i to make a local atomic binary decision μ^i_m. i is to denote the final decision result of node i. where, $_i$ =1 generation alarm packet to destination immediately.

Single Decision Rule (SDR):

μmi = 1, if xmi $\geq_3$mi;
0 otherwise;
where, $_3{}^i{}_m$ is the per-sample threshold of node i for the mth atomic event E_m.

Composite Decision Rule (CDR) :

i = 1 if μ1i AND μ2i AND ... AND μ|iM| =1 ;
0 otherwise;

3.2. Dynamic Programming and Serialization

- **Local Broadcast:**

a) Emergency Source Nodes(ESNs):
for any node i, if $\exists_m \in M$, $\mu^i_m = 1$;

b) Emergency Forwarding Nodes(EFNs): For any node i, if $\forall_m \in M$, $\mu^i_m = 0$.
Each node i in ESNs, will conduct a local primary decision message MSG^{local}_i which contains the information of $[\mu^i_1, \mu^i_2, \ldots, \mu^i_{|M|}$.
After finishing the sensing procedure, the local primary detection message MSG^{local}_i will broadcasts to its neighbours using Local Broadcast Algorithm to make further decision.

- **Algorithm 1: Local Broadcast Algorithm**

Input: The observation node i: x^i_m, m z M. Output: The decision of node i: ^{i}.
while t ≤ T do
Step 1: Set a decision timer T.
Step 2: Node i keeps sending its own primary decision message and overhearing decision message from neighbours and then node i goes to step 3.
Step 3: Using CDR as Eq. 2, each node could make the decision ^{i}. If ^{i} = 1, there must exist certain abnormal event. Node i goes to step 4. Otherwise, node i goes to step 5.
Step4: Node i will generate and forward the alarm packet Ψ, namely alarm to the destination immediately using Algorithm 2.
Step 5: Node i will forward MSG^{local}_i to its neigh-bours and keep in overhearing the MSG^{local}_i from other nodes.
Step 6: When node i receives a local primary detection message MSG^{local}_j from node j, the emergency information $[\mu^i_1,\mu^i_2, ..., \mu^i_{|M|}]$ of node i will be updated as $\mu^i_m = \mu^i_m — \mu^j_m$, $\forall_m$ z M, and then goto step 3.
Step 7: When node i receives Ψ from other node, it will suspend to send MSG^{local}_i.
end while
Step 8: When timer T expires, it will keep silent and clear the value of μ^i_m, m z M.

- **Algorithm 2 :Fast Broadcast**

Input: The observation node i: x^i_m, m z M. Output: The decision of node i: ^{i}.
Step 1: For any node i in ESNs, if it makes decision using Eq. 2, it will generate the event alarm packet Ψ.
Step 2: When node i in ESNs receives alarm packet Ψ at the first time, it will suspend to send MSG^{local}_i and broadcast Ψ.
Step 3: When node i in ESNs receive alarm packet Ψ again, it will drop it and keep silent.
Step 4: When node i in EFNs receive the alarm packet Ψ, it will continue to send alarm packet.

Among the ESNs, the primary detection procedure and message broadcast will be conducted, which has at least two benefits.

1) Saving energy by limiting the packet forwarding,
2) To improve the reliability and shorten the latency by reducing the congestion in routing path.

- **Emergency Routing Procedure**

As we are using geographic routing mechanism which is based on location awareness, the location information can be exchanged with immediate neighbours with the periodic packets. Because of which, each node is aware of its immediate neighbours within its radio range and their location. This location information is used for node to locally make a routing decision such that packets progress geographically towards their final destination. If the density of the node is large such that every node has a neighbour that is closer to the sink than itself, then the Greedy Approach can find routes close to the minimum hop paths.

Whenever the alarm packet Ψ is generated, then the emergency routing procedure will be conducted among both ESNs and EFNs. After that, the single alarm packet is transmitted to destination through EFNs. Also, the single alarm packet can be face the problem of link loss or failure. For that, a simple dynamic multicopy scheme similar to the conventional multi-path routing for continuous flow is active at the moment of alarm packet loss.

Dynamic Multi-copy scheme works as: An alarm packet Ψ, is received for any node i in EFNs, it will forward the packet to the destination. Meanwhile, the second closest node i.e. candidate forwarding node c closest to the destination from node i, keeps track of Ψ transmission and store a copy of Ψ in its buffer. If node c detects a retransmission from node i to its closest hop to destination, to avoid the single transmission failure, it will extract the copy of Ψ and forward it as a new independent packet.

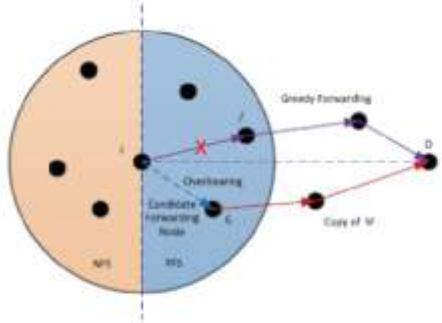

Figure 2: Candidate Forwarding

3.3. Data independence and Data Flow architecture

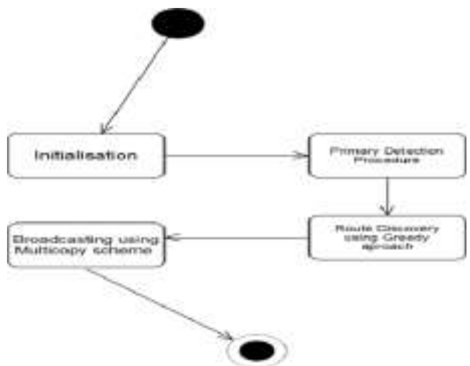

Figure 3: Data Flow Architecture

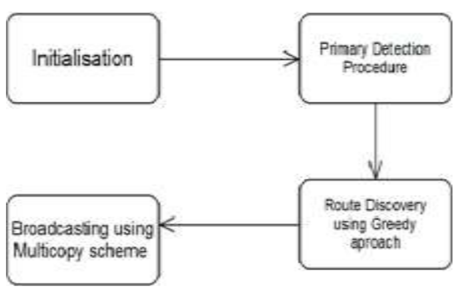

Figure 4: Systen Architecture

4. Results and Discussion

Expected Research Outcome

Following outcomes will be achived using this algorithm.

- Identify Composite event
- Pass Fewer events massage to sink
- Reduce energy consumption of network
- Reliability of the alarm packet delivery

Conclusion

In this paper, I have proposed an efficient event detection protocol in event-driven wireless sensor networks to detect the event and delivery of emergency message reliably and timely. My algorithm composes composite events, each of which consisting of a few of atomic events. To improve the reliable transmission of the single alarm packet, I used a GPSR to find the path and dynamic multi-copy scheme for continuous flow and provide a considerable improved performance in term of reliability and timeliness.

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