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CRUCIAL EVENT MONITORING IN WIRELESS SENSOR NETWORKS

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Abstract— **In mission-critical applications, such as battlefield investigation, fire detection in woodland, and gas monitoring in coal mines, wireless sensor networks are deployed in a wide range of areas, with a large number of sensor nodes detecting and reporting some information of urgencies to the end-users. As there may be no communication infrastructure, users are usually equipped with communicating devices to communicate with sensor nodes. When a decisive event (e.g., gas leak or fire) occurs in the monitoring area and is detected by a sensor node, an alarm needs to be broadcast to the other nodes as soon as possible. Sensor nodes can warn users nearby to escape or take some response to the event. In this paper we aim to design two resolute traffic paths for the transmission of alarm message, and level-by-level offset based wake-up pattern according to the paths, respectively. When a crucial event occurs, an alarm is rapidly transmitted along one of the traffic paths to a center node, and then it is immediately broadcast by the center node along another path without conflict.**

Keywords- **Wireless sensor network, Event Monitoring, CCDS.**

I. INTRODUCTION

Wireless Sensor Networks are more powerful in that they are amenable to support a lot of very different real world applications. They are also an exigent research trouble in engineering because of their litheness. In several WSN applications, individual nodes cannot be easily connected to a wired power supply. Hence, energy efficiency along with life time of a proposed solution has been a very important figure of merit as a long life time is usually desirable. Realizing such a wireless sensor networks is a crucial step.

In order to increase the battery life time sensor nodes are made to snooze. When an event occurs it will wake up and is scheduled to broadcast the message. So, it follows task scheduling.

Many parallel applications consist of multiple computational components. While the execution of various these components or tasks depends on the completion of other tasks, others can be executed at the similar time, which enhances parallelism of the problem. The task scheduling setback is the dilemma of assigning the tasks in the system in a way that will optimize the overall performance of the application, while guaranteeing the accuracy of the outcome.

The task scheduling dilemma can be modeled as a weighted directed acyclic graph (DAG). A vertex stands for a task, and its weight the size of the task computation. An arc stands for the communication among two tasks, and its weight represents the communication expenditure. The directed edge shows the dependency between two tasks. The primary goal of task scheduling is to schedule tasks on processors and diminish the make span of the schedule, i.e., the completion time of the last task relative to the start time of the first task. The yield of the difficulty is an assignment of tasks to processors.

II. Literature Review

Sleep scheduling is a usual way for power management to save energy. Recently, many sleep schedules for event monitoring have been designed [1]-[4]. However, most of them focus on minimizing the energy consumption. Actually, broadcasting delay is an important issue for the application of the critical event monitoring. To minimize the broadcasting delay, it is needed to minimize the time wasted for waiting during the broadcasting. The ideal scenario is the destination nodes wake up immediately when the source nodes obtain the broadcasting packets.

Here, the broadcasting delay is definitely minimum. Based on this idea, a level-by-level offset schedule was proposed in [5]. Hence, it is possible to achieve low transmission delay with the level-by-level offset schedule in multi-hop WSNs [6]-[9]. Energy management in sensor networks is crucial to prolong the network lifetime. Though existing sleep scheduling algorithms save energy, they lead to a large increase in end-to-end latency. A new sleep schedule (Q-MAC) for query based sensor networks that provides minimum end-to-end latency with energy efficient data transmission[10][12]. To eliminate the collision in broadcasting, a colored connected dominant set (CCDS) in the WSN via the IMC algorithm proposed in [12] is established.

III. Path Determination Algorithm

BFS and CCDS (Colored Connected Dominant Set) are two scheduling technique. Any node which detects a critical event sends an alarm message to the centre node which is called uplink path. This uplink is performed by using BFS. BFS is used to find shortest path from any node to canter node in predefined static manner. An alarm is generated by a node represented in gray colour and it immediately sends the message through predefined BFS path to canter node represented in black colour. After reaching centre node the message is transmitting from there to all other node this is called as downlink path. CCDS is used for downlink path. CCDS is constructed using RMC (Recursive Minimal Cover) algorithm.

IV. Proposed Approach

The proposed Algorithm is still based on the level-by-level offset schedule, to achieve low broadcasting delay in a big scale wireless sensor network. The proposed scheduling technique comprises two phases:

- Any node which notices a crucial event sends an alarm packet to the centre node along a preset path according to level-by-level offset schedule.
- The centre node broadcasts the alarm packet to the entire network also according to level-by-level offset schedule.

The proposed scheduling system should restrain two parts:

- Set up the two traffic paths in the WSN uplink (traffic paths from nodes to the centre node) and downlink (traffic path from the centre node to other nodes)
- Calculate the wake-up parameters (e.g., time slot and channel) for all nodes to handle all possible traffics.

To minimize the broadcast delay, we establish a breadth first search (BFS) tree for the uplink traffic and a colored connected dominant set (CCDS) for the downlink traffic, correspondingly. Features of the proposed scheduling method are as follows:

- The upper bound of the broadcasting delay is 3D + 2L , where D is the maximum hop of nodes to the centre node, and L is the length of duty cycle, the unit is the size of time slot. As the delay is only a linear arrangement of hops and duty cycle, it could be very small even in large scale wireless sensor networks.
- The broadcasting delay is free of the length of the duty cycle and density of nodes, but it enhances linearly with the number of the hops.

- Energy use is also much lesser when compared with existing system.

V. Traffic Paths

First of all, we choose a sensor node as the centre node. Then, we construct the BFS tree which divides all nodes into layers 1, 2, 3, ..., , where is the node set ith minimum hop to in the WSN. With the BFS tree, the uplink paths for nodes can be easily obtained.

To establish the second traffic path, we establish the CCDS in with three steps: 1) construct a maximum independent set (MIS) in ; 2) select connector nodes to form a connected dominated set (CDS), and partition connector nodes and independent nodes in each layer into 4 disjoint sets with Recursive Minimal Cover algorithm; 3) colour the CDS to be CCDS with no more than 12 channels. The fine points are illustrated as follows, and the variables therein are defined below.

C - The centre node in the networks
Hi - The nodes with minimal hop i to c in G
H’i - The nodes with minimal hop i to c in CDS
li - The independent nodes with minimal hop i to c in CDS
Ci - The connector nodes with minimal hop
Bi - The dominated nodes dominated by li

Construction of MIS

```
Input: BFS
$l \leftarrow \varphi$
for $i \leftarrow 0$ to D do
    Find an MIS $l' \subset H_i$ also independent of l
    $l \leftarrow l \cup l'$
end for
return
```

Connector nodes selection

```
$C \leftarrow \varphi$
for $i \leftarrow 2$ to $D - 1$ do
    $U \leftarrow l \cap H_i$
    $W \leftarrow (H_{i-1} \cup H_{i-2}) \cap l$
    Input: U and W
    Applying Recursive Minimal Cover algotihm
    Output: $U = U_{i,1} \cup U_{i,2} \cup U_{i,3} \cup U_{i,4}$
        $W \supseteq W_{i-1,1} \cup W_{i-1,2} \cup W_{i-1,3} \cup W_{i-1,4}$
    $C \leftarrow C \cup W_{i-1,1} \cup W_{i-1,2} \cup W_{i-1,3} \cup W_{i-1,4}$
end for
$B \leftarrow (V \backslash J) \backslash C$
return C , l ,B and CDS
```

Colors assignment

```
Input: CDS
Output: CCDS
Divide l into $l_0, l_2, l_4, \ldots$
Divide B into $B_0, B_2, B_4, \ldots$
Divide C into $C_1, C_3, C_5, \ldots$
Coloring = ( l, E) with $cl_1, \ldots, cl_{12}$, and each node in gets its sending channel according to the color
for $i \leftarrow 0$ to $2 - 1$ do
    for each node $n_k \in C_{i+1} \cup B_i$ do
        $chr(n_k) \leftarrow c\,h(n_t)$, is any parents of nk in li
    end for
    for $m \leftarrow 0$ to 3 do
        Each node in wi,m obtains color clm as its sending color
        Each node in Ui,m obtains color clm as its waking color
    end for
end for
```

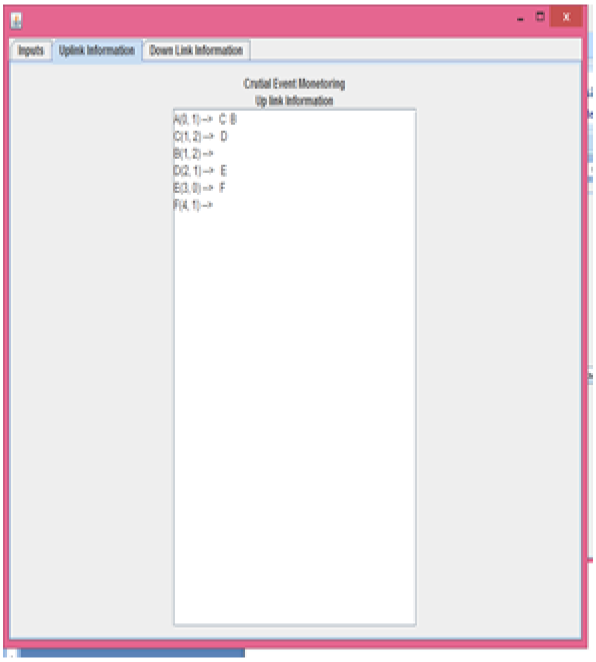
Recursive Minimal Cover:

```
$A \leftarrow 0, l \leftarrow 0, X' \leftarrow X, Y' \leftarrow Y$ ;
while $X \neq 0$
```

```
 C ← a minimal cover of X’ contained in Y’;
for each y ∈ C,
x ← a private neighbour of y in X’,
A ← A∪ {(x, y)};
l (x, y) ← l;
X’ ← X’ \ {x};
Y’ ← C;
Output A and l
```

VI. Experimental Evaluation

The proposed framework is implemented in JDK 1.8 using NetBeans 8.0 Environment. The snapshots of our implementation are as shown below:



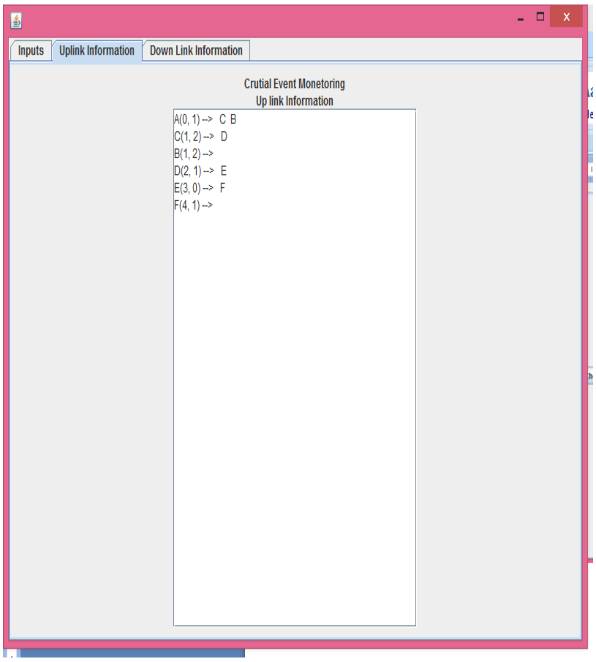
```
A(0, 1) -->  C  B
C(1, 2) -->  D
B(1, 2) -->
D(2, 1) -->  E
E(3, 0) -->  F
F(4, 1) -->
```

Figure1. Snapshot

VII. Conclusion

The important issue that is to be discussed in many applications involving Wireless Sensor Networks is the power efficiency and data aggregation or data gathering. A new power efficient sleep scheduling scheme has been suggested in this thesis which improves the performance of sensed data on Wireless Sensor Networks (WSNs). This proposed power efficient sleep scheduling algorithm is an energy efficient tree approach. The proposed solution is adapted to consider the remaining power levels of nodes in order to increase the lifetime of the networks.

To minimize the broadcast delay, we establish a breadth first search (BFS) tree for the uplink traffic and a colored connected dominant set (CCDS) for the downlink traffic, correspondingly. Features of the proposed scheduling scheme are as follows:



```
A(0, 1) -->  C  B
C(1, 2) -->  D
B(1, 2) -->
D(2, 1) -->  E
E(3, 0) -->  F
F(4, 1) -->
```

- The upper bound of the broadcasting delay is 3D + 2L, where D is the maximum hop of nodes to the centre node, and L is the length of duty cycle, the unit is the size of time slot. Since the delay is only a linear arrangement of hops and duty cycle, it might be very little even in large scale wireless sensor networks.

- The broadcasting delay is free of the length of the duty cycle and density of nodes, but it augments linearly with the number of the hops.

- Energy utilization is also much lesser when compared with existing system.

The proposed snoozing scheme could essentially decrease the delay of alarm broadcasting from any node in WSN. The upper bound of the delay is 3D+ 2L, that is just a linear grouping of hops and duty cycle. Furthermore, the alarm broadcasting delay is independent of the density of nodes in WSN. The energy utilization of the proposed method is much lower than that of existing methods.

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