Alarm System in WSN for Critical Event Monitoring: Indian Agriculture

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Abstract -- The evolution of wireless sensor network technology has enabled us to develop advanced system for real time monitoring. We aim to focus on key factors discovered for effective utilization of WSN for Agriculture boost up. Some issues discussed concerns with how information technology contributes to the wide sphere of Agriculture and rural developments as they are two sides of a coin. We have briefly surveyed methods to provide WSN based services to Agriculture, which decreases the cost of production and increases the efficiency of production. This paper describes the application of WSN for crop monitoring with Alarm system. We focus on Critical Event Monitoring. When the critical event occurs an alarm message should be broadcasted to entire network and to the farmer as soon as possible. In this paper we propose a novel sleep scheduling method to reduce the delay of alarm broadcasting from any sensor node in WSN.
Keywords – Agriculture, Alarm System, Sleep Schedule, WSN

1 INTRODUCTION

Wireless sensor network (WSNs) are being used in a wide variety of critical applications such as military and healthcare application, agriculture and industrial process monitoring. WSN is private network made by large number of sensor nodes which do a specific function. WSN has several advantages including easy installation, cost effectiveness, small size and low power consumption, which is essential for our Indian farmers. In recent years, Agriculture faces many challenges, while humidity depends on agriculture and water for survival, so precision agriculture monitoring is critical and demand for environmental monitoring and remote controlling in agriculture is rapidly growing.

In India, many government, private and research institutes are implementing WSN for natural resources and agriculture monitoring application, e.g. Gramya Vikas: A distributed collaboration model for rural development planning (Adinarayan et al., 2009), COMMON-Sense Net: improved water management for resource-poor farmers via sensor network (Panchard et al., 2006; COMMON Sense Net, 2011), etc. Sensor based services of Bhuvan for Land, Weather, Ocean and Disaster management (NRSC, 2011), environmental sensor based services of Ubiquitous Agriculture (uAgri C-DAC, 2011), mobile based agricultural advisory system mKRISHI (mKRISHI, 2011), etc. are few examples of the application of sensor technology for monitoring natural phenomenon. Sugar Cane is the one of the most widely grown crop in Karnataka and is the richest crop for farmers which need the water supply after every 10-15 days. WSN provide a friendly hand for the farmers to monitor the Acers of sugar land. WSN provides continuously monitored information to the farmers and a alarm message for the critical event in the crop field. This facility makes the farmer to involve themselves in other activities instead of spending the whole time in the crop field which is most important for the new generation. By providing the wireless technology for Indian agriculture is the best effort for diverting the new generation towards the agriculture.

When a critical event 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. Then, sensor nodes can warn users nearby to flee or take some response to the event. As sensor nodes for event monitoring are expected to work for a long time without recharging their batteries, sleep scheduling method is always used during the monitoring process. Obviously, sleep scheduling could cause transmission delay because sender nodes should wait until receiver nodes are active and ready to receive the message. The delay could be significant as the network scale increases. Therefore, a delay-efficient sleep scheduling method needs to be designed to ensure low broadcasting delay from any node in the WSN. Critical condition in the farming field like: Temperature, Humidity, Leaf wetness, soil moisture should be detected and informed to the farmer as soon as it is detected.

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. In this paper, we propose a novel sleep scheduling method, which is still based on the level-by-level offset schedule, to achieve low broadcasting delay in a large scale WSN. As the alarm message may be originated by any possible node, we set two phases for the alarm broadcasting in the proposed sleep scheduling method. First, when a node detects a critical event, it originates an alarm message and quickly transmits it to a center node along a predetermined path with a level-by-level offset way. Then, the center node broadcasts the alarm message to the other nodes along another path also with a level-by-level offset way.

Through designing a special wake-up pattern, the two possible traffics could be both carried by a node, and the node just needs to be awake for no more than Ʈ time in each duty cycle, where Ʈ is the minimum time needed by a node to transmit an alarm packet. To eliminate the collision in broadcasting, a colored connected dominant set (CCDS) in the WSN via the IMC algorithm proposed in [7] is established. Each node transmits or receives packets in a specific channel according to the color assigned.

II. RELATED WORK

Many sleep schedules for event monitoring have been designed [2], [3], [4], [5]. However, most of them focus on minimizing the energy consumption. Actually, in the critical event monitoring, only a small number of packets need to be transmitted during most of the time. When a critical event is detected, the alarm packet should be broadcast to the entire network as soon as possible. Therefore, broadcasting delay is an important issue for the application of the critical event monitoring.

A centralized gateway node collects all transmission requirements during a contention period and then schedules the distributions according to the reservation path. An energy-adaptive MAC protocol, Gateway MAC (G-MAC) implements a new cluster-centric paradigm to effectively distribute cluster energy resources and extend network lifetime. Concentrating the transmissions into a smaller active period reduces idle listening, but it also increases the probability of collisions. Receiving and discarding messages intended for other nodes, or message overhearing, is commonly employed in non-energy constrained networks to increase throughput and high delay [6]. Continuous monitoring applications are an important class of wireless sensor application. These applications require periodic refreshed data information at the sink nodes [2]. The need of the sensor node was to transmit continuously in periodic fashion to the sink nodes it leads to excessive energy consumption. DMAC protocol specifically design for the wireless sensor network, where the communication pattern is restricted to an established unidirectional data gathering tree. Here, all nodes having a periodic receive– transmit sleep cycle with level-by-level offset schedule ,which means that all nodes wake up when the source node have just gotten a data packets, and go to the sleep as soon as they transmit packets to the destination nodes. The level-by-level offset schedule in DMAC can achieve much lower transmission delay in one traffic direction; it is not efficient in bidirectional delay guarantee [8]. The authors presented several sleep scheduling patterns that adhere to the bidirectional end-to-end delay constraints, such as shifted even and odd pattern, ladder pattern, two ladder pattern and crossed-ladders pattern. However, the patterns are not suitable to alarm broadcasting in the WSN, because the traffic discussed is just a single flow. If the sink node broadcasts packets according to the patterns, there will be serious collision in the network [9]. In this query based sensor network a node cannot voluntary send data packets that they sensed to the sink node, unless the sink node sends them queries, these queries are very complex. Hence the sink node needs to predict the data arrival time for each destination nodes. Collecting information from the environment by keeping all the nodes active and transmitting to the sink is energy expensive. Therefore, the scheme is not suitable to alarm broadcasting in the WSN for critical event detection [10]. ADB is based on asynchronous wake-up. It exploits some information contained in data packets and ACK, so to arrange the transmission among nodes. When sensor nodes take prior knowledge of all the link quality, packet broadcasting in ADB actually follows a determined broadcasting tree in the network. Furthermore, as sensor nodes with ADB wake up asynchronously, collision can almost be avoided. In this technique, to compare the proposed scheduling scheme with ADB [11] and DW-MAC [12].

III. THE PROPOSED METHOD

3.1 Problem Description

We assume that a certain node, called as center node, in the network (G) (e.g., sink node). The center node computes the sleep scheduling according to the proposed scheduling scheme and broadcasts the scheduling to all the other nodes.

3.2 System Architecture

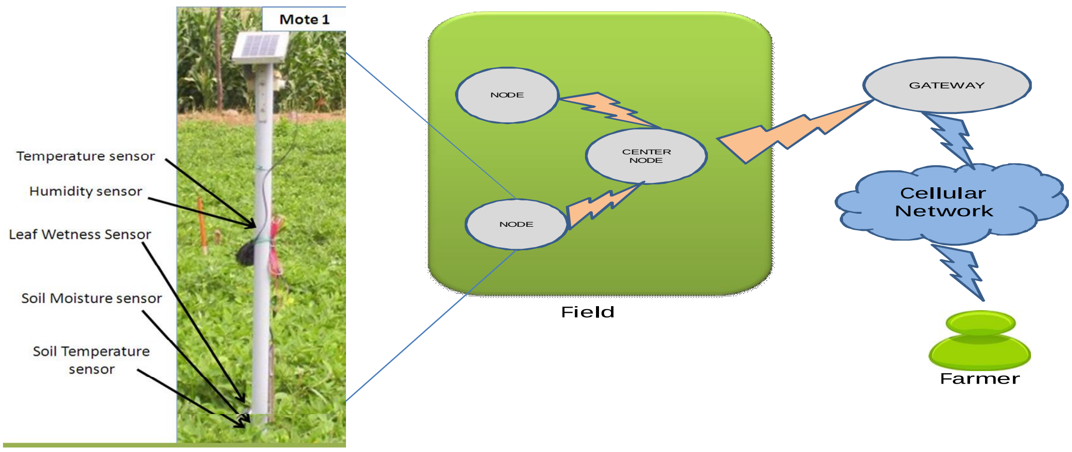

Fig1. Nodes in the Field

The critical event monitoring in a WSN, sensor nodes are usually set with passive event detection capability and it allow a node to detect an event even when its wireless communication module is in sleep mode. Upon the detection of an event by the sensor, the radio part of the sensor node is immediately woken up and is ready to send an alarm message. The time is partition into different time slots. The length of each slot concerning the minimum time is needed by sensor nodes to transmit or receive a packet, which is denoted as Ʈ. To assume the network topology is steady and denote it as a graph G. Time of sensor nodes in the proposed scheme is assumed to be locally synchronous, which can be implemented and maintained with periodical beacon broadcasting from the center node.

3.3 Basic Idea

The proposed scheduling method includes three phases: 1) Any node in the network which detects a critical event sends an alarm packet to the center node along a predetermined path according to level-by-level offset schedule; 2) The center node broadcasts the alarm packet to the entire network also according to level-by-level offset schedule; 3) Center node send the alarm packet to the gateway through which it will be delivered to the farmer. The proposed method defines the traffic paths from nodes to the center node as uplink and defines the traffic path from the center node to other nodes as downlink.

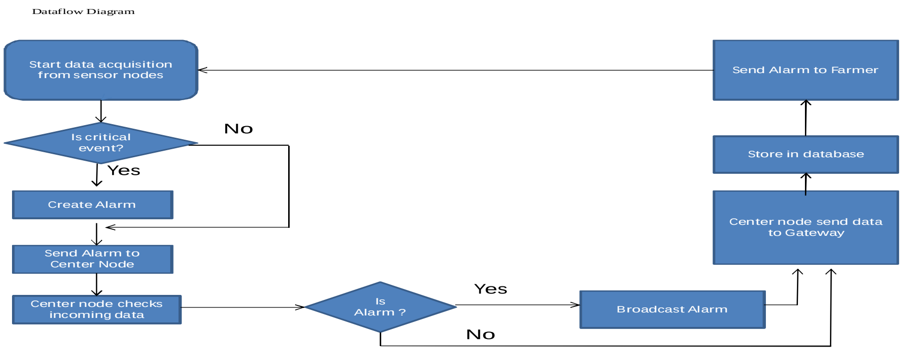

Fig2. Data Flow of Alarm System

3.4 Traffic Paths

Select certain node as center node. Then construct the BFS tree from node to the center node in the network. Here BFS tree divides all nodes of network into layers H1, H2, H3, …, HD, where Hi is the node set with minimum hop i to c in the WSN. With this BFS tree the uplink from the node to the center node is easily established.

A Colored Connected Dominant Set (CCDS) is established in downlink traffic to reduce the broadcasting delay. To establish the CCDS in G with three steps:

1) Construct a maximum independent set (MIS) in G.
2) Select connector nodes to form a Connected Dominated Set (CDS), and partition connector nodes and independent nodes in each layer into four disjoint sets with IMC (Iterative Minimal Covering) algorithm Proposed in [7]
3) Color the CDS to be CCDS with no more than 12 channels.

3.5 Wake – up pattern

Once all the nodes in the network gets the uplink and down link traffic paths we need to provide wake up pattern for the sensors to wake up and receive alarm packet to achieve minimum delay for both of the traffic paths.In our proposed method, there are two paths and here we maintain two level- by- level offset schedules: 1) sensor nodes on path in the BFS wake up level-by-level according to their distances to the center node; 2) after the center node wakes up, the nodes in the CCDS will go on wake up level-by-level according to the their hop distance in the CCDS. When critical event occurs at the node, node creates the alarm packet and it could be quickly forwarded to the center node along the path in the BFS, then, the center node immediately broadcasts it along the path in the CCDS. After this broadcasting the center node send the alarm packet to the gateway and gateway passes the alarm message to the farmer.

IV. COMPARSION AND ANALYSIS

In the proposed method, the maximum hop of the shortest path in the CCDS from any node to the center node is no more than 2D and we analyzed that the upper bound of alarm broadcasting delay in WSN is no more than 3D+2L, where D is the maximum hop of nodes to the center node, and L is the length of duty cycle, the unit is the size of time slot. By conducting the simulation of the proposed method, ADB [11] and DW-MAC [12] we can clear that the proposed method does not exhibit good performance in the case of minimum time slot. We first set the size of the time slot to be the minimum time Ʈ for sensor nodes to transmit an alarm packet, e.g., 2 ms. When an alarm transmission fails between two adjacent nodes with the proposed scheme, the sender node has to retransmit the alarm after 2 duty cycles. While, for the ADB and the improved DW-MAC schemes, the sender node retransmits the alarm after 1 duty cycle. Obviously, the proposed scheme does not exhibit good performance in the case of minimum time slot. To improve it, we set the size of the time slot to be 10 ms. Each sensor node still listens for 2 ms during each duty cycle. When a sensor node wakes up to listen to the channel and detects a collision or a failing reception during the 2 ms, it will keep listening and receiving till the end of this time slot. Accordingly, when the sender node finds that it fails to transmit the alarm packet during the 2 ms, it will keep retransmitting the packet till the end of the time slot.

With this improvement, sensor nodes may successfully retransmit packets within a time slot and do not need to retransmit packets after 2 duty cycles. Hence, the transmission delay could be largely reduced.

V. CONCLUSION

India is developing at a faster rate but due to urbanization crop fields are getting converted to new forms of urban world. Also farming community is becoming narrower day by day due to better opportunities. The gap between need and production is increasing at a rapid rate. In this paper, we proposed a alarm system for farmers using sleeping schema with critical event monitoring in WSNs. The proposed method helps the formers to get the real time monitored information even if they are not at the field. The proposed sleeping schema could essentially decrease the delay of alarm broadcasting from any node in WSN. The upper bound of the delay is 3D+2L.In future this proposed system will be fabricated, deployed and tested.

VI. REFERENCES

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