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Energy and converge optimization at disaster situation using Mobile sink in Wireless sensor network

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Abstract. In this position paper we address key challenges in the deployment of wireless sensor networks (WSNs) with mobile sinks for large-scale, continuous monitoring. Each sensor node is a low-power and constrained device, generally composed by: a processor with limited processing power; a restricted quantity of memory; a sensor board, which may contain different kinds of sensor data acquisition devices; a battery, which provides power for the sensor node work and a radio that allows wireless communication. the main aim of these researches is to extend the network lifetime, since, in the operational environment, to charge or to exchange the sensor nodes' batteries is probably an impossible/unfeasible activity. we have also present algorithms that address some of the problems that arise in this field and compare that methods. Disasters management and emergency services used to protect a person or society from the cost of disasters. Timely report and responses are especially important for reducing the number of sufferers and damages from incidents. In such cases, the communication structure that may not function well. This makes it hard to gain information about the incident, and then to respond to the incident rapidly and properly. Sensor networks can provide a good solution to these problems through actively monitoring and well-timed reporting emergency incidents to base station. Our objective on this topic aim to study different sensor network protocols to resolve some key technical problems in this area, thus identify the energy efficient wireless sensor network architecture for significant improvement of disaster management . We propose an opportunistic routing scheme for increasing battery life in wireless sensor networks operating in volatile environments.

Introduction

Wireless sensor networks (WSNs) are formed from sensor nodes with limited resources that are deployed to detect physical phenomena. These nodes generate data and operate in a multi-hop fashion to relay data from other nodes. In our case, we consider relaying data to a base station (static data sink) in buildings during a fire as could be used for monitoring the spread of the fire, locating people in the building, and providing real time information to firefighters, etc. This needs robust and rapid communication, yet the sensor field may become unreliable as nodes are consumed by the fire. We envisage firefighters entering the building each with a small powered node attached to them as part of their equipment pack. These nodes can act as mobile sink nodes which are able to relay data to the base station in a single hop, using for example IEEE 802.11. The main question we consider is how to make best use of these mobile sinks in order to improve the efficacy of network delivery.

WSN for air pollution monitoring

Kavi k. Khedo (2010) et al. Report on a “WSN air pollution monitoring system (WAPMS)”.Indeed with the increasing number of vehicles on our roads and rapid urbanization air pollution has considerably increased in last decades. To reduce this problem they use ‘Recursive Converging algorithm’ and duplicate elimination technique. both the techniques are represented by authors. The algorithm is used to merge data to eliminate duplicates, filter out invalid readings and summarize to simple form which significantly reduce the quantity of data to be transmitted to the sink and thus saving Energy [1].

WSN for emergency response

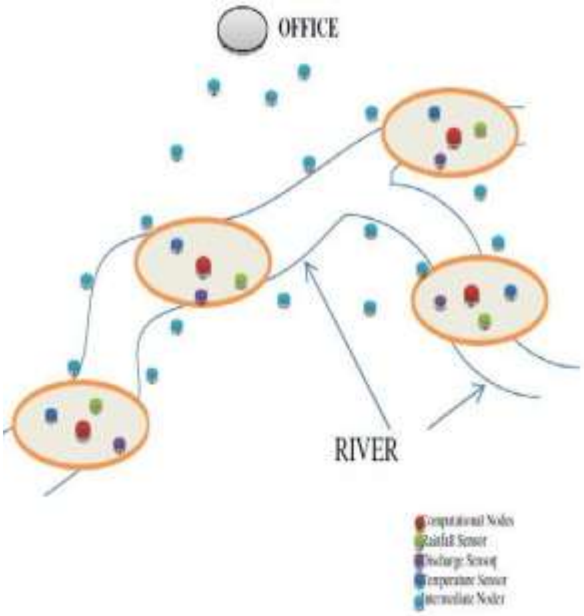
A Location aware WSN protocol for emergency response task when disaster happens is described by Ashok Kumar (2009). In this paper localization, Communication is the main aspects of disaster-aided network (DAN).In localization aspects, a ‘ranging and position estimation methodology' for patient localization at disaster site is proposed. As the result shows that DAN system supports efficient resource planning, quick evacuating of the patient and increase of situation awareness during disaster management [13].

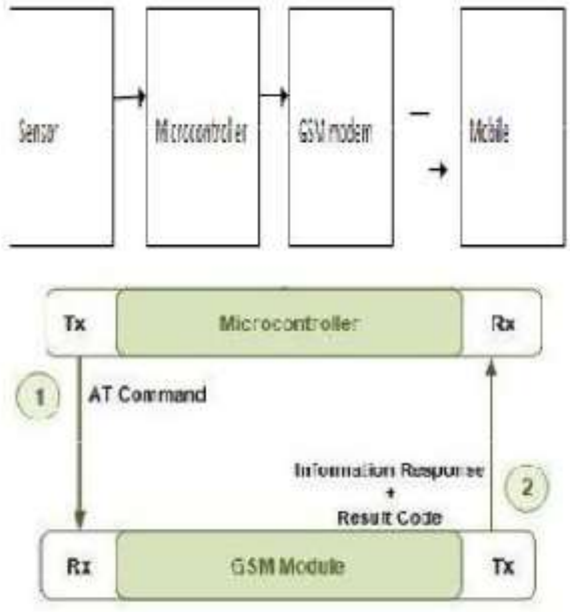
WSN for earthquake detection

Rui tan (2010) et al. Describing in their current research in “Quality driven Volcanic Earthquake Detection using WSN”. In this paper, they described novel qualities driven approach to achieve real time, long-lived volcanic detection. These approaches based on ‘collaborative signal processing algorithm’. The result of this is minimizing sensor’s Energy consumption subject to sense quality requirement [11]. Makoto Suzuki (2007) et al. Proposing “A high density earthquake monitoring system using WSNs”. For high precision monitoring, they developed Pave net OS, which is hard real time operating system for sensor nodes, and accelerate the sensor board. In this model work in wireless mode and acceleration sensor board for necessary earthquake monitoring. As a result, they have easily preliminary evaluation of high precision and high density earthquake monitoring system [10].

WSN FOR FORECASTING

Victor seal (2012) et al. Describing "A simple flood forecasting scheme using wireless sensor network" This work presents a forecasting model designed using WSNs to predict flood in rivers using a simple and fast calculations to provide real time results and, save the lives of people who may be affected by the flood. The novel algorithm is used to predict from the flood forecasting and use the independent number of guidelines. Figure-4 depicts the WSN deployment scheme in a flood prone river basin. The result is to give awareness to the people and, save their life [5].





PERFORMANCE ANALYSIS OF DISASTER MANAGEMENT PROTOCOLS

Mohamed youis (2004) et al, analyzed that "On Handling QOS Traffic in WSN" Many new routing and MAC layer protocols have been proposed for WSNs tackling the issues raised by the resource constrained unattended sensor nodes in large-scale deployments. Transmission of data in such cases requires the Energy and QOS aware network management to ensure efficient usage of the sensor resources and effective access to the gathered measurements. They highlight the architectural and operational challenges of handling of QOS traffic in sensor networks [8]. Sanjay Patel (2011) report On an "Interfacing of Sensor Network to Communication Network for Disaster Management". This work with the sensor network and Communication network for disaster management using GSM modem which the concerned authorities dealing with disaster management get the message on their mobile phones about disaster information. Figure-5 given a general block diagram for Interfacing of Sensor Network to Communication Network for Disaster Management.

WSN FOR ENVIRONMENTAL MONITORING

Al-Sakib Khan Pathan (2006) et al. Analyzing "Smartening the Environment is using WSNs in a developing country". In this paper, they explore the prospects of wireless sensor networks and propose a design level framework for developing the smart environment using WSNs. Here update the information about flood, water level, traffic and controlling, environmental frequently. If any changes mean, they used two phases. First phase used to collect the data and send to the local base station. The second phase involves data distribution network, where the processed data sent to different factors involved in network [9].

ASSUMPTIONS AND APPROACH

Assumptions

Firstly, we have some assumptions about sensor nodes and the base station (BS).

1. There is a static BS and many stationary sensor nodes.
2. Each sensor transmits data back to the BS through a multi-hop path. Each sensor has the same maximum transmission range, and is aware of its "relative" location (within the building). We also have assumptions about the mobile sink (MS).
3. The MS is aware of its own position, relying on well-known localization mechanisms such as [7].
4. The MS moves uncontrollably but part-predictably through the field.
5. The MS can detect its speed and direction of travel. For simplicity, we assume that the original routing tree for

routing data from sensor nodes to the BS in the absence of a mobile sink is constructed using literature standard routing protocols, e.g. [8,9].

Approach

Our approach is explained in the context of four scenarios in which a mobile sink may be used during a building fire emergency.

Table 1 summarizes the notation.

KBSi	The hop count to reach the BS from sensor node i
KMSi	The hop count to reach the MS from sensor node i
Kjoin	The value to decide if sensor should join the MS-tree (join if $K_{BSi} > K_{MSi} + K_{join}$)
K	The number of hop counts each beacon should be extended from the MS.
RE_Threshold	The remaining energy threshold to join and leave the MS-tree
SPEED_Threshold	Speed threshold of the MS for issuing a beacon broadcast.
NK	The average number of nodes within K hops
NK-1	The average number of nodes within K-1 hops
Prx	The power consumption for receiving a message
Ptx	The power consumption for transmitting a message
D	The average number of neighbors of each node
T_i	The transmission range equal for each node
S	The 2D region in which the sensors are deployed
N	The total number of sensor nodes

Stationary:

When the MS arrives at a new location in the sensor field, and offers a shorter route to the BS for nodes in its immediate area. MS broadcasts a beacon message, and this message floods though the network for up to K hops. Each sensor that can hear the beacon decides whether it is better to route via the MS (and continue flooding the beacon), or to continue with its old route to the BS. We assume nodes will join the temporary MS-tree, which is rooted at the MS, as soon as they find the MS-tree offers a shorter path. Note that re-routing for a small improvement may be more expensive than keeping the original route due to the overhead of building up the MS-tree, and collapsing it when the MS is out of range. To estimate the cost of building the MS-tree, we look at the best case when each node within (K-1) hops receives and broadcasts the beacon once and the nodes at exactly K hops only receive the beacon messages without broadcasting them. In this case, the cost of building the MS-tree in K hops is minimal, Assuming the nodes are uniformly deployed and the area of K-hop neighborhood of a node is covered by the area of the circle centered at the node with radius KT_i, the average number of nodes within K hop can be estimated. However, when the goal is to consider energy efficiency, the energy cost and/or the residual energy metrics are used. Sensor nodes will decide to set up or join the MS-tree if the power consumption it offers is less than the original route. For load balancing, the metrics can be data rates, transmission rates, etc. Sensor nodes in this case choose the light way to transmit data. In this paper, we combine two metrics: the residual energy and hop count value. To join the MS-tree, a sensor node that receives the beacon (within K hops from the MS) will compare its local hop K_{BSi} (the hop count to reach the BS) and its new hop K_{MSi} (the hop count to reach the MS). In case that $K_{BSi} > K_{MSi} + K_{join}$, the node will join the MS-tree and forward the beacon to its neighbors if $K_{MSi} < K$. Otherwise, it ignores the beacon message. Sensor nodes can decide to leave the MS-tree if their power is running low (due to relaying/forwarding data to the MS). (i.e. if its residual energy is lower than RE_ Threshold). To do that, the node broadcasts a beacon with hop count INFINITY. The children can then find their new parents or leave the MS-tree. When the MS is about to move, it again broadcasts a beacon. How to collapse or revise the tree is discussed below.

Movement:

The MS is moving, while acting as a relay (routing data back to the BS). In this scenario, the BS collects data from sensors and MSs. The MS has knowledge of its own velocity and has a strategy for sending the *beacon*. When the MS is moving, the hop count for each sensor node may change frequently. To deal with this, the node will follow the collapsing policy to decide whether to connect to a new parent or leave the MS-tree. The collapsing policy: When a node in the MS-tree receives no beacon from the MS, or a beacon with hop count of INFINITY, it firstly sends a warning message to its descendants, saying that the MS-link might be broken. The sensor nodes will wait for a back off time (K_{MSi}).L/R_i (L is length of beacon message, R_i is data rate). During this time, they will stop forwarding data and store data internally if necessary. If a sensor node receives any beacon message within the back off time, it will join the new parent if $K_{BSi} > K_{MSi} + K_{join}$, then it forwards its new K_{MSi} to the neighbors. In case that $K_{BSi} \leq K_{MSi} + K_{join}$, the node will revert to the original path to the BS. If it does not receive a beacon in that period, it also wipes out its MS-tree information, and reverts to the standard tree. The MS has known of its own velocity and direction, and has a strategy for sending the *beacon*. If its speed exceeds *SPEED_Threshold*, the MS stops broadcasting the *beacon*, or broadcasts a beacon with INFINITY hop count which indicates that it will not be able to receive any data. This strategy is to prevent data losses, and to save energy consumption for sensor nodes in neighborhood.

Reservation:

In a building, the MS can predict the direction of movement in some cases such as when the MS moves along corridors. Then, it broadcasts the RESERVATION message at a time t1. This message will include the predicted location and the time t2 at which the MS is expected to arrive. Ideally this would be achieved using a directional antenna on the MS, as shown in Figure 3, but otherwise we can apply geographic routing, as in GPSR [12]. When a sensor node receives a RESERVATION message, if it is in the collection region, it will join the MS-tree and prepares data to for the MS. In this scenario, we have to deal with the case that the MS is delayed, or never reaches its planned destination. Sensor nodes must decide how to prepare data for the MS arrival, whether it sends data immediately to the MS, or continue to send data on the original path to the BS until sometime t1’ (t1≤t1’≤t2). If t1’ is close to t2, when the MS arrives, the data might not be ready. However, if t1’=t1, sensor nodes will send data to the MS immediately using the MS-tree. When the MS’ arrival is delayed, the sensor nodes in collection region will wait for a while before they collapse the MS-tree, and send all data back to the BS via the original path. During this wait time, if they hear from the MS, the collection will be performed normally until the MS moves out of the area.

Connection:

Since we assume the WSN is operating in a volatile environment, where some nodes are being destroyed, it is likely that some clusters of nodes will become disconnected from the rest of the network. The mobile sink offers a temporary connection. In each of the three modes described above, we need to adjust the behavior of the MS and other nodes to recognize and give priority to disconnected regions. In addition, the disconnected nodes need to organize their data collection to be able to take advantage of this transient link if it appears. We assume that once a cluster recognizes it is disconnected, its implements a new policy for storing data, discarding less important data, and stopping transmission of data once energy becomes depleted.

Evaluation

In order to evaluate our approach we designed an opportunistic routing protocol and implemented it on (a) a small laboratory-based WSN and (b) within the popular ns-2 network simulator. Details are given in [1], and here we present just the key simulation results. In the simulation, 150 nodes are distributed in a grid area of 10-meter cell length; 149 sensor nodes are placed at crossing points of the grid; the location of the base station (BS – node 0) is fixed at the bottom-left corner of the network map. Hence, the maximum number of hops in the original network using the standard protocol is 25. Table 2 shows the simulation parameters. The transmission range is 10 meters; hence each node can talk to 4 neighbors (left, right, up, down). Each sensor node will sense data and transmit to the BS every Pi seconds. For modeling the hazardous environment we are not concerned with faithfully modeling a spreading fire (for example); instead, we simply wish to create isolated regions, and to puncture holes in the network. Thus we simply create rectangles of nodes and disable the nodes on the perimeter. We pick two random coordinates for the bottom left and top right corners of the rectangle, and then disable all the nodes on the boundary of that rectangle following a simple policy. To disable a node, we generate a random time point where the node will die. And then for each step, we check if any nodes reach their time points, and those nodes will be turned off indicating that they are dead. We introduce a mobile sink walking into the simulation area with the Random Way Point Model supported in ns-2. The reservation is made randomly as presented in scenario 3 by the mobile sink (MS).

Parameters	Default Value
Packet size	50 bytes
Transmission range	10 meters
Data Period, Pi	Varied in {5, 10, 20, 30} seconds

(a) ns-2 parameters

We are interested in the number of packets successfully received by the BS, and their latency. In the following we will show the impact of the MS though number of packets the BS can receive successfully by time when we use and do not use the MS. With this, we can see the delivery latency, how fast the BS can received data with the aid of the MS. In this simulation, we vary the K hop value from 5 to 10 to see the different benefits from the MS with different collection area sizes. In the network with maximum number of hops is 25, the smallest K with 5 hops is reasonable.

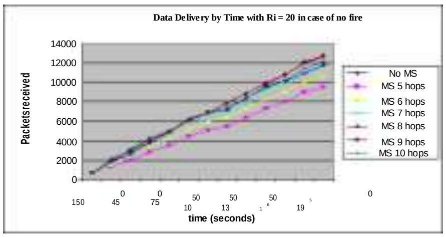
RE_Threshold	100 J
Kjoin	2
K	Varied from 5 to 10
Pause time of the MS	Varied in {10, 15, 20, 25, 30}
SPEED_Thresh old	4 meter/second

(b) Protocol parameters

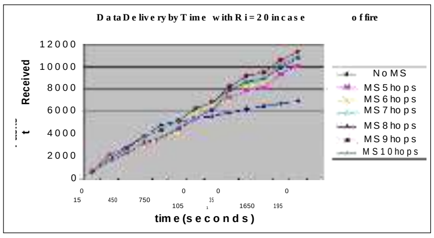
Table 2. Configuration of simulation

We first measure and compare the data delivery time in normal behavior when no fire occurs. Figure 3(a) shows the number of packets received by the BS over time when no MS is used and when we introduce a MS with K hops collecting data. Here, we vary the K parameter from 5 to 10 hops. In this experiment, we see that the MS doesn't help at all if K is 5, or 6, or 7. When we increase K with 8, or 9 hops, the mobile sink offers a faster delivery data to the BS. However, with K increased to 10 hops, the data delivery is approximately the same as the case when not using a MS. The introduction of the MS seems to give mixed results. We believe this is explained by the MS occasionally moving too close to the BS, and so creating an overhead in messages without offering any faster route. If the k value is too high, the MS tree is too large, and some data is forwarded to the MS only to arrive after the MS has already departed, and the data has to be re-routed back to the base station, thus increasing latency.

We now introduce the spreading hazard into the network and we vary the K value from 5 to 10. Figure 3(b) shows that the MS gives a significant impact in data delivery when fire occurs with the biggest benefit obtained when K is 8 or 9. With our fire spread model, some nodes will die gradually. The points when the data delivery without the MS changes dramatically, approximately t=840s, is when the network starts to become disconnected. We see the benefit of the mobile sink being able to offer connectivity. At that point, the delivery rate for the No MS situation decreases, and is soon overtaken by the different MS cases. Note that the gradient of the data delivery lines in the Figure 3(b) change at some points, for instance, MS with 5 hops at 1740s, or MS with 10 hops at 1300s, etc. This is due to the difference in the amount of data collected when the MS is moving compared to when it is paused. Overall, we can see that the gives a significant benefit in data delivery. At time = 1950s, the MS increases by approximately 50% the amount of data received by the BS.



(a) Normal behavior



(b) Emergency behavior

Figure 3. Data Delivery by Time with Pi=20

Conclusion

This survey studies the role of sensor network in disaster management. It furthermore studied the different types of disaster management protocols and their application in extremely disastrous conditions. The performance such protocols are studied based on Energy efficiency, location awareness and network lifetime. We have presented a scheme for opportunistically using an uncontrolled mobile sink to achieve reliable and robust data delivery in wireless sensor networks during building emergencies. Our experiments show that with the reservation technique, use of a mobile sink yields increased message delivery rate by up to 50%. Current work includes completing our sensor node software implementation, while future work will include mathematical analysis and extensions for dealing with multiple mobile sinks.

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