Routing Protocol for Indoor Monitoring Systems

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Abstract.
Extreme events like fire can cause massive damage to the indoor area. Damage occurs due to the extreme events can cause in life threatening conditions inside the indoor after that event. In such situation wireless sensor network (WSN) [1] based real time event driven indoor monitoring system is necessary to reduce the loss of human lives by identifying the source of the extreme events inside the hazardous indoor area. In this paper we present a routing protocol for a real time event driven indoor monitoring system which is use for selectively monitor the indoor area after an event occurred like fire. In case of fire the temperature recorded using temperature sensor of the stationary sensor motes as well as mobile sensor motes is very vital. Depending on the floor map of indoor, these sensor motes are placed permanently or temporarily. We need to gather sensed data with position information for tracking down the source of the extreme event based on sub area wise comparison of temperature of the total hazardous indoor area.

Keywords: Indoor Monitoring System, Routing protocol, Hazardous indoor area.

1. Introduction

Traditionally, indoor area monitoring systems were wire based. The sensors are placed at several vital points in the structure and connected to a central Data Acquisition Systems over a cable. For indoor area monitoring, the wired systems have lots of primary problems regarding installation and maintenance. Wired systems are not capable of real time event driven hazardous area monitoring. Wireless Monitoring System based on WSN have been used for numerous monitoring applications and suitable for real time event driven indoor area monitoring. A Real-time event driven indoor monitoring system (REIMS) requires the appropriate architecture for WSN topology as well as a suitable routing protocol.

Thus we effectively divide the complete monitoring system into four disjoint parts which are stitched together to make a complete REIMS system for indoor area.

- Localization
- Coverage technique
- Selective clustering routing protocol
- Event detection and data collection from deployment site

The routing protocol proposed by us covers the requirements of REIMS system .

The remainder of the paper is organized as follows. Section 2 describes related work.Section 3.1 describes the design view of REIMS. The implementation of the clustering-based routing protocol for REIMS is given in Section 3.2. Conclusion and future work is given in Section 4.

2. Prior Work

Wireless sensor networks which have been used for several monitoring applications. Foremost are the Habitat monitoring applications such as the great duck island experiment [2], studying the redwood tree macro scope project [3], Zebranet project [4] etc. Many WSN systems have been developed to support environment monitoring [5], object tracking [6], scientific observation [7], and so on. Wireless Sensor Network also provides an solution for indoor monitoring [8,9]. Thomas Schmid [10] describe an indoor environmental monitoring network based on WSNs. Won-Suk Jang used WSN technologies for condition monitoring of buildings [11]. A WSN system described in [12] was deployed in a number of residential and commercial buildings .W.S. Jang and W. M. Healy analyze WSN performance metric for indoor monitoring applications [13]. So, Wireless sensor networks are capable of real time event driven hazardous area monitoring.Routing protocol for those kind of REIMS is very important issue.

3. Design of REIMS

3.1. REIMS Architecture

Each node in the REIMS system is a Cricket motes consisting of an RF transceiver, a microcontroller, and other associated hardware. There are three types of REIMS nodes. They are stationary beacon node, mobile listener node and forwarder node. Stationary node and forwarder nodes are fixed reference points of the Cricket based localization system (nodes pre deployed at ceiling as per coverage algorithm). Forwarder node have same characteristic as stationary beacon node but it have no sensing responsibility. Main responsibility of the forwarder is data forwarding.

The flow of data is from all mobile sensor nodes towards the base station. Figure 1 gives the design view of the REIMS system. The three distinct modules named data collection performed by stationary beacon and mobile listener, data aggregator performed by mobile listener and data forwarder performed by forwarder node are responsible for sensing, data fusion and data forwarding to the base station.

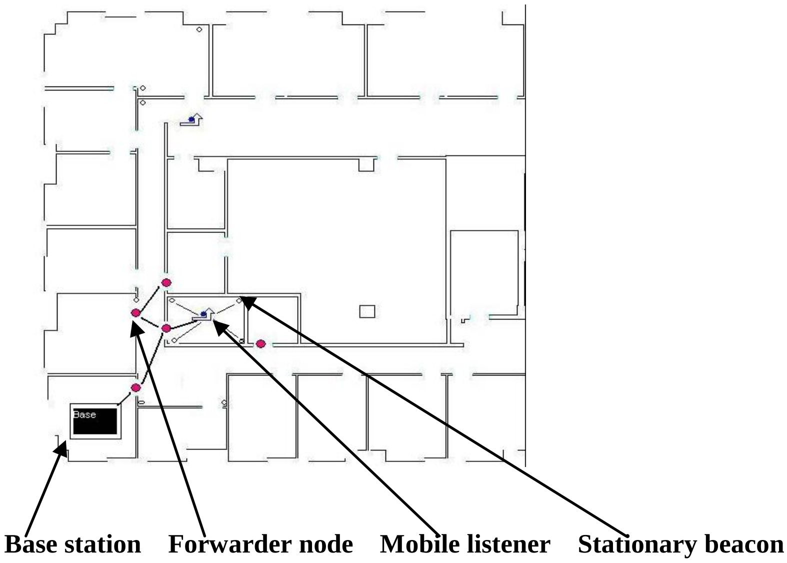

Fig. 1: Design View of the REIMS system

3.2. Routing protocol of REIMS

Our dynamic WSN architecture with a selective clustering routing protocol designed specifically for our real-time event driven indoor monitoring system (REIMS) with the facility of selective monitoring.

According to the map of the indoor area all the nodes in the network are divided into clusters. There are three kinds of sensor nodes in the WSN: the stationary cluster member nodes , the mobile cluster head nodes and the communication backbone nodes.

Therefore the Dynamic WSN architecture we implement is divided into two parts. The first part is consisting of low transmission range, energy constrained stationary cluster member nodes(SCM) and high transmission range mobile cluster head nodes(MCH), which forms the data compilation network . The data compilation network , which is charged with the collection and transmission the sensed data.

The Second part is consisting of large transmission range communication backbone nodes(CB) to the base station, which forms the data communication network. The data communication network is the key to the communication with the base station, which is charged with the forwarding of the monitoring data to the base station and remote control instruction from base station.

In our proposed algorithms, we use four packets. They are as follows.

BEACON_DATA: This is a data packet from SCM to MCH which gives information of sensed data of a SCM. This packet has several fields such as SCM's Id, SCM's position(x,y and z co-ordinate) and sensed data value.

LISTENER_DATA: This is a data packet from MCH to CB which gives aggregated sensed data of MCH to CB. This packet has several fields such as MCH's Id, MCH's position(x,y and z coordinate) , MCH's aggregated sensed data value and MCH's destination Id.

FORWARDER_DATA: This is a data packet from CB to CB or Base station which gives information of aggregated sensed data of a particular MCH. This packet has several fields such as CB's destination Id, MCH's Id, MCH's position(x,y and z coordinate) and MCH's aggregated sensed data value .

DEST_SELECT: This is a data packet from CB to MCH or CB which gives information of level of CB. This packet has several fields such CB's Id and hop count of each CB node from the sink which indicates its level.

Our proposed selective clustering routing protocol has four algorithms for SCM, MCH, CB and Base station as mentioned bellow

Algorithm for SCM

1) Initialization of mode :Set mode=Beacon
2) After a random interval send BEACON_DATA packet (contain own id, position data and aggregated sensor data) and go to step 3.
3) Go to step 2.

Algorithm for MCH

1) Initialization of mode: Set mode=Listener, destination=NULL, HOPCOUNT = 1000, COUNT =0.
2) If packet received and type of the packet = DEST_SELECT then go to step 3 otherwise go to step 4.
3) Retrieve value of hop count field of DEST_SELECT packet. If value of hop count < HOPCOUNT then destination = value of CB's Id field of DEST_SELECT packet.
4) If packet received and type of the packet = BEACON_DATA then COUNT = COUNT +1. MCH aggregate sensor data of beacon with its own sensor data based on aggregator function (maximum sensed value) and go to step 5 otherwise go to step 2.
5) If COUNT > 10 and destination! =NULL then Set mode = Beacon and broadcast LISTENER_DATA packet (MCH's id , position data and aggregated sensor data) and then Set mode = listener and go to step 2 otherwise go to step 4.

Algorithm for CB

1) Initialization of mode: Set mode=Listener ,forwardmode = INITIAL, destination=NULL,HOPCOUNT = 1000,COUNT =0.
2) If packet received and type of the packet = DEST_SELECT then go to step 3 otherwise go to step 5.
3) Retrieve value of hop count field of DEST_SELECT packet. If value of hop count < HOPCOUNT then destination = value of Base station's or CB's Id field of DEST_SELECT packet then go to step 4.
4) If forwardmode = INITIAL then Set forwardmode = WORKING and Set mode = Beacon then go to step 9 otherwise go to step 5.
5) If packet received and type of the packet = LISTENER_DATA. Retrieve all information of LISTENER_DATA and go to step 6 otherwise go to step 7.
6) If value destination id field of LISTENER_DATA = own id then Set mode = Beacon and broadcast FORWARD_DATA packet (destination id, MCH's id, MCH's position data and MCH's aggregated sensor data) and then Set mode = listener and go to step 2.
7) If packet received and type of the packet = FORWARD_DATA. Retrieve all information of FORWARD_DATA and go to step 8 otherwise go to step 2.
8) If value destination id field of LISTENER_DATA = own id then Set mode = Beacon and broadcast FORWARD_DATA packet (destination id, MCH's id, MCH's position data and MCH's aggregated sensor data) and then Set mode = listener and go to step 2.
9) If FORWARD < 5 then broadcast DEST_SELECT packet with own id and hopcount field of DEST_SELECT = hopcount + 1 and go to step 10otherwise go to step 11.
10) Increase value of FORWARD by 1 and go to step 11.
11) Set mode = Listener and go to step 2.

Algorithm for Base station

1) Initialization of mode: Set mode=Beacon, basemode = INITIAL, destination=NULL,FORWARD =0.
2) If basemode = INITIAL and Set mode = Beacon then go to step 5 otherwise go to step 4.
3) If packet received and type of the packet = FORWARD_DATA. Retrieve all information of FORWARD_DATA and go to step 6 otherwise go to step 2.
4) Report data contained in the FORWARD_DATA packet (MCH's id, MCH's position data and MCH's aggregated sensor data) to the serial port then go to step 2.
5) If FORWARD < 5 then broadcast DEST_SELECT packet with own id and hopcount field of DEST_SELECT = 0 and go to step 6 otherwise go to step 7.
6) Increase value of FORWARD by 1 and go to step 8.
7) Set mode = Listener and basemode = WORKING and go to step 2.

4. Conclusion and Future Work

In this paper we proposed a routing protocol for a Real Time Event Based Indoor Monitoring system. This protocol proposes a new approach to fetch the data from the remote site using the mobile sensor nodes which has not been used earlier in other sensor network projects. A new approach of inverting nature of cricket motes from beacon to listener and listener to beacon in a rapid way has been done. Although our work focuses on event base monitoring of indoor environment, the routing protocol can be used in other places as well.

We plan to integrate all the different components of the system in near future . Deployment of sensors in an intelligent manner, need to be tackled. Issues such as rare events in the automation of the design are also required to handle. Thus rigorous testing before live use is needed.

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