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# TRANSMISSION OF MULTIPLE EMERGENCY INFORMATION WITH THE COORDINATION OF NEIGHBORING ROUTERS IN WIRELESS SENSOR NETWORKS

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*Abstract*

***Wireless Sensor Network (WSN) has been widely considered as one of the most important category of networks. One of the applications of WSN is in Emergency Management Systems. Environmental monitoring systems, especially nuclear plants require transmission of emergency information in a dynamic manner. A conventional centralized management system may not be able to cope with huge number of sensors, rapidly changing topology and cannot assure the real-time transmission of emergency information. Decentralized System is presented to solve these problems. In Decentralized System, emergency information is distributed to the neighboring routers where each router transmits the emergency information to the sink by mutual coordination. In this paper, Decentralized System is proposed for the transmission of multiple emergency information with the coordination of neighboring routers without transmission collision between the routers.***

*Keywords:*

***Wireless Sensor Networks (WSN), Emergency Information, Router, Collisions***

## 1. INTRODUCTION

Wireless Sensor Networks (WSNs) have been widely considered as one of the most important category of networks [1]. Enabled by recent advances in microelectronics mechanical systems and wireless communication technologies, tiny, cheap, and smart sensors deployed in a physical area and networked through wireless links and the Internet provide unprecedented opportunities for a variety of civilian and military applications, like environmental monitoring, battle field surveillance and industry process control [2],[3]. Distinguished from traditional wireless communication networks, (cellular systems and mobile ad hoc networks (MANETS)), WSNs have unique characteristics and constraints. Denser level of node deployment, higher unreliability of sensor nodes, self-configurable, application specific, severe energy computation and storage constraints, which present many new challenges in the development and application of WSNs.

This paper addresses an environmental monitoring application for wireless sensor networks. Environmental monitoring system requires efficient supervision of environment. In order to satisfy this application need, real-time property is needed for monitoring system to become adaptive in dynamically changing topology. A lot of cheap sensors can be installed easily, and they can be flexibly added, removed and relocated in wireless environment. The centralized management systems have certain drawbacks. In central control, a complicated topology change procedure is needed in situation like node addition or the relocation. Because the environment changes dynamically, it is necessary to exchange control information for maintenance of the routing, frequently to the central sink node. The excessive control information sent to the sink node contributes towards high probability of collisions at routers nearby the sink node.

This paper proposes a Decentralized System where each routers and nodes cooperate with each other for the transmission of multiple emergency information packets autonomously to the sink without collision.

## 2. RELATED WORK

We consider a wireless sensor network consisting of a set of sensor nodes and a base station. The sensor nodes periodically sample local phenomena such as temperature and humidity, and transport the acquired data to the base station. An aggregate form of the data acquired by sensor nodes will be collected at the base station. K. Mori in [4], presents a concept of Autonomous Decentralized System and its Data Field (DF) Architecture. In this concept, autonomous subsystem is defined with two properties of autonomous controllability and autonomous coordinability, and a system is grasped as the result of integration of autonomous subsystems. Each autonomous subsystem is mutually connected only through the DF where all of the data is broadcasted and each subsystem independently selects to receive only the necessary data. It is driven only by the received data. This paper proposed autonomous controllability and autonomous coordinability but there is no autonomous community formation among the routers that supports the transmission of information.

David Malan [5], proposed An Ad Hoc Sensor Network Infrastructure for Emergency Medical care, integrating low power, wireless vital sign sensors, PDAs, and PC-class systems. Code Blue will enhance responder's ability to assess patients on scene, ensure seamless transfer of data among care givers, and facilitate efficient allocation of hospital resources. K. Mahmood, X. Lu [6], proposed Autonomous Pull-Push Community Construction Technology for High-Assurance. This paper presents community construction technology that share service discovered by one member among others in a flexible way to improve timeliness and reduce network cost. This paper gives information about the community construction and transmission of information. S. Niki et al. in [7] addresses an environmental monitoring system in the production plant as a practical application of the sensor network. In this paper, Autonomous Decentralized Community Wireless Sensor Network System (ADCWSN) is presented. In ADCWSN, all nodes are autonomous, and each node copes with problems by mutual corporation according to the dynamic situation. This paper proposed, Autonomous Initialization Technology and Autonomous Intra-Community Collaboration Technology. Autonomous Initialization Technology enables addition of new nodes at any time. Intra-Community Collaboration Technology accepts new sensors flexibly. This paper proposes high speed connectivity among the routers and routers autonomously judge the dynamic situation, but it has high overhead in implementation. A. Boukerche et al. in [8], presented a Wireless Actors and Sensor Network (WASNs). WASNs can provide a more accurate real time monitoring tool for the emergency preparedness class of application. This protocol uses a QoS mechanism which causes overhead in terms of latency. Although data aggregation on the actor nodes reduces the overuse of the nodes next to the sink, occurrence of failure in these nodes is larger than in other sensor nodes of the network. Similarly, by using actors as aggregation nodes, there is an overuse of the sensor nodes closer to the actor node. K. Lorincz et al. in [9], proposes a software infrastructure which integrates sensor nodes and other wireless devices into a disaster response setting and provides facilities for ad hoc network formation, resources naming and discovery. The architecture presented can be referred for rapidly changing and critical care environments. Lin Wang et al. in [10], has contributed an emergency navigation system with a large number of sensors. The dynamics of the environment and the mobility of users are the key issues for the efficiency and effectiveness of navigation protocols. Measurements of the distributed navigation system play an important role in the maintenance of the navigation system during emergencies. Testing and evaluation of navigation systems is not possible in practical scenarios. Therefore, measurement indexes are important in navigation systems. The indexes should affect the safety and effectiveness of the system. Predictions of dangerous areas are crucial for global safety. Achieving the accuracy of the measurement indexes is very difficult in real time scenarios.

## 3. SYSTEM ARCHITECTURE

System architecture is the conceptual design that defines the structure and behavior of the system. Fig.1 depicts the architecture of the emergency information transmission in wireless sensor network. In configure block user has to configure the wireless sensor network. The inputs to the configure block are the number of sensor nodes, routers and their geographical coordinates. ‘Monitor sensor’ works as the normal sensor, which detects and transmits the emergency information on the onset of an emergency. ‘Router’ consists of three sub modules to create Emergency path, Normal path and Forward packets. These routers detect the packets and classify them as the normal packets or emergency packets and send the emergency packets to the sink.

‘Sink’ module accepts data packets from all the routers. Statistics module collects the parameters, from the wireless channel module and calculates the drop packet ratio and the performance matrix.

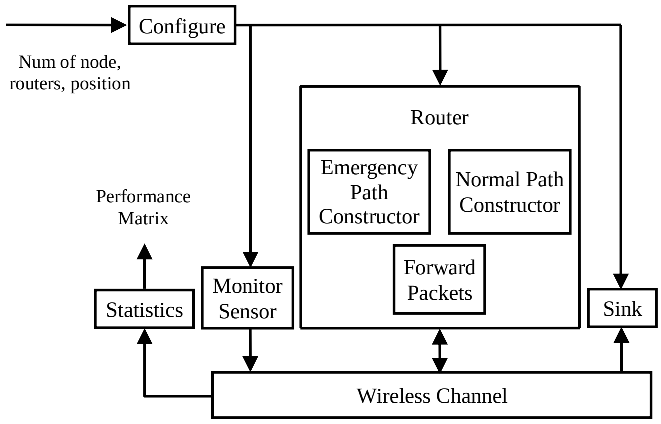


Fig.1. Architecture of Emergency Information Transmission in WSN System

## 4. PROTOCOL DESCRIPTION

This section describes the priority based MAC protocol and AODV routing protocol used for the transmission of packets.

### 4.1 PRIORITY BASED MAC PROTOCOL

First the topology of the entire Wireless Sensor Network (WSN) is set as required. The MAC type used here is 802.11. For transmission and reception of data packets to take place in a WSN, there is a need to have a source node, the transmission paths to be followed, and a sink node. Source nodes can vary but sink nodes are fixed once the transmission of data packets occur. The final collection of the transmitted data occurs at the sink node. The collected data is used according to the application as needed. The transmission range, packet size, sink location, data rate, simulation time and initial energy are initial settings for the application. Emergency information is transmitted based on the priority of the packets.

### 4.2 ROUTING PROTOCOL

A routing protocol is a protocol that specifies how routers communicate with each other, disseminating information that enables them to select routes between any two nodes on a computer network, the choice of the route being done by routing algorithms. Each router has a prior knowledge only of networks attached to it directly. A routing protocol shares this information first among immediate neighbors, and then throughout the network. This way, routers gain knowledge of the topology of the network. The term routing protocol may refer specifically to one operating at layer three of the OSI model, which similarly disseminates topology information between routers. As we are discussing about the emergency information transmission in any disaster situation we use AODV routing protocol for mobile and stable nodes in wireless sensor networks. AODV [11] is a reactive routing protocol and a route from one node to another node can be found as and when required. Each intermediate node in the network forwards the Route Request (RREQ) message until it reaches the destination node. The destination node responds to the RREQ message by transmitting the Route Reply (RREP) message. As the RREP flows through the network, it determines the route from source node to destination node. The sequence number is increased by each originating node and is used to determine whether the received message is the most recent one. The older routing table entries are replaced by the newer ones. AODV gives low Media Access Delay. The performance of the protocol depends on the size of the network.

## 5. REDUCTION OF COLLISIONS

Collision [12] occurs due to the high density of data packets in a typical communication channel. The emergency information packets get dropped due to collisions.

Collision has the following drawbacks:

1. Increases energy dissipation rates of sensor nodes.
2. Causes packet loss, which in turn decreases the network throughput.
3. Hinders fair event detections and reliable data transmission.

In this paper we outline how the possibility of collisions of the emergency information can be reduced. Collision occurs when two routers or nodes send data at the same time, over the same transmission medium or channel. Medium Access Control (MAC) Protocols have been developed to assist each node and router to decide when and how to access the channel. These protocols use timers. The timer value depends on the topology of the network. The shorter the period of message, the higher the possibility of collisions. As the topology dynamically changes the timer value should also change dynamically. In our system, depending on the dynamic situation the timer changes automatically. In the transmission of emergency information the router itself changes the timer value. This approach helps in transmission of emergency information without collision and packet loss. We can assure that emergency information packets are delivered without collision as the router independently takes the decision and modifies the timer value according to the situation.

## 6. RESULTS AND DISCUSSIONS

In simulation different types of scenarios are considered, scenarios with different number of nodes and network traffic. We have done the design and the implementation of the work using NS2. Simulation with NS2 is generally divided into four parts, network model design, apply data, run simulation, view results and analyze the results. Here we are judging the efficiency in the transmission of emergency information by comparing the convention system with the proposed system. The convention system was a centralized management system. The proposed system is a decentralized system where emergency information is distributed to all the neighboring routers, with the coordination of the neighbor routers the emergency information is transmitted to the sink without collision. If one router fails to transmit the information another router can transmit the information because when emergency happens the current router will distribute the emergency information to its neighboring router. The network topology used in the simulation is two dimensional mesh network.

$$\text{Emergency information arrival rate} = \frac{E_{received}}{\sum_{y=1}^{x} E_{generated}} \qquad (1)$$

Fig.2 shows that the emergency information is transmitted to the sink without collisions. Arrival rate of emergency information is represented by the rate between number of emergency information messages which could be transmitted from sender router to the sink in 700ms ($E_{received}$) and the total number of emergency information packets generated by each router ($E_{generated}$). '$x$' is the total number of routers used for transmission of the emergency information. The simulation parameters are chosen as depicted below.

| # Simulation parameter setup # | | |
|---|---|---|
| Channel type | : | Wireless Channel |
| Radio-propagation model | : | Two Ray Ground network |
| Interface type | : | Wireless Physical Interface |
| MAC type | : | 802.11 |
| Interface queue type | : | Drop Tail/Priority Queue |
| Antenna model | : | Omni antenna |
| Interface Queue length | : | 50 |
| Routing Protocol | : | AODV |
| X dimension of topography | : | 900 meters |
| Y dimension of topography | : | 900 meters |

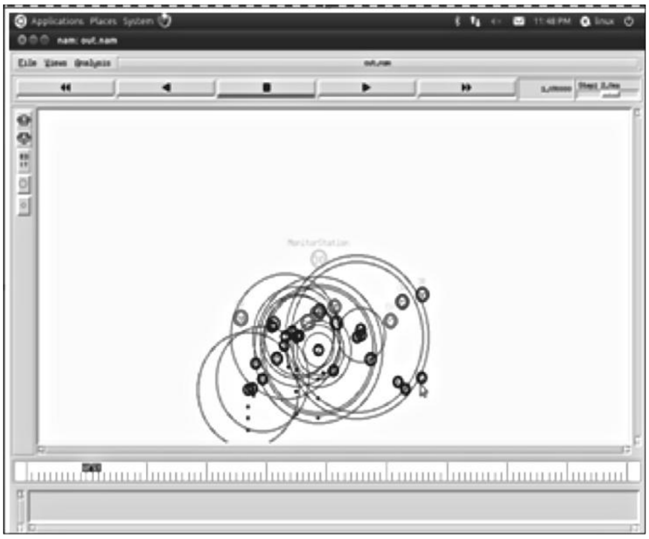

Fig.2. Emergency information transmission

In Fig.3, vertical axis indicates arrival rate of emergency information message at sink in 700(ms) and the horizontal axis indicates the number of emergency messages. As the number of emergency information increases the arrival rate of emergency information at the sink in the conventional system become less, but there is an improvement in the proposed system. Collision of emergency information is reduced in the proposed system.

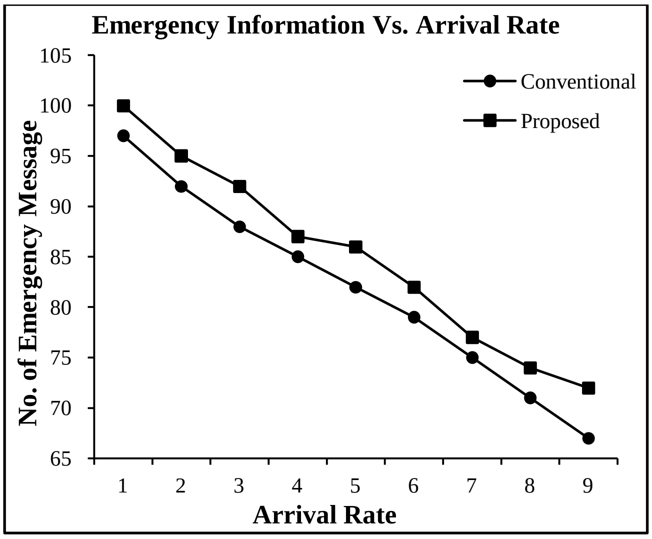


Fig.3. Emergency Information Arrival Rate in 700(ms)

The implementation of this work is effected through the following modules.

**Configure Module**: This module acts as the input module. Number of nodes, number of routers, node position, routing method and other configurable parameters are set here.

**Simulator**: After configuration of the parameters, the simulator module starts running according to the parameters. It creates a new instance of the simulator, adds nodes, router and sink to that instance. This module acts as interface for three other modules such as: node, router, and sink.

**Monitor node**: This module imitates the real world sensor node behavior. Normally it senses data and forwards to the router.

**Router**: This module constructs route to the sink using route table. The router module constructs two types of routes; the normal route for the normal packet and the emergency route for the emergency packet.

**Sink**: This module collects the data. Sink is the monitor station and it is the destination point for all packets.

**Statistics**: This module collects packet delivery ratio and packet dropped ratio and plot the necessary graphs.

The Fig.4 indicates the initialization sequence to set up the wireless environment and send normal data packets to sink. The steps are as follows.

**Step 1** : User calls create network on the configure module.

**Step 2** : Configure module creates new instance of sensor network with all the necessary parameters.

**Step 3** : Configure module creates new instance of Monitor Sensor.

**Step 4** : Configure module creates new instance of Router.

**Step 5** : Configure module creates new instance of Sink.

**Step 6** : User calls 'starts' on the monitor sensor.

**Step 7** : Monitor sensor sends normal data to the sink through the router.

**Step 8** : Router constructs the path to the sink.

**Step 9** : Router forwards the packet.

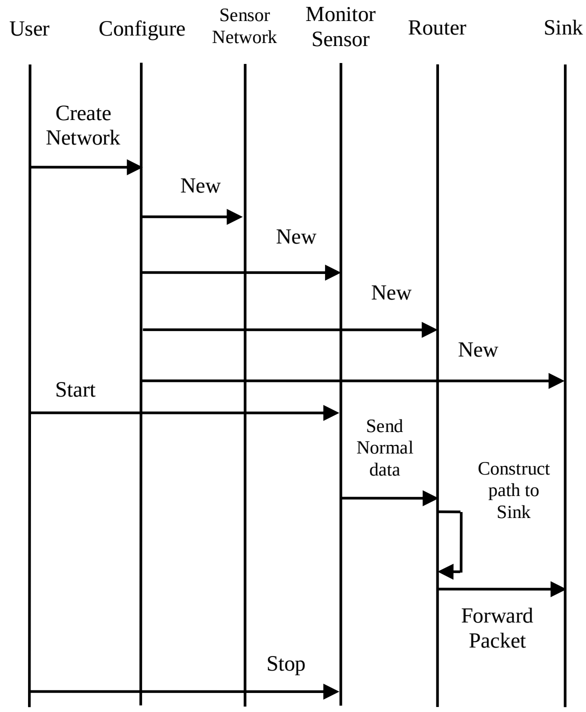


Fig.4. Sequence diagram to send normal data to sink

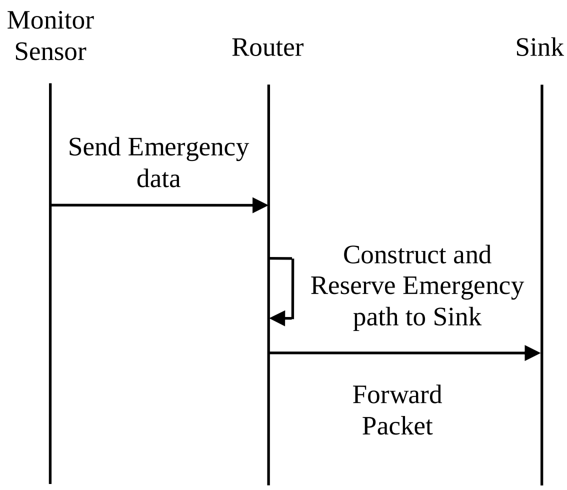


Fig.5. Sequence diagram to send emergency data to the sink

The Fig.5 indicates the sequence diagram to send emergency data packets to the sink. The various steps for emergency data transmission are as follows.

**Step 1** : Monitor sensor sends emergency data to router.

**Step 2** : Once the router detects the emergency signal it constructs emergency path to the sink and reserves it only for the emergency signal.

**Step 3** : Router forwards packet to the sink.

## 7. CONCLUSION

When emergencies happen, the emergency information message is distributed to the neighbor routers and the routers independently decide and judge through which router the emergency information message has to be transmitted to the sink. This approach should also satisfy the real-time property when multiple emergencies happen. This paper proposes Decentralized System for multiple emergency information transmission. When multiple emergency appear in the network number of routers coordinate with each other in the transmission of emergency information without collision and packet loss. The efficiency can be confirmed by the simulation results.

## REFERENCES


[1] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam and E. Cayirci, "Wireless sensor networks: a survey", *Computer Networks*, Vol. 38, No. 4, pp. 393-422, 2002.

[2] "The 29 Palms Experiment: Tracking Vehicles with a UAV-Delivered Sensor Network". Available at: http://robotics.eecs.berkeley.edu/~pister/29Palms0103/.

[3] J.M. Kahn, R.H. Katz and K.S.J. Pister, "Emerging Challenges: Mobile Networking for 'Smart Dust'", *Journal of Communications and Networks*, Vol. 2, No. 3, pp. 188-196, 2000.

[4] K. Mori, "Autonomous decentralized systems: concept, data field architecture and future trends", *Proceedings of the International Symposium on Autonomous Decentralized Systems*, pp. 28-34, 1993.

[5] D. Malan, T. Fulford-Jones, M. Welsh and S. Moulton, "Code Blue: An Ad Hoc Sensor Network Infrastructure for Emergency Medical Care", *Proceedings of the International Workshop on Wearable and Implantable Body Sensor Networks*, 2004.

[6] K. Mahmood, X. Lu, Y. Horikoshi and K. Mori, "Autonomous Pull-Push Community Construction Technology for High-Assurance", *IEICE Transactions on Information and Systems*, Vol. E92-D, No. 10, pp. 1836-1846, 2009.

[7] S. Niki, S. Murakami, K. Mahmood, L. Xiaodong and K. Mori, "Autonomous Decentralized Community Wireless Sensor Network Architecture to Achieve High-Speed Connectivity under Dynamical Situation", *Proceedings of International Symposium on Autonomous Decentralized Systems*, pp. 1-8, 2009.

[8] A. Boukerche, R.B. Araujo and L. Villas, "A Wireless Actor and Sensor Networks QoS Aware Routing Protocol for the Emergency Preparedness Class of Applications", *Proceedings of 31st IEEE Conference on Local Computer Networks*, pp. 832-839, 2006.

[9] K. Lorincz, D.J. Malan, T.R.F. Fulford-Jones, A. Nawoj, A. Clavel, V. Shnayder, G. Mainland, M. Welsh and S. Moulton, "Sensor networks for emergency response: challenges and opportunities", *IEEE Pervasive Computing*, Vol. 3, No. 4, pp. 16-23, 2004.

[10] Lin Wang and Wenyuan Liu, "Navigability and Reachability Index for Emergency Navigation Systems Using Wireless Sensor Networks", *Tsinghua Science and Technology*, Vol. 16, No. 6, pp. 657–668, 2011.

[11] Harpreet Singh and Gurpreet Singh Josan, "Performance Analysis of AODV & DSR Routing Protocols in Wireless Sensor Networks", *International Journal of Engineering Research and Applications*, Vol. 2, No. 5, pp. 2212-2216, 2012.

[12] Moses Nesa Sudha, Muniappan Lakshapalam Valarmathi, George Rajsekar, Michael Kurien Mathew, Nagarajan Dineshraj, Sivasankaran Rajbarath, "Minimization of Collision in Energy Constrained Wireless Sensor Network", *Wireless Sensor Network*, Vol. 1, No. 4, pp. 350-357, 2009.