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Cracker Industry Fire Monitoring System Over Cluster Based WSN

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Abstract: Anarchic fires accidents occurring in cracker industry causes significant damage not only to resources but also grave loss of human life. Even though, several safety forethoughts are carried out by these industries none of them are effective. The current survey shows us that the safety systems lack in real-time monitoring and early detection of fire threats caused during fire accidents .The fire-accident issues can be broadly classified into how the fire detection is made how fast fire data is processed and effective way of communication in case of fire. The solutions to this issue is wireless sensor networks can gather sensory data values, such as temperature and humidity from all points of a fields.

Key words: Wireless sensor network, cluster, scalability, fire accident, cracker industry

INTRODUCTION

The fire accidents induced by cracker industry has lost the life of many. Here are some statistical data giving us some information about such accidents caused in tamilnadu. The statistical data reveals that the no of cracker fire accidents caused during 3 years is shown in Table 1. Recent furtherance in electro mechanical, wireless communication networks and low-cost sensor technologies have enabled the emersion and development of Wireless Sensor Networks (WSN) as a new epitome of computer networking (Steingart *et al*., 2005). A wireless sensor network is penned of a number of low-cost, tiny sensor nodes that are capable of sensing, data processing, short range wireless communication and sensor nodes are deployed in areas of interest to cooperatively monitor physical or environmental conditions, such as vibrations, sound, temperature, pressure, motion, electromagnetic disturbance, etc. (Culler *et al*., 2004). Wireless sensor networks have shown more and more popularity for both military and commercial applications, including industrial process monitoring and control, structure health monitoring, habitat and environment monitoring, health-care applications, home automation, vehicle networks and intelligent transportation systems.

In many applications, the emplacement information of each sensor node in the network is decisive for the service. This is because users normally need to know not only what happens but also where interested events happen or where the quarry is? In a calamity relief operation using WSN to locate survivorship in a collapsed cracker industry building, it is critical that sensors report monitoring information along with their location.

Table 1: Statistical data of cracker fire accidents in Tamilnadu

Date and year	Killed	Injured	Location
19.04.2005	2	22	Anuppankulam
25.07.2005	-	6	Sivakasi
20.08.2005	4	-	Sivakasi
07.07.2009	17	-	Madurai
20.07.2009	18	33	Namaskari
28.07.2009	3	-	Chanpatti
03.08.2009	1	-	Sivakasi
29.09.2009	2	3	Sattur
30.03.2010	1	6	Dindigul
10.08.2010	-	8	Sivakasi
26.08.2010	1	-	Virudhunagar
17.10.2010	3	3	Cuddalore
21.01.2011	-	8	Virudhunagar
05.06.2011	1	-	Sivakasi
03.10.2011	2	-	Sattur
28.12.2011	4	2	Sivakasi
03.02.2012	-	1	Sevalpatti
07.03.2012	1	2	Sivakasi
22.03.2012	4	1	Sivakasi
27.03.2012	-	2	Sattur
10.08.2012	1	-	Thulukkakurichi
13.08.2012	1	-	Virudunagar
04.09.2012	38	60	Mudhalitti

Localization plays a key role in many sensor network applications however, itself is a tough problem because of the demanding requirements for low cost, high energy efficiency and small coverage area at the resource constrained sensor node side, as well as practical issues associated with network deployments. Researchers list major difficulties that challenge accurate and efficient positioning in wireless sensor networks in the following.

Energy constraints: The requirement for a low-cost and low-energy design at each sensor node prohibits

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localization with additional hardware support. For example, GPS (Global Position System) which is the most widely used technique in localization, can hardly be applicable for every sensor node in the network (Abraham *et al*., 2012). Similarly, extra ranging modules, such as directional antennas, electronic compass, laser rangers, video cameras etc., are severely limited due to their incompatible size, considerable cost or excessive power consumption. This indicates that a localization solution must be sensor node friendly where features of low-cost, energy effective and small footprint are necessary.

Quatifiability: A wireless sensor network could potentially be composed of a large number of nodes. It is also projected that future wireless sensor networks may include thousands or even millions of nodes. In all those networks, traditional per-node location parameters configuration could be extremely costly, if not impossible. Therefore, a localization design must be network scalable, meaning that it should be cost-effective with both small and large scale systems.

Abrasive environments: Wireless sensor networks are likely to be randomly deployed in inaccessible terrains and environments, such as battlefield and conflict zone, as well as inhabitable areas, etc. Furthermore, there is normally no infrastructure (e.g., radio signals from wireless AP towers or power line radiations as coordinate references) that can be used for localization purpose (Vennila *et al*., 2012). In this case, self-organized localization without close-in human interference and calibration is essential. In other words, the localization mechanism is highly preferred to function as an autonomous system that is free of in-field manual calibration and extensive environment profiling. Many ideas have been proposed for node localization in WSN. Based on whether accurate ranging is required, there are generally 2 types of methods: Range based localization and range-free localization. Range-based approaches could achieve good accuracy but costly for requiring either per-node ranging hardware or careful system calibration and environment interpreting and thus are not appropriate for large-scale outdoor sensor networks. Range-free designs to localize senor nodes based on simple sensing, such as wireless connectivity, anchor proximity or localization events detection. Those methods feature reduced system cost at the resource constrained sensor node side, however with less accuracy depending on network topology, anchor density and event distribution. Realizing the limitations of existing research for large-scale outdoor environments, researchers tried to investigate practical solutions to bridge the gap between low cost and high accuracy for range-free localization.

PROPOSED FIRE DETECTION SYSTEM DESIGN

In this study, researchers describe the WSN-based cracker fire detection system. Researchers first identify some of the important design destinatisons and boasts that a wireless sensor network should have in order to be able to successfully admonisher crackers and observe fires.

Energy efficient detection: Sensor nodes are powered with battery supply, therefore a wireless sensor network is positioned for early fire detection should consume energy very efficiently (Ha *et al*., 2012). Energy consumption should also be balanced fairly among nodes.

Earlier detection and precise localization: It is important to detect a fire as early as possible and to estimate the fire location with high accuracy (Bonevska *et al*., 2009). A fire usually grows exponentially and it is crucial that the fire should be detected and interfered in about fraction of a second to prevent the fire from spreading to a large area. Accurately estimating the fire position is important to send the information to the fire extinguisher to the correct spot in the shortest possible amount of time.

Auspicate capacity: Being able to forecast the spread direction and speed is important for planning fire fighting, being proactive in mobilizing resources and warning the surrounding area. Accurate forecasting requires accurate and fresh sensory data to arrive at the decision and control center from all points of the forest, especially from and around the region where the fire has occurred (i.e., critical zones).

Ability to change in abrasive environments: A sensor network for fire detection will operate usually in harsh environments and therefore should be able to deal with and adapt to harsh conditions. It should be able to recover from node damages, link errors, high temperature, humidity, etc. (Vennila *et al*., 2012). The aim in this research is to consider the above goals as much as researchers can in designing a wireless sensor network for fire detection. The design of the proposal is shown in Fig. 1. Once sensor detects the fire, it intimates the controller that fire as been detected as per the algorithm

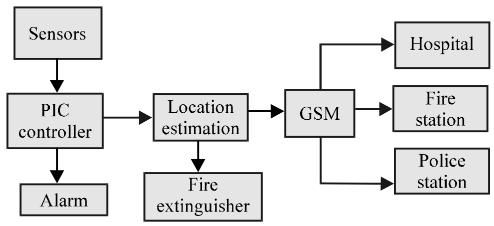

Fig. 1: System model of fire detection system

it determines the effect of fire and takes the necessary action as algorithm, the location is determined and the data is given to the fire extinguisher and GSM module. From the GSM, module is informed to the nearest hospital, police station and fire station.

DESIGN OF THE SYSTEM MODEL

In this study, researchers present details of the design, including clumping, information aggregation and information litigating.

Clumping: Researchers choose a clustering algorithm as the routing protocol in the wireless sensor network. Clustering routing also meets the demand of the network method. More specifically, researchers can treat sensor nodes, cluster headers as input layer nodes, hidden layer nodes in the network, respectively. In each cluster will be sent to the manager node via the sink. The cluster header is selected dynamically to balance the energy consumption of all sensor nodes.

Information aggregation: Each node can generate 3 classes of data packets: Regular Report (RR); Query Response (QR) and Emergence Report (ER). A tag is inserted into each packet to identify the packet class. Each node periodically collects sensing data and encapsulates them into a RR packet whose destination is the respective cluster head. The QR packet is only sent to the sink by part of nodes immediately after getting a query packet from the sink. A node that detected an abnormal event, e.g., smoke is detected will immediately generate and send the sink an ER packet containing the information related to the abnormal event.

Information litigating: Once a cluster header receives a packet from other nodes, it processes the packet according to the packet type. With this, researchers illustrate how each type of packets is processed. When a cluster header receives an ER packet that contains an abnormal event, it will forward the ER packet to the sink as rapidly as possible. The ER packet has the highest priority to be forwarded by intermediate nodes towards the sink that is after an intermediate node receives an ER packet, the node will insert the new ER packet ahead of any other types of packets in the outing packet queue. When a cluster header receives a QR packet, the header can apply the aggregation algorithms to process the QR Packet. The processing of RR packets in cluster headers is more involved. A constructed neural network will take all the received RR packets as input Processed Report (PR) packet and be sent to the sink.

NETWORK ARCHITECTURE

Efficient and effective operation of a WSN depends also on the architecture and logical topology of the network. Researchers designed the architecture and logical topology of the WSN considering the goals of a fire detection system and limitations of wireless sensor nodes. There are 2 possible alternatives for the network topology: Flat and hierarchical. In flat topology, sensor nodes run in a totally distributed manner with equal responsibilities. In a hierarchical clustered topology, some nodes are designated as cluster-heads. Hence, researchers propose a clustered logical topology for the network to properly and adaptively control the sensor nodes under various conditions. Clustered topology has benefits in terms of achieving effective control of nodes depending on changing conditions, rapid reaction to fire threat and energy and bandwidth efficiency. It also enables data aggregation or data fusion to be performed at well-designated nodes, i.e., cluster-heads. In this way, the volume of traffic carried inside the network can be reduced and faster reaction to urgent events can be done. This is especially useful for fire detection applications because most of the time the maximum temperature from a region is needed instead of individual temperature values from all sensor nodes. Moreover, cluster-heads can apply smart scheduling and adaptive transmissions to reduce the load on sensor nodes closer to the sink.

In a clustered topology, a specific number or percentage of sensor nodes (where this depends on some system parameters and deployment) will form a group (a cluster) and connect to a cluster-head which will have some additional responsibilities. The cluster-heads may have superior physical capabilities, as well such as being equipped with a GPS module or having larger memory, processing and energy resources. They should also have the capability to adjust their transmit power to transmit to longer distances when necessary.

TEMPERATURE EVENT TRIGGERING ANALYSIS

The flow model of cracker detection scheme is shown in Fig. 2. The temperature of area of interest is the particular location is identified and this information is

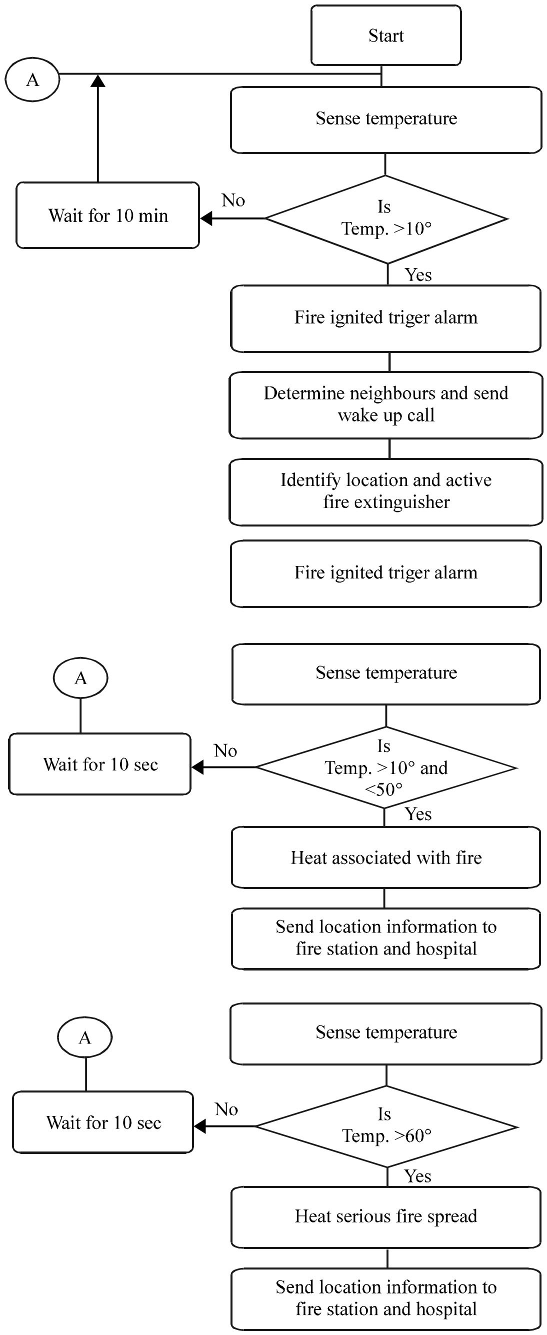

Fig. 2: Flow model of fire system

passed to fire extinguisher motor through microcontroller monitored every second if the temperature due to fire will rise is >10 fire ignited trigger alarm is switched on the sensor will identify the neighboring nodes to transmit that fire is ignited in the industry and also send wakeup call to its neighboring nodes. Using appropriate localization algorithm such FMLM, Area Identification Methods, once with relay switch. If the temperature rise is >10° then

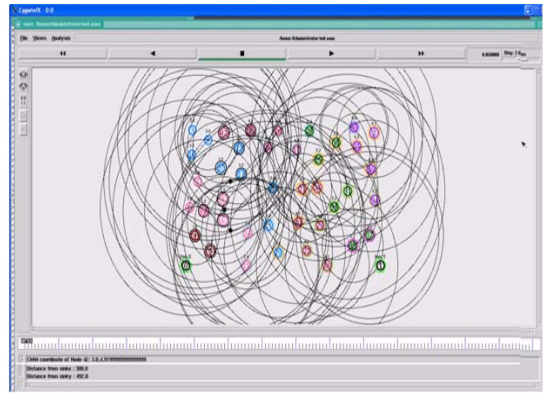

Fig. 3: Packet transmission

the processor monitor the temperature about 10 min. The fire once ignited starts to increase very rapidly when the temperature after e proper fire extinguisher ignition fire temperature is less than greater than 10 and leser than 50°. The processor informs that fire has started to spread with heat, following the message its certainly informs to the nearest fire station and to hospital to prevent damage to resources and human life. The fire temperature may further increase and this is been sensed again, if the temperature is >50° informs that there is rapid spread of fire which is causes serious damage and an emergency alarm signal is activated immediately to nearest fire station, hospital and police station to prevent further damage to resources and human life.

SIMULATION

In this, simulation results are presented and analyzed. Researchers simulated the DV-Hop and the proposed methods (FMLM and CMM) to evaluate the localization performance which includes the location error and the error range. The comparison variables are number of sensors, communication ranges and number of anchor nodes. The experiment region is a square area with the fixed size of 350*200 m^2. The sink node sends the hc packet to the neighboring nodes and from the neighboring nodes the hc packet is distributed all over the Ad-hoc network (Fig. 3).

CONCLUSION

In this study, researchers proposed cracker fire detection system based on Wireless Sensor Networks using an organizational hierarchy approach. Initially, the problem was formulated and then it was modeled using sensor for fire detection scheme. An ontology model related to the deployment with effectiveness and efficiency. The prototype system show that the system provides early extinguishing of a fire disaster so that damages will be reduced effectively and also lot people life are saved. Wireless sensor network is a tool to increase safety of cracker industry, once deployed these sensor nodes acts as an indicator of emergency system. The system model implements the architecture and communication model which indicates the efficiency. Prototype system tests show that the system provides early extinguishing of a fire disaster so that damages will be reduced effectively.

REFERENCES

Abraham, A., K.K. Rushil, M.S. Ruchit, G. Ashwini, V.U. Naik and G.N. Kumar, 2012. Energy efficient detection of forest fires using Wireless Sensor Networks. Proceedings of the International Conference on Wireless Networks, September, 1-2, 2012, IACSIT Press, Singapore, pp: 197-201.

Bonevska, S., A. Jankova and A. Mateska, 2009. Early fire detection with WSN. Proceedings of the 17th Telecommunication forum TELFOR, November 24-26, 2009, Serbia, Belgrade, pp: 1482-1485.

Culler, D., D. Estrin and M. Srivastava, 2004. Guest editors' introduction: Overview of sensor networks. Computer, 37: 41-49.

Ha, Y.G., H. Kim and Y.C. Byun, 2012. Energy-efficient fire monitoring over cluster-based wireless sensor networks. Int. J. Distrib. Sens. Networks. 10.1155/ 2012/460754.

Steingart, D., J. Wilson, A. Redfern, P. Wright, R. Romero and L. Lim, 2005. Augmented cognition for fire emergency response: An iterative user study. Proceedings of the 1st International Conference on Augmented Cognition, July 22-27, 2005, Las Vegas, NV.

Vennila, V.B., R.K. Gnanamurthy and B. Bhuvaneswari, 2012. Wireless Sensor Network for forest fire sensing and detection in tamilnadu. Eng. Sci. Technol.: Int. J., 2: 306-309.