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Forest Fire Detection Utilizing ACO in Wireless Sensor Network

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ABSTRACT

Natural disasters have expanded due to man recently being senseless and with the impacts or effects of the damages they caused on the nature. These factors which adversely influence the ecosystem in the world have been noticed and the hitches are needed to be forestalled. As known, fires are the leading of these disasters. The majority of the fires are triggered by the environmental causes despite the fact that minority of them are self-triggered. To prevent fires many different safety systems have been developed. Among these systems, Wireless Sensor Networks stand out with their ease of use and low cost. In this study implementation of systems for keeping track of fires in a certain area with Wireless Sensor Networks has been discussed. The system utilizes data identified with the residual battery energy of sensor nodes to increase or decrease the range of transmission of sensor nodes and relocation scheme for the sink node in network. Some numerical and theoretical calculations are given to demonstrate that our proposed system is utilized to reduce the energy consumption in network of the remote framework essentially.

Keywords : Wireless Sensor Networks, Forest Fire Detection, Ant Colony Optimization, Cluster Head Selection.

I. INTRODUCTION

There are numerous issues in automatic fire discovery, of which the most critical ones are about various sensor mixes and suitable systems for speedy and commotion tolerant fire identification. Analysts have been examining fires occurring in different places, for example residential area, timberland and mines to discover a few answers for fire observing. A vital issue in automatic fire detection is division of flame sources from noise sources. For the residential fires, being flaring or non- flaming, the general pattern is to concentrate either on the sensor and sensor mixes or location methods. In another word, scientists have concentrated either on distinguishing the best arrangement of sensors which cooperatively can recognize fire utilizing basic strategies or on structuring complex identification systems that utilization single or, best case scenario exceptionally little arrangement of basic sensors. A very long while of forestry research investigate have brought about numerous advances in field of timberland fire checking. The Fire Weather Index (FWI) system being created by the Canadian Forest Service and the National Fire Danger Rating System (NFDRS) presented by the National Oceanic and Atmospheric Administration are two instances of such advances. Contemplating the best in class strategies uncovers two fundamental patterns in flame identification, i.e., existing systems have either considered flame location as an utilization of a specific field or the principle worry for which methods have been explicitly structured.

Numerous commercial items can just recognize airborne smoke by utilizing either ionization sensors or photoelectric sensors. An alert is produced endless supply of the airborne smoke. The issue with such detection is aggravation sources, for example, a cigarette or a toasting bread. Along these lines, numerous specialists concur on the reality decreasing false caution rates in fire detection requires utilizing more than one sensor alongside a proper recognizing algorithm.

Forest fires are among the disasters making dangers mankind and biological communities all through the world. The likelihood of forest fires is consistently expanding because of environmental change and human activities. A great part of the forest areas are under the risk of out of control fires as a result of its climatic and topographical qualities and forest fires cause loss of human and animal lives, hurt ecosystems and national riches consistently, particularly in the late spring months. Forest fires affect individuals negatively, animals, forests and soil separated from economic harm. The pessimistic impact of wild fires on individuals is the air contamination, which cause health issues, for example, respiratory and cardiovascular issues because of smoke. So as to limit harm, early identification of woods fires is a urgent issue. Without an unmistakable and right comprehension of the circulation and elements of forest fires, it is difficult to adequately oversee them. Sensor network technology is considered as one of the vital technologies for the current Century. A wireless sensor network (WSN) contains of a huge number of sensor nodes, which are remotely deployed either inside the phenomenon or near to it. Random deployment, self-organizing, cooperative effort and data fusion are some features of sensor nodes. Since sensor nodes may be strategically, randomly, and densely deployed in a forest, sensor nodes can depend the exact origin of the fire to the end users before the fire is spread and goes uncontrollable.

The section I explains the Introduction of forest fire detection techniques. Section II presents the literature review of existing systems and Section III present proposed system implementation details Section IV presents experimental analysis, results and discussion of proposed system. Section V concludes our proposed system. While at the end list of references paper are presented.

II. LITERATURE REVIEW

Majid Bahrepour, Nirvana Meratnia, Paul Havinga [1] survey previous studies from three perspectives: (1) fire detection techniques for residential areas, (2) fire detection techniques for forests, and (3) contributions of sensor networks to early fire detection.

In [2], the author used FWI index and his novel k-coverage algorithm to recognize forest fires. K-coverage algorithm monitors each point by using k or more sensor nodes to enhance fault tolerance. Therefore, some sensors can be put in standby mode to extend network lifetime. Although there are many algorithms to find the minimum number of sensors to be utilized, they are usually NP complete problems. The proposed k-coverage solution proved to prolong the network life time. Forest fire detection was not the focus of this work and was considered as an application for the novel k-coverage problem.

Lim et al. [3] proposed an innovative framework for residential fire detection. They introduced metric of interval-message-ration (IMR) and evaluated their framework utilizing the IMR metric. They concluded that the framework is not only applicable for fire-detection but can also be applied for other disaster recoveries. Here they consider residential area for detection of fire. That would be beneficial in other areas also.

Lu Zhiping et al [4] proposed a forest fire detection solution using WSN. Their system is made of sensor nodes, gateway(s), and task manager(s). Each sensor node is equipped with temperature and humidity sensors. After obtaining sensory information at sensor nodes, data are fused at gateways and data-analysis and decision making are done by task manager nodes.

Sr	Title	Authors	Description	Limitations
1	Automatic Fire Detection: A Survey from Wireless Sensor Network Perspective	M. Bahrepour, N. Meratnia, P.Havinga	Author did study of previous methodology from three perspectives	Here author only consider three perspectives
2	Efficient K-Coverage Algorithms for Wireless Sensor Networks and Their Applications to Early Detection of Forest Fires	Bagheri, M	utilized FWI index and his novel k-coverage algorithm to recognize forest fires	Author did not focused on fire detection. He focused on enhancing network lifetime.
3	A Fire Detection and Rescue Support Framework with Wireless Sensor Networks	Lim, Y.-s., S. Lim	Author proposed an innovative framework for residential fire detection. They present metric of interval-message-ration (IMR) and evaluated their framework using the IMR	Here residential fire detection is main focus of author
4	The Design of Wireless Sensor Networks for Forest Fire Monitoring System	Zhiping, L., Q. Huibin	Utilized wireless sensor network to detect fire in forest	If deployed node fail then there is issue to detect.
5	Forest Fire Modeling	M. Hefeeda,	Author focus on detecting the	Sensors are deployed in forest

	and Early Detection u Adhoc & Sensor Wireless Networks	M. Bagheri	fire earlier before it occurs also they moderate the aspect that generate fire. Analyzed forest weather for that	for earlier detection if fails.
6	On connected multiple point coverage in wireless sensor networks	Yang, S., Dai, F., Cardei, M., And Wu, J	Present techniques to prolong network lifetime.	Main focus is prolonging network lifetime

Author [5] present the design and evaluation of a WSN for early detection of forest fires. They present the key aspects in modeling forest fires. We do this by analyzing the Fire Weather Index (FWI) System, and show how its different components can be utilized in designing efficient fire detection systems. The FWI System is one of the most comprehensive forest fire danger rating systems in North America, and it is backed by several years of forestry research. The analysis of the FWI System could be of interest in its own right to researchers working in the sensor network area and to sensor manufacturers who can optimize the communication and sensing modules of their products to better fit forest fire detection systems. Then, model the forest fire detection problem as a coverage problem in WSN, and they present a distributed algorithm to solve it. In addition, we show how our algorithm can achieve various coverage degrees at different subareas of the forest, which can be used to provide unequal monitoring quality of forest zones. Unequal monitoring is important to protect residential and industrial neighborhoods close to forests. Finally, they present a simple data aggregation scheme based on the FWI System. This data aggregation scheme significantly prolongs the network lifetime, because it only delivers the data that is of interest to the application. They validate several aspects of their design using simulation.

Sensors are assumed to self-organize into clusters by utilizing a distributed protocol. After the termination of the clustering protocol, sensors know their cluster heads and the whole network is connected. Any of the protocols described in the recent survey in can be employed. Author proposed system does not restrict the cluster size, and it allows single- and multi-hop intra-cluster communications. The sensor clustering and data routing problems are outside the scope of this paper. Author consider four problems [6] here. First, modeling the forest fire detection application as a coverage problem in wireless sensor networks. Second, designing a distributed coverage protocol. Third, developing a data aggregation scheme that is suitable for the forest fire detection application. The last issue is achieving unequal fire protection in different zones in the forest, e.g., forest zones near industrial plants and residential areas, or forest zones with drier conditions and higher temperatures.

Selecting the minimum subset for activation is desired because it reduces total energy consumption and thus prolongs the network lifetime. Computing the minimum subset, however, is NP-hard as per Yang et al. [7]. In [5] Hefeeda et al, author designed a logarithmic factor approximation algorithm to solve the k-coverage problem. Author’s previous work focused on the theoretical analysis of the algorithm without paying much attention to the specific application. In the current work, we customize this algorithm to the forest fire detection application, and they consider several issues that were not addressed before.

Forest fires have multidimensional negative effects in social, economic and ecological matters. Unfortunately, Turkey is one of the countries subjected to wildfires every year. It is difficult to say that firefighting can be successful without enough data about fire such as spread direction and speed etc. The more data about wildfire means the more effective fire management. Economically, firefighting is well called to be a costly task. It is wise to invest in early warning systems which are definitely much less costly on the whole.

Algorithm

1) Proposed Algorithm

Let S be a system such that, S= Input, Process, Output

Input:
Sensing Information

IP = {IP1; IP2…, IPn}

IP is a set of input represents sensing information.

Process:
1) Set of sensor nodes.
SN = {SN1; SN2; …., SNn}
SN is a set of sensor nodes in a network.

2) Cluster Formation
CF = {CF1; CF2…., CFn}
CF is set of clusters created in set up phase. Each cluster having number of sensor nodes.

3) Calculate residual energy of each node The energy spent of a node that transmits. l-bits packet over distance d is:

$$E_{Tx}(l, \hat{d}) = E_{Tx-elec}(l) + E_{Tx-amp}(l, d) = E_{elec} * l + \varepsilon_{fs} d(2) * l$$

Where, with amplifying index $\varepsilon_{fs}, \varepsilon_{ms}$ respectively,

$$\hat{d_0} = \sqrt{\frac{\varepsilon_{f8}}{\varepsilon\ mp}}$$

the energy consumption of receiving this message is:

$$E_{Rx}(l) = E_{exel} * l$$

4) Cluster Head selection using T2FLCA
CHead = {CHead1; CHead2…. CHeadn}
CHead is set of cluster heads, which are useful for communication among clusters.
Kopt is the optimal cluster number for each round:

$$K_{opt} = \lfloor n * p * (\frac{n-dead}{n}) + 0.5 \rfloor$$

Where n = the number of nodes
Dead = the number of energy-exhausted nodes
P = CH probability.

5) Multi hop routing using ACO algorithm Once we found the clusters, the intra cluster data transmission will have started. For this Chain of CH is formed. Calculate transmission probability Pijof CH:

$$P_{i,j} = \frac{[T_{ij}(t)]^{\alpha}[\eta_{ij}^{\beta}]}{\Sigma_8[T_{ij}(t)]\alpha[\eta_{ij}^{\beta}]}$$

Output:
Data routing to base station.

System Architecture

System Architecture

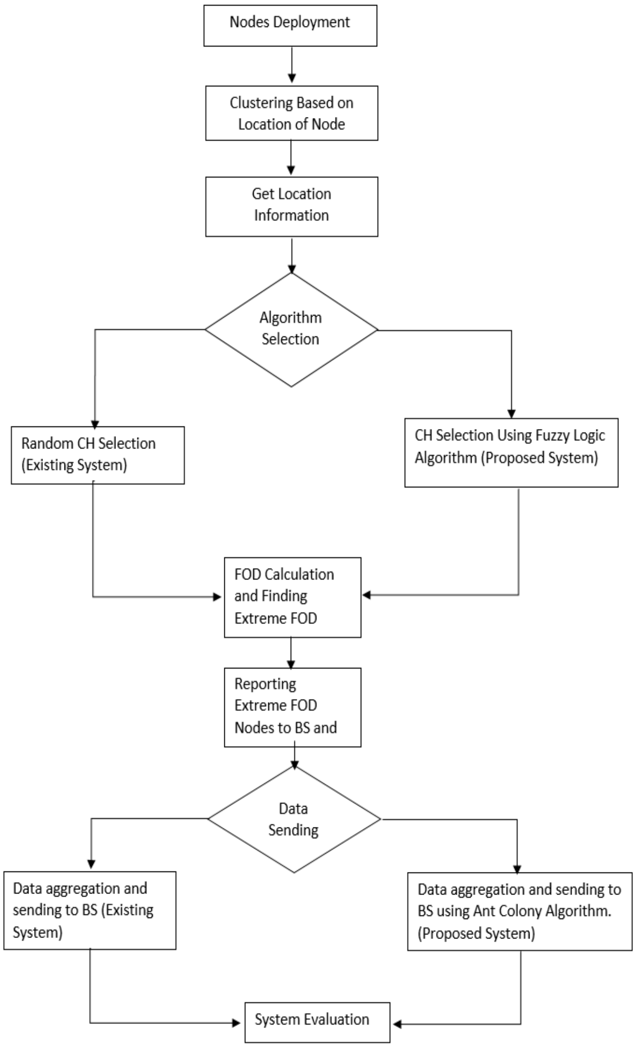

Fig 1. System Architecture

Here in Fig.1 show the system architecture.

III. RESULT AND DISCUSSIONS

Experimental Setup

All the experimental cases are implemented in NetBeans IDE in congestion with algorithms and strategies, and run in environment with System having configuration of Intel Core i5-6200U, 2.30 GHz Windows 10 (64 bit) machine with 8GB of RAM.

Result

Following figure 2 shows the time comparison between proposed system and existing system. The time required for implementing the proposed system is less than the time required for the existing system.

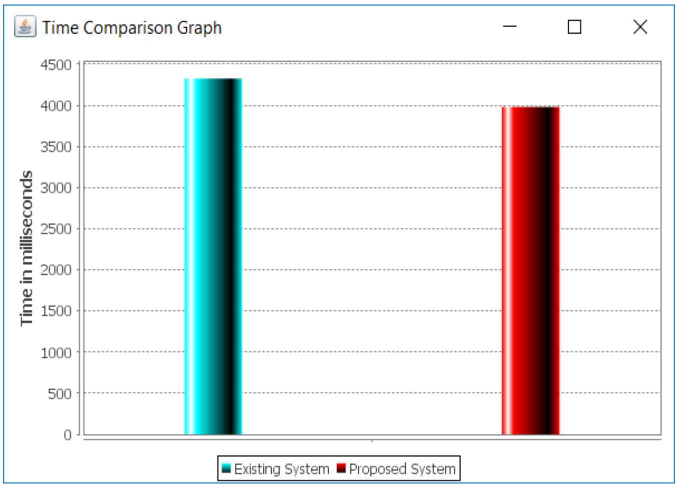

Figure 2. Time Comparison Graph

Figure 3 shows the comparison graph between energy consumption ratio of existing and proposed system. In the proposed system energy consumption ratio is less compared to
the energy consumption ratio in the existing system.

Energy Consumption Formula:

Remaining Energy=Energy Available – Energy Consumed;

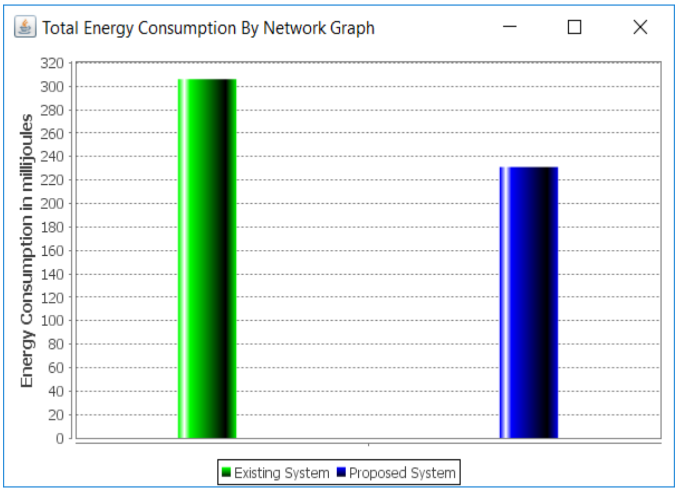

Figure 3. Energy Consumption Graph

IV. CONCLUSION

This examination initially uncovers that WSN technology is an exceptionally encouraging green innovation for the future in identifying proficiently the forest fires in our nation. Besides, and through the experiments consider, we finish up the adequacy of the proposed methodology as far as energy efficiency and algorithmic complex nature compare with the existing methodology is better and its reasonableness to the setting of our nation predominantly amid summer seasons. The more data recovered by WSN about forest fires means the more effective fire management by forest authorities. Hence, introducing the paradigm of multi-modal detection of Forest fires seems to be a good solution for the future in which scalar data and multi-media data can be collected by heterogonous.

V. REFERENCES

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