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# Forest Fire Monitoring System Using WSNs Technology

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Abstract: Forest fire is one of disaster contribute air pollution and bad for environment because of carbon as well as haze particle in fire. In dry seasons forest fire happened in most of area with forestry environment in Indonesia. Riau province is located in Sumatera Island of Indonesia, the area with high possibility of forest fire because of typical peatland. The objective of this research is to design and contribute a new technology for fire detection using Wireless Sensor Networks (WSNs) Technology and intelligent software for accurate fire detection. This research proposes WSNs for detection of forest fire in peatland area by using sensor node with embedded multiple sensors for accuracy of fire detection. A prototype of sensor node has been designed and tested in laboratory to check the results and calibrate to the actual environmental. Four sensors embedded which are temperature and humidity sensor, fire and smoke detection sensor, and particle sensor. The value detection from all of sensors analyse with intelligent software to achieve accurate information and data from fire including location. Result shows sensor node of WSNs be able to detect fire and send the information about all the parameters that indicator of forest fire. The design and development of WSNs sensors node is to give assistance to local government or agency in overcome current issues in Riau Province specially and Indonesia in major because of forest fire.

## 1 INTRODUCTION

Forest fire in Indonesia is a disaster that incident most of every year happen, especially in summer season. Data shows that total loss because of forest fire in 1997 is USD2.45 billion (Yulianti et al., 2012), but this loss data still smaller compare to previous year in 1995, the loss is USD19.1 billion. Riau province is one of the area that very high risk to this disaster because of type of land which is peat land and easy to get fire. According to goverment agency, the total economic loss for Riau province in year 2015 because of forest fire up to USD1.65 billion. Beside economic loss, most of activities stop because of badly environmental (haze) and all of school closed, no activities in government offices and others institution. The impact of this forest fire is not only in Indonesia or Riau Province but to the others countries such as Malaysia and Singapore, because of Riau is directly border to those countries. Current procedure to get forest fire data used satellite to detect hotspot then information collect send to the authority and team will go to the site for action to stop fire, there is no prevention action although there is some socialization and campaign to communities to stop firing land and forest but in some area because of peat land its can be fire by itself.

In this research focus on developing of ground level smart monitoring system for forest fire detection, a smart sensor node of WSNs proposed with new design and intelligent system to collect accurate data of fire. The integration of WSNs sensors node then share the information would have beneficial to local community and local authority to access the information through developed real-time database. It is anticipated to be a solution that faster and cheaper than to satellite data acquisition as usual and this would definitely be beneficial to social welfare and economy development. In addition, the development of real-time monitoring system would

also require some support from the government as a policy maker to understand how the system works and also understand the behavior of the results so that an appropriate action can be taken.

## 2 RELATED WORKS

Wireless Sensor Networks (WSNs) can be applied in many applications, for example in the application of remote environments, industrial automatic control, remote sensing and target targets. Application applications that are similar to environmental monitoring systems, namely for forest fire detection which can make monitoring and detection real time. The WSN consists of many and many small nodes in most scenarios, where small nodes are placed in hostile environments that are distant and inaccessible or over a large geographical area. A large number of sensor nodes feel the changes in the environment and report it to the cluster head node or sensor base station, then through the gate to transfer data to the server whose deployment and maintenance must be easy and scalable (Kadir et al., 2019).

A new approach for forest fire monitoring and detection as discussed in (Liu et al., 2018) which using data aggregation in WSNs. The proposed approach can provide a faster and more efficient reaction to forest fires while consuming WSN energy economically, which has been validated and evaluated in extensive simulation experiments. WSNs can provide better solutions for disaster management and rescue operations such as earthquake detection and warning systems, flood detection, landslide detection, forest fire detection, water level sensors used to measure various parameters and discussed in (Pant et al., 2017, Aranzazu-Suescun and Cardei, 2017).

Several research on WSNs as discuss in (Kadir et al., 2018), the WSNs simulator is developed based on proposed Sensor model and WSN model. WSN Simulator handles important design issues such as: supervised area coverage related to initial sensor placement, number of sensors needed for targeted deployment, and changes in coverage as a function of time. The WSN algorithm for identifying dangerous data injections and estimating measurements that are resistant to some of the sensors that are compromised and even when they collude in the attack. Methodology for applying this algorithm in different contexts and evaluating the results in three different datasets taken from the dissemination of different WSNs. (Illiano and Lupu, 2015, Kadir et al., 2016).

Another research that has been done is the application of WSN in predicting natural disasters such as hail, fire, rainfall etc. WSN is rare and stochastic (Kansal et al., 2015). The application of WSN in energy conservation, reduces delays in sending data and increases network life. Cluster agent chain (CCMAR) routing is used for low energy adaptive cluster hierarchies (LEACH) and power-saving collection in sensor information systems (PEGASIS) (Sasirekha and Swamynathan, 2017).

## 3 WSN IN FOREST FIRE DETECTION ANALYSIS

Some of the number of forest fires based on imaginary satellites monitored in Riau Province is spread in most areas, especially in the southern region. Figure 1 shows the number of hotspots, based on the distribution pattern spread across all districts in Riau Province.


Figure 1: Number of fire hotspots in Riau Province based on satellite image.

Area of hotspot coverage assumes a set of WSNs sensor node distributed over a geographical region in Riau Province to monitor that area. Coverage function P is given as:

$$P = f(x, y, t) = \{(x_1, y_1), \ldots (x_n, y_n)\},$$
$$(x_k, y_k) = f(t), k = 1,2,3,\ldots,n \quad (1)$$

where (x, y) is the sensor coordinate in the area monitored, and t is time. The model uses projection in 2D space of the fire control area, which is a 3D ball. In this case the stationary network, without the cellular WSN sensor, but the sensor position depends

on time, because the sensor node is expected to stop operating on time. In terminating this operation can have different causes: hardware errors, accidents, battery depletion, and accidental sensor removal, etc.

Assume to determine IP index coverage as a scalar value that represents the percentage of coverage for an area that is being watched at a certain time as:

$$IP = \frac{\text{area covered with sensors}}{\text{the total area of the surveillance region}} \cdot 100\% \quad (2)$$

The basic model component is a WSNs sensor node defined as a vector:

$$S = (d, E(t)) \quad (3)$$

where d is the sensor transmission range, or the radius of the transmission area, the area covered by the radio signal to exchange data with the neighboring node. E (t) is the energy available for sensor power supply. Assume a homogeneous sensor network with n integrated type sensors and one hub sensor for communication with node dispatchers (Kadir et al., 2019).

Network parameters are described as a vector:

$$M = (n, f_0, \Delta E) \quad (4)$$

where n is the number of sensors, fo is the regular transmission frequency, and ΔE is the energy consumption per transmission. Assume that sensor nodes transmit data collected periodically to neighboring nodes. Energy consumption ΔE includes energy spent on sensing and processing data. Each node has two roles:

(a) feel the data of the environment and its transmission.
(b) receives data from neighboring nodes and forwarding.

The role of the WSN hub sensor node is to collect data from each sensor node and forward data to a base station or coordination center. Data packets are received and forwarded by the hub node containing the address of the originator sensor node and the measurement value (temperature, humidity and CO2). The WSN hub node has an uninterruptible power supply and the communication channel between the hub node and the coordination center is unrelenting. Therefore, the simulation treats the sensor hub as "always available". The main purpose of this simulation is to optimize network routes for transmitting data from sensor nodes to hub nodes (Aksamovic et al., 2017).

## 4 DEVELOPMENT WSN NODE FOR FOREST FIRE DETECTION

Forest fires are natural or man-made phenomena, in many cases in the world. The combustion area is mainly located in a climate of temperatures where rainfall is high enough to allow for a significant level of vegetation, but in the summer session a very hot and dry environment can create a dangerous fuel load. Global warming will contribute to increasing the number and importance of this disaster. In each season, not only thousands of hectares of forest are destroyed by wild land fires, but also property, assets and public resources and facilities are destroyed by fire. In addition, firefighters and civilians are at risk, to deal with horrific casualties every year. Figure 2 shows a diagram of a number of WSN sensors used in forest areas for fire detection.

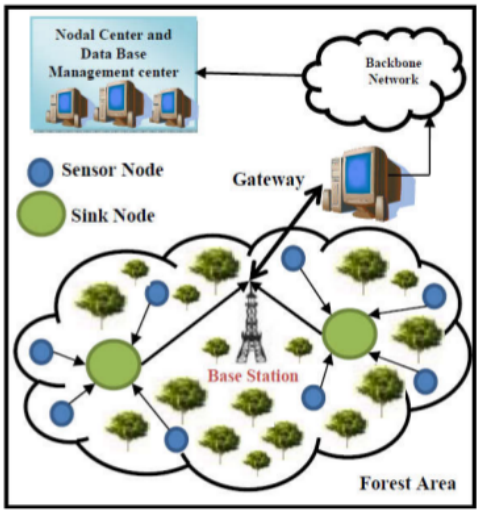


Figure 2: Topology of WSN sensor nodes deploy in forest for fire detection.

Forest fires in general and dynamic phenomena that can change their nature and behavior at a time from one place to another and with the passage of time. The fact is that forest fuels available in certain locations are limited, so that fires that continue to burn must

spread to neighboring fuels. This is done through the dissemination of complex heat to neighboring fuels and carried out through the behavior of complex fires. Another approach is based on the WSN paradigm that has been designed and developed in the context of a research project that includes all key actors in the forest and fire suppression for operations.

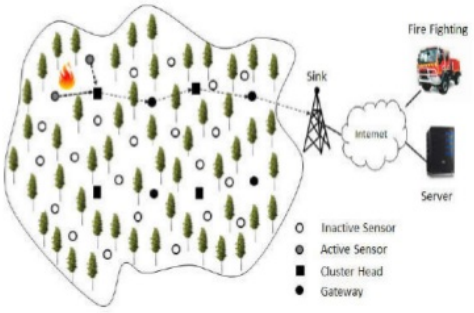


Figure 3: A WSNs sensor nodes propose use ZigBee standard.

Another scenario in Figure 3 shows the proposed schematic structure of the development of WSNs based systems for forest fire detection and protection management, which consists of multi-sensor nodes, coordinators, cluster heads, routers and remote decision-making servers. This tree-cluster network topology structure proposes a design to reduce energy loss and data packets when transferring. The ZigBee technique is a global standard based on IEEE 802.15.4 which applies to low-level wireless Personal Area Networks (PAN). ZigBee is one of the wireless network standards that is targeted at low power sensors that are applicable to 868/915 MHz and 2.4 GHz multi frequencies. ZigBee's proposed technical advantage is offering systems with long battery life, small size, low cost, high reliability, and automatic or semi-automatic installation. Therefore, in this development the node design of WSNs to achieve the optimal choice for forest fire detection and monitoring is occupied by a multi-sensor system (Kadir, 2017).

The actual hardware at the WSN node for fire detection and monitoring can be found in many types on the market. Where temperature, humidity, smoke and carbon sensors are installed in the node to detect all parameters that are highly related to forest fires. Figure 4 shows the actual sensor fabrication in testing for calibration of environmental parameters, before the sensor nodes are placed in the field, the sensor nodes must configure based on the design and requirements. All nodes will send data or messages to the WSN coordinator which has a function to receive all information from scattered nodes.

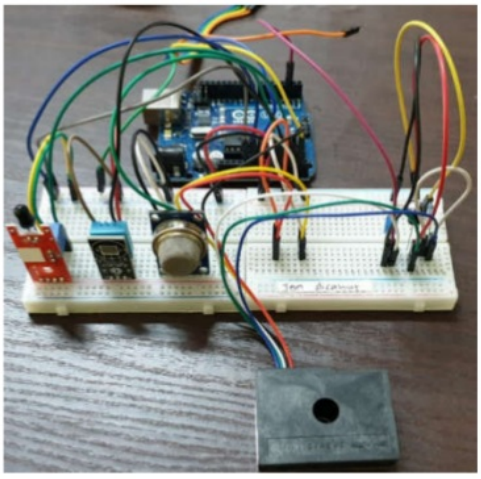

Figure 4: A Prototype of WSNs sensor nodes with multiple sensors use Arduino processor.

## 4 CONCLUSIONS

Development of WSN nodes for forest fire detection and subsequently for monitoring has been proposed with a new method with several sensors for accuracy detection. The design with analysis and mathematical approach according to the region must cover those in all of Riau Province. Temperature, humidity, fire, smoke and carbon sensors are in the spotlight in this case because these parameters are the main parameters for fire cases both on land and in the forest. The proposed sensor nodes use the ZigBee model, with low power, the sensor nodes can be used in long life as nodes powered by batteries. To cover the entire province of Riau, at least the network coordinator must be established in each area and one gateway to access the server (cloud database) and monitoring computers. The concept of the proposed very applicable WSNs to be used to detect forest fires, especially in Riau Province, is useful for preparing your submission.

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## REFERENCES

AKSAMOVIC, A., HEBIBOVIC, M. & BOSKOVIC, D. Forest fire early detection system design utilising the WSN simulator. 2017 XXVI International Conference on Information, Communication and Automation Technologies (ICAT), 26-28 Oct. 2017 2017. 1-5.

ARANZAZU-SUESCUN, C. & CARDEI, M. 2017. Distributed algorithms for event reporting in mobile-sink WSNs for Internet of Things. *Tsinghua Science and Technology,* 22**,** 413-426.

ILLIANO, V. P. & LUPU, E. C. 2015. Detecting Malicious Data Injections in Event Detection Wireless Sensor Networks. *IEEE Transactions on Network and Service Management,* 12**,** 496-510.

KADIR, E. A. A reconfigurable MIMO antenna system for wireless communications. 2017 4th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI), 19-21 Sept. 2017 2017. 1-4.

KADIR, E. A., IRIE, H. & ROSA, S. L. Modeling of Wireless Sensor Networks for Detection Land and Forest Fire Hotspot. 2019 International Conference on Electronics, Information, and Communication (ICEIC), 22-25 Jan. 2019 2019. 1-5.

KADIR, E. A., ROSA, S. L. & GUNAWAN, H. Application of RFID technology and e-seal in container terminal process. 2016 4th International Conference on Information and Communication Technology (ICoICT), 25-27 May 2016 2016. 1-6.

KADIR, E. A., ROSA, S. L. & YULIANTI, A. Application of WSNs for Detection Land and Forest Fire in Riau Province Indonesia. 2018 International Conference on Electrical Engineering and Computer Science (ICECOS), 2-4 Oct. 2018 2018. 25-28.

KANSAL, A., SINGH, Y., KUMAR, N. & MOHINDRU, V. Detection of forest fires using machine learning technique: A perspective. 2015 Third International Conference on Image Information Processing (ICIIP), 21-24 Dec. 2015 2015. 241-245.

LIU, Y., LIU, Y., XU, H. & TEO, K. L. Forest fire monitoring, detection and decision making systems by wireless sensor network. 2018 Chinese Control And Decision Conference (CCDC), 9-11 June 2018 2018. 5482-5486.

PANT, D., VERMA, S. & DHULIYA, P. A study on disaster detection and management using WSN in Himalayan region of Uttarakhand. 2017 3rd International Conference on Advances in Computing,Communication & Automation (ICACCA) (Fall), 15-16 Sept. 2017 2017. 1-6.

SASIREKHA, S. & SWAMYNATHAN, S. 2017. Cluster-chain mobile agent routing algorithm for efficient data aggregation in wireless sensor network. *Journal of Communications and Networks,* 19**,** 392-401.

YULIANTI, N., HAYASAKA, H. & USU, A. 2012. Recent Forest and Peat Fire Trends in Indonesia The Latest Decade by MODIS Hotspot Data. *Global Environmental Research,* 16**,** 105-116.

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