Fire Detection In Forest Using WSN

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Abstract- *Forest Fires often occur in natural places as a result of human irresponsibility and environmental change. They harm the ecosystem and may lead to the death of humans and wild animals. As a result, wildfires should be spotted early in order to avoid further damage. Many current systems exist, such as satellite systems, CCD cameras, cable systems, and Bluetooth technologies. These systems may produce a comprehensive view of the Earth, but only after a lengthy scan time. This approach is not very precise since it inhibits fire detection only after the fire begins. A wireless network built on a Zig methodology was offered as an alternative to existing techniques of sensing devices. WSNs are utilized for a variety of purposes, including environment management, robotics, farming, and safety. This article describes the construction of a system for detecting temperature, humidity, and smoke in order to avert a calamity (forest fire) that might result in the loss of a wide range of natural thread. Several experiments were carried out in this project to demonstrate the system's feasibility.*

Keywords- Wireless sensor network, ZigBee.

I. INTRODUCTION

1.1. Background

Forests all living organisms rely on them for sustenance. Our lives may be ruled by woods, interdependence, as well as the link. Wildfires are a severe issue that we currently face. It’s been experienced by general populace as well as the state. Lands and wildfires in Riau have a significant impact on the spread of haze pollution over state lines. On average, wildfires in Riau province's peatlands account for 60% of the region's total. As a result, haze is a natural phenomenon that happens frequently during wildfires and has an influence on neighboring nations like Malaysia and Singapore. To address this issue, the government has created a number of initiatives aimed at bringing an appealing or a judicial consequence against any activity that jeopardizes the forest's survival. Despite the fact that the whole work programmer has been created, the forests continue to perform poorly.

In terms of contemporary technical breakthroughs, sustainability initiatives often need the use of a technology capable of assessing and monitoring indications of wildfires. Cellular network, which can transport data without the need of wires, is predicted to be one of the applicable technologies that may help forest conservation programmers. Even though the monitoring system is anticipated to deliver data on the basis of a burn warning for the wide terrain.

We Propose the ZigBee wireless sensing technologies and describe how it may be used to create a monitoring system The system to monitor true relevant factors, such as temperature and relative humidity, and quickly transfer the data to the monitoring center's computer. The computer will evaluate and handle the acquired data. In comparison to standard baroscopic data and fundamental sustainable forest information, the program can conduct an instantaneous evaluation of a possible fire threat. The analytical findings will then be provided to the appropriate department as that of the strategy foundation upon which agency will decide whether to battle fires or prevent fires.

1.2. Forest Fire (Wildfire)

A wildfire, also known as a wildlife habitat fire, is a burning that occurs in a region of flammable vegetation in rural settings. A wildfire may also be characterized as a controlled burn, blaze, deserts fire, bushfire, forest fire, hill start firing, peat fire, vegetable fire, or veld fire, depending on the kind of vegetation present.

Wildfires are classified based on the source of ignite, their structural qualities, the amount of flammable substance present, and the influence of climate on the fire. Flames may inflict economic and human existence damage, yet found naturally forest fires may benefit native plants, wildlife, or habitats which have developed with fire. High-severity wildfires generate complicated young Silurian period forest habitat (also known as "snag forest habitat"), which frequently has more species richness and variety than unburned old forest. Many plant species rely on fire's effects for life processes. Wildfires in habitats where wildfires are infrequent or non-native flora has intruded may have severe ecological consequences. The intensity and behavior of wildfires are determined by a mix of variables such as accessible fuels, physical location, and weather. Studies of historical weather conditions and regional wildfire histories in northern Mexico demonstrate that climate is the primary driver of significant regional fires, whether through rainy seasons that develop huge fuels or dry and warming that extends favorable fire conditions.

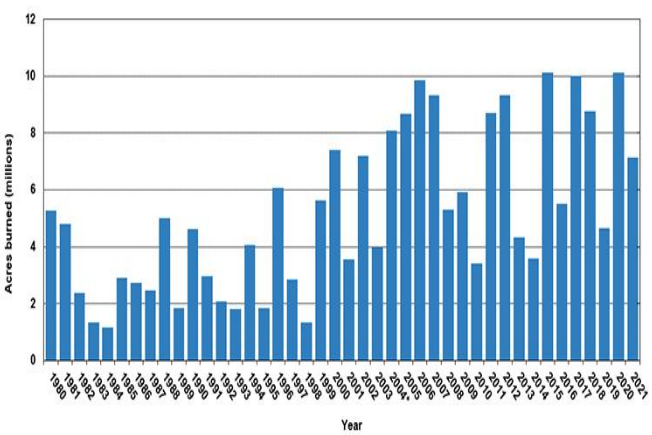


Fig 1. Forest fires over the years

Strategies the methods used for fire protection, identification, and control have evolved throughout time. Controlled burning is a widespread and economical practice that involves purposefully starting tiny fires to reduce the quantity of flammable material accessible for a possible wildfire. Plants as well as other waste that could act as fuel may be burnt on a regular basis to preserve high diversity of species and reduce the buildup of vegetation and other trash. For many woods, using wildfires is the most cost-effective and environmentally friendly approach. Logging may also be used to reduce fuels, however fuel treatment and thin have little influence on catastrophic fire behavior under extreme meteorological circumstances. According to Jan Van Wagtendonk, a scientist just at Yellowstone Research Unit, wildfire is "the most efficient treatment for lowering a fire's pace of development, results showed that perceived severity, flare duration, and heat per unit of land." In fire-prone locations, building standards often mandate that buildings be constructed of fire materials and that a defensive space be kept by removing combustible debris within a defined distance from the building.

In the past, manual procedures were being used to detect forest fire. A watchman was appointed to monitor a specific area for fire accidents. His duties were to look around the surroundings and to observe the environment to foresee any incoming fire. The manual method was simple; however, it required manpower, had limited range, and prone to human errors. Another method was patrolling which was faster than the former. In patrolling, the guard moves on the vehicle to monitor the area for any fire accidents. The advantage of this method was that it was fast and required less manpower. However, the transportation cost was very high. The wireless sensor network (WSN) has attracted a lot of interest from the research community working on automated fire detection. Using WSN nodes is an efficient way to determine the fire accidents well in time. To reduce fire hazards, there is a need to make such a node which can be implanted in different areas which will send data from various sensors attached to the WSN node. The WSN is a suitable and low-cost solution for fire detection. It is a reliable solution for different monitoring problems and used in various fields such as forests , wild lands, residential areas , buildings , rural areas . Fire detection is important for the above mentioned areas for the protection of land, infrastructure, and human and animal life. The WSN node is implemented using different set of sensors. In fire detection is carried out using multiple combinations of the sensors and cameras such as infrared, internet protocol (IP), and thermal cameras. It gives us the visualization and 3D image of the area of implementation. However, it is expensive and requires manpower continuously for its monitoring.

Table 1. A comparison between indoor and outdoor losses due to fire.

Risks	Risk factor	
	Indoor	Outdoor
Human life	High	Low
Wild life	Low	High
Assets	High	Low
Environment	Low	High
Infrastructure	High	Low

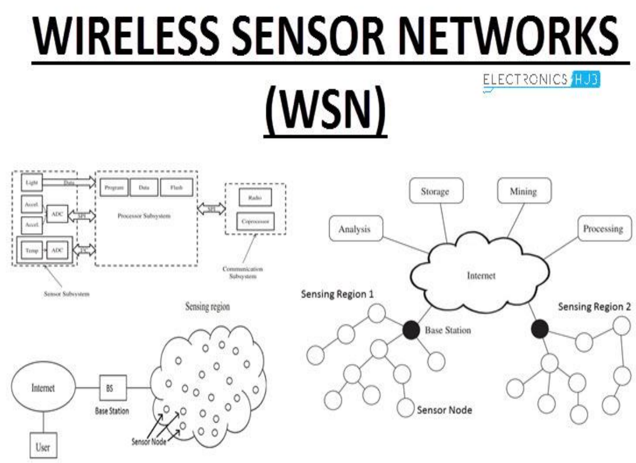
proposed a WSN model for fire detection using only temperature sensors. The model provided high accuracy and used cheap temperature sensors. The authors in extended the work in by increasing the types of sensors such as temperature, humidity, pressure and position sensor etc. In , Antonio et al. proposed a hierarchy of WSN which is used for early fire detection. It includes the sensor nodes (SNs) to sense air temperature, relative humidity, wind speed and direction, CO and CO2 levels and provided the data to central nodes which transmit the data to the control center. However, the designed WSN lacked intelligence and provided less efficiency. Haile et al. in described a WSN node based on wildfire hazard prediction (WFHP) system. The WSN-WFHP system model used 2-tiered WSN architecture and consists of 16 weather sensor nodes. This makes the WSN more efficient and precise. However, due to the limited types of sensors used, these algorithms yield ineffective results and may not detect fire on time. In , the author used fuzzy logic with multiple sets of sensors such as temperature, humidity, light intensity, and distance sensor for intelligent fire detection. However, it increased the exponential growth of rule-based decision making. The authors in made improvement in fuzzy logic by using multiple approaches such as fuzzy logic II, tree classifier, and neighbor-based fuzzy logic algorithms for fire detection. These approaches reduced the rules for correct decision making. However, fuzzy logic is unsupervised, so it may give errors while detecting the fire. Therefore, we used supervised intelligent 2542 KHALID et al./Turk J Elec Eng.& Comp Sic system in the proposed fire detection WSN node. It is based on the Bayesian optimization machine learning algorithm with less chances of false fire detection. The WSN will be trained for most of the sets of values that may cause fire, eventually detecting the fire incident. In this work, we present the wireless sensor node with different sensors such as flame detection sensor, gas sensor (smoke), temperature sensor, humidity sensor, and light sensor. These sensors will monitor the environmental parameters continuously and send the data collected from sensors to the base station, where it will be monitored to prevent any kind of hazardous fire. This application will be useful for almost every type of environment and it will be convenient as it is going to be wireless. The node used will be cheap and small so that it can be implemented anywhere. The main contributions of the paper are:

1) To use optimal combination of sensors for fire detection.
2) To select hardware components for smart fire detection with low cost, compact size, and low-power WSN node.
3) To provide a hardware design of smart fire WSN node in terms of schematic model, PCB model, and final hardware assembly.
4) To provide cost analysis of the proposed hardware.
5) To test the hardware under different real-time environmental conditions.
6) To apply machine learning algorithm for intelligent and reliable decisions. The paper is organized as follows:

Section 1 includes the introduction for fire detection. In Section 2, we provide comprehensive discussion about the architecture of WSN node. The description of sensors used in the proposed work and fundamental parts of the WSN node along with voltage sensor circuit are explained in Section 3. Complete circuit design of smart fire node and their budget analysis is discussed in Section 4. Testing of the hardware and machine learning algorithms is discussed in Section 5 followed by discussion and conclusion in Section

1.3. Wireless Sensor Network (WSN)

Wireless Sensor Node (WSN) is indeed a rail wife system that is installed ad hoc in a huge range of wireless sensors are used to monitor systems, physiological, or environmental conditions. Sensor nodes in WSN are equipped with an integrated CPU that regulates and analyzes the surroundings in a specific region. They are linked to the Ground Station, which serves as the WSN System's processing unit. A WSN System's base station is linked to the Internet to exchange data.



WSN Overview.

Over the last ten years, the WSN has attracted a lot of attention from research community due to its various applications. The WSN is a wireless network composed of different devices used for monitoring and controlling applications. The main applications include health and environment monitoring, home and office automation and military-related applications. The block diagram of WSN is shown in Figure 1. The WSN consists of two major parts i.e. WSN node and base station.

1.3.1 WSN node

The sensor node is the main component of WSN which is responsible to sense the changing parameters of the environment and transmit the information to the base station. A WSN node consists of a transceiver, microcontroller, sensors, and power source. The components of the WSN node are illustrated in Figure 2a. The sensors are mounted on the node which is responsible for collecting information. The microcontroller receives the sensor data and transmits it towards the base unit through the transceiver. The battery source provides the necessary power for operations. The architecture of multiple sensor nodes is placed at different places and these nodes can communicate with each other by applying different networking algorithms. The nodes can be placed by using different network topologies such as star, mesh, and hybrid.

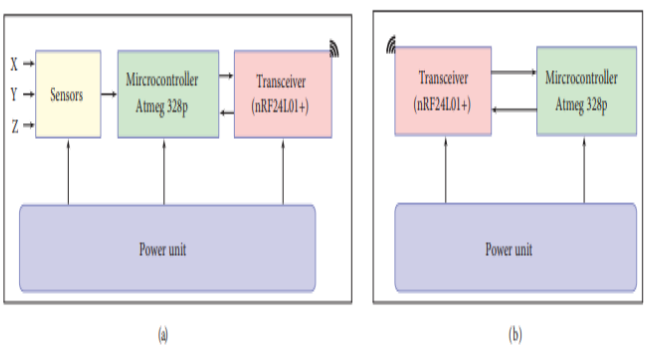


Figure 2. Components of WSN: a) WSN node b) base station.

1.3.2 Base station

The base station is responsible for receiving the information sent by the WSN node and delivers it to the end user. It operates as a bridge between the sensor node and the user. The base unit consists of a transceiver, microcontroller, and battery. A block diagram of a base station is shown in Figure 2b. The transceiver is used to receive the information from WSN node and microcontroller takes necessary decisions using the data received from sensors. Due to this control functionality, base station is also known as an administrative unit. The battery source provides the power to the microcontroller and transceiver.

II. PROPOSED WIRELESS SENSOR NETWORK NODE

In this paper, we propose a WSN node which will be used to detect the fire using sensors including flame sensor, smoke sensor, light sensor, temperature, and humidity sensor. The smoke sensor is used to detect the smoke produced in the early stage of fire. The flame sensor detects the flame of the fire. The node also includes temperature and humidity sensor used to measure the temperature and humidity of the environment because the fire affects the temperature and humidity of the environment. The fire also produces light variations in the environment. The node measures the light intensity by using the light dependent resistor (LDR). The combination of the sensors used here provide accurate and early fire detection. These sensors will provide the data to a microcontroller. The microcontroller is connected to the radio frequency (RF) transceiver due to its large range and low cost. The transceiver will transmit the data to the base station. A lithium ion battery is used to supply the power to the node components. The battery status is monitored with the help of voltage dependent resistor (VDR) circuit. Figure 3 shows the block diagram of the proposed fire detection WSN node and a brief discussion of various components is provided in the following sections.

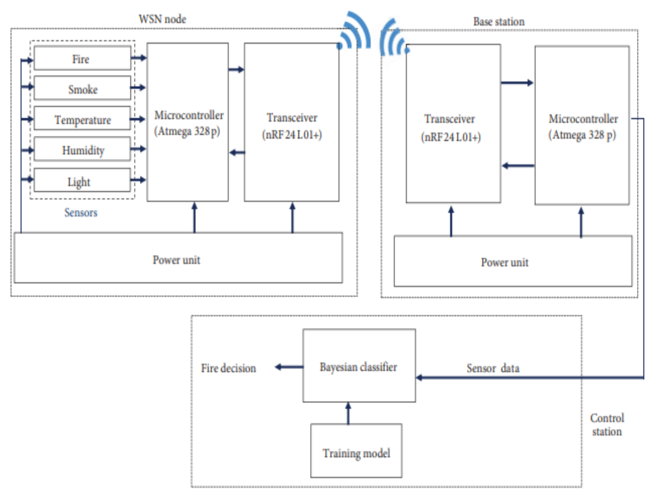


Figure 3. Framework of the proposed WSN-based fire detection.

2.1 Sensors

We used different sensors to detect the fire in our proposed WSN node. The technical details of each sensor used are provided as follows.

2.2. Flame sensor

The infrared (IR) flame detection sensor is used to detect the infrared wavelength (760 − 1100 mm) emitted from the flame of fire (see Figure 4a). It operates at low voltage (3.3 V to 5 V) and detects the flame up to 1 m. It gives both analog and digital output. The digital output is set with the help of adjustable sensitivity knob. It has comparator chip LM393 which keeps the output readings more stable.

2.3. Temperature and humidity sensor

The DHT22 digital temperature and humidity sensor is used due to its small size and low power consumption (see Figure 4b). It measures both temperature and humidity and provides digital output. It is more accurate and stable than other available sensors. Its operating voltage is 3.3 − 6 V. The temperature measurement ranges from −40 to 125 ◦ C with ± 0.5 ◦ C accuracy. The humidity measurement is from 0 − 100% with ±2% accuracy.

2.4. Smoke sensor

The MQ-2 smoke sensor with sensitive material SnO2 is used to detect smoke (see Figure 4c). The SnO2 has low conductivity in clean air and high conductivity for liquefied petroleum gas (LPG), Methane, Hydrogen, and Propane gases in the environment. The sensor produces high output voltage in case of high conductivity. It is a low-cost sensor and operates at 5 V ± 0.1 V

2.5. Light intensity sensor

A 5-mm LDR is used as a light intensity sensor due to its low cost (see Figure 4d). In case of increased brightness, its resistance reduces and produces low voltage drop across it, whereas in darkness it acts as a high-value resistor so the voltage drop is high. It is used in series with another resistor and voltage drop across that resistor is measured.

2.6 Microcontroller

Most of the WSN nodes use Arduino microcontroller development board due to ease in implementation and simplicity. In this work, we use ATmega328p microcontroller chip instead of the whole Arduino board due to three main reasons: (I) reduced cost, (ii) small size, and (iii) power efficiency. The dimension of the chip is 34.8 × 7.49 mm compared to the Arduino which is 68.6 × 53.3 mm. The Arduino consumes about 50 mA in active mode while the chip only consumes 16 mA. Therefore, power consumption is reduced 3 times less than the Arduino. The chip operates at 1.8–5 V voltage levels with 4–204 MHz clock speed.

2.7. Transceiver

In this paper, we use NRF24L01+, an RF transceiver with 2.4 GHz operating frequency. It has very low cost in comparison to other transceivers and consumes less power. The voltage operating range lies between 1.9 and 3.6 V. It has a small size (dimension: 12 × 18 mm) and transmission range is about 100 to 1000 m. The NRF24L01+ module can operate on three different data rates according to applications which are 250kbps, 1 Mbps, and 2 Mbps. The NRF24L01+, with channel frequency band of 2400–2525 MHz, provides 125 independent channels for multiuser communication. One transceiver can communicate with 5 transceivers at a time. Therefore, by using different end devices and coordinate routers we can make a complete network of different topologies. The power consumption is about 12 mA during transmission. The NRF24L01+ has 4 power modes which can be selected according to the power of the amplifier and the distance travelled by the transceiver. The modes are named as minimum power, low power, high power, and maximum power. The hardware chips of RF, ZigBee, Bluetooth, and RF transceivers are shown in Figures 5a–5d respectively while a detailed comparison is provided in Table 2.

Table 2. A comparison of different transceivers used in wireless sensor networks.

Transceiver	Cost	Range	Data rate	Power
Bluetooth	$7.69	10 m	2.1 Mbps	Moderate
Wi-Fi	$4.5	400 m	54 Mbps	High
Zigbee	$19.99	100 m	250 kbps	Low
RF module	$2	250 m	2 Mbps	Moderate

2.8. Power source

The power source is the key component in WSN node. It is important to design the battery that provides high storage capacity, low self-discharge rate, and must be environment friendly. In order to reduce the cost and improve battery life, lithium ion cells (2 cells in series) are used. Each 18650 lithium ion cell provides 3.7 V with 2600 math capacity. It can be used in open environment without reducing its efficiency. A voltage sensor circuit is used to monitor the power utilization during the working of node.

III. LITERATURE REVIEW

1. **Rashi Srivastava (2018) Forest Fire Prediction Modelling Using Fuzzy Logic**

Forest fire is an essential part of the livelihood of mankind. It provides us flora and fauna as well as produces oxygen and absorbs Carbon di oxide which is very essential for the life. A large part of these precious forests get destroyed due to fire which occurs due to various reasons like human negligence, natural disaster, lightening, accident etc. The forest fire not only engulf the tree but produces toxic gases which is very harmful for the environment. The proposed model trying to develop a WSN (wireless sensor network) based model which will detect the fire and also can predict the occurrence of fire in forest by analyzing parameter such as temperature, humidity and time using fuzzy logic.

4. Guoli Zhang (2019) Forest Fire Susceptibility Modeling Using a Convolutional Neural Network for Yunnan Province of China

Forest fires have caused considerable losses to ecologies, societies, and economies worldwide. To minimize these losses and reduce forest fires, modeling and predicting the occurrence of forest fires are meaningful because they can support forest fire prevention and management. In recent years, the convolutional neural network (CNN) has become an important state-of-the-art deep learning algorithm, and its implementation has enriched many fields. Therefore, we proposed a spatial prediction model for forest fire susceptibility using a CNN. Past forest fire locations in Yunnan Province, China, from 2002 to 2010, and a set of 14 forest fire influencing factors were mapped using a geographic information system. Oversampling was applied to eliminate the class imbalance, and proportional stratified sampling was used to construct the training/validation sample libraries. A CNN architecture that is suitable for the prediction of forest fire susceptibility was designed and hyperparameters were optimized to improve the prediction accuracy. Then, the test dataset was fed into the trained model to construct the spatial prediction map of forest fire susceptibility in Yunnan Province. Finally, the prediction performance of the proposed model was assessed using several statistical measures—Wilcoxon signed-rank test, receiver operating characteristic curve, and area under the curve (AUC). The results confirmed the higher accuracy of the proposed CNN model (AUC 0.86) than those of the random forests, support vector machine, multilayer perceptron neural network, and kernel logistic regression benchmark classifiers. The CNN has stronger fitting and classification abilities and can make full use of neighborhood information, which is a promising alternative for the spatial prediction of forest fire susceptibility. This research extends the application of CNN to the prediction of forest fire susceptibility.

5. Mobeen Ahmed MALIK (2019) A smart wireless sensor network node for fire detection

Fires generally occur due to human carelessness and the change in environmental conditions. The uncontrolled fire results in death incidents of humans and animals as well as severe threats to the ecosystem. The preservation of the natural environment is important. The wireless sensor networks, widely used in different monitoring applications, is used in this work. For fire detection, we use flame, smoke, temperature, humidity, and light intensity sensors in our proposed network node which is low-cost, reduced-size, and power-efficient. The experiments are performed in a well-controlled real-time environment. The proposed node transmits the sensed data to the central node. The central node then transfers the data gathered from all the nodes to the control station using an air interface. To decide whether there is an incident of fire or not, and to have an idea on fire intensity, we combine multiple attributes sensed from a single node using Bayesian approach due to its simplicity and resemblance with human reasoning. In the experimental setup, the conditions for fire with different intensity are generated and the results confirm the validity of the proposed approach in terms of accuracy and less false alarms.

6. Byoungjun Kim (2019) A Video-Based Fire Detection Using Deep Learning Models

Fire is an abnormal event which can cause significant damage to lives and property. In this paper, we propose a deep learning-based fire detection method using a video sequence, which imitates the human fire detection process. The proposed method uses Faster Region-based Convolutional Neural Network (R-CNN) to detect the suspected regions of fire (SRoFs) and of non-fire based on their spatial features. Then, the summarized features within the bounding boxes in successive frames are accumulated by Long Short-Term Memory (LSTM) to classify whether there is a fire or not in a short-term period. The decisions for successive short-term periods are then combined in the majority voting for the final decision in a long-term period. In addition, the areas of both flame and smoke are calculated and their temporal changes are reported to interpret the dynamic fire behavior with the final fire decision. Experiments show that the proposed long-term video-based method can successfully improve the fire detection accuracy compared with the still image-based or short-term video-based method by reducing both the false detections and the misdetections.

7. Shaily R. Gandhi (2014) Automatization of Forest Fire Detection Using Geospatial Technique

Healthy forest is the vital resource to regulate climate at a regional and global level. Forest fire has been regarded as one of the major reasons for the loss of forest and degradation of the environment. Global warming is increasing its intensity at an alarming rate. Real-time fire detection is a necessity to avoid large scale losses. Remote sensing is a quick and cheap technique for detecting and monitoring forest fires on a large scale. Advance Very Radiometer Resolution (AVHRR) has been used already for a long period for fire detection. The use of Moderate Resolution Imaging Radio Spectrometer (MODIS) for fire detection has recently preceded AVHRR and a large number of fire products are being developed.

MODIS based forest fire detection and monitoring system can solve the problem of real-time forest fire monitoring. The system facilitates data acquisition, processing, reporting and feedback on the fire location information in an automated manner. It provides location information at 1 × 1 kilometer resolution on the active fires which are present during the satellite overpass twice a day. The users are provided with the information on SMS alert with fire location details, email notification, and online visualization of fire locations on website automatically. The whole processes are automated and provide better accuracy for fire detection.

8. M.S.Sruthi (2017) Smart IoT Based System For CO2 Monitoring and Forest Fire Detection with Effective Alert Mechanism

Internet of Things (IoT) is a vision towards Future Internet where “things” are provided with enough intelligence to interconnects devices which may be machines, sensors or everyday objects that independently exchanges data between device-to-device and device-to-server either directly or over the internet without the human intervention. Implement IoT to monitoring atmospheric CO2 rate using MG811 carbon dioxide sensor and early detection of forest fires using temperature and humidity sensor with Raspberry pi. Cabon dioxide, which is an important constituent of environment is causing global warming and air pollution on the earth’s surface. To save our earth, monitoring, controlling and preventing these changes is a big challenge. In terms of a long range control of CO2 emission at their source is more desirable and effective method to protect our earth.This system aims to collect massive amount of data for detecting and controlling the pollution caused by the emission of CO2 and store the data in secure server for effective analysis. Also all the process parameters within an interval selectable by the user are recorded online. This is very useful for future analysis and review of atmospheric condition of a particular area.

9. Arnoldo Díaz-Ramírez (2012) Wireless Sensor Networks and Fusion Information Methods for Forest Fire Detection

Research in wireless sensor networks (WSNs) has experienced a significant growth in recent years. One topic of special interest is the use of WSNs in the detection of forest fires. In this paper, we propose two algorithms for forest fire detection. The proposed algorithms are based on information fusion techniques. The first algorithm uses a threshold method and nodes equipped with temperature, humidity and light sensors. The second algorithm uses the DempsterShafer theory and assumes that the nodes use temperature and humidity sensors. Evaluation results show that both methods are able to efficiently detect fires in their initial stages.

10. Gurleen Kaur (2017) Wireless Sensor Networks for Fire Detection and Control

Due to current technological progress, the manufacturing of tiny and low price sensors became technically and economically feasible. Sensors can measure physical surroundings related to the environment and convert them into an electric signal. A huge quantity of these disposable sensors is networked to detect and monitor fire. This paper provides an analysis of utilisation of wireless sensor networks for fire detection and control.

IV. METHODOLOGY

In this system there are three modules. Each one has the specific function. The device sensing the humidity, temperature, and smoke in digitally. The user set certain temperature level for the system. In case the sensed temperature level is beyond the setting level. The system transmits the information to the pc or the user.

4.1 EXISTING METHODS

Now there are many methods used for providing fire detection to forest. They are remote monitoring, surveillance system and ZIGBEE technology etc. But the cost of manufacturing these systems are quite high when compared to the proposed system. In this scenario surveillance systems are that much secure like proposed system, because it is easily detecting the forest fire and send the information to long distance. Existing systems are cost effective and they are not that much secure comparing to this proposed system. Many existing systems are based on Wireless Sensor Network and remote monitoring. These systems are efficient for detecting fire in very short duration.

1. TRANSMITTER

The system is being detected the level of temperature, Smoke by using the sensors. The analog information is converted into the digital by using ADC which is inbuilt of microcontroller .Whenever there is a fire occurring, the transmitter transmits the data through the USART.

2. TRANSCEIVER

This is the second module of the system. Which is used to receive the data from the transmitter of the module1 and also transmit again to the receiver2 using the zigbee technology. 3. RECEIVER The receiver is used to receiving the data. Here we are using the M2M communication which is nothing but machine to machine communication. This M2M is one type of coding method software coding which can transmit the data to the next receiver in parallel manner. In this manner we are communicating long distance.

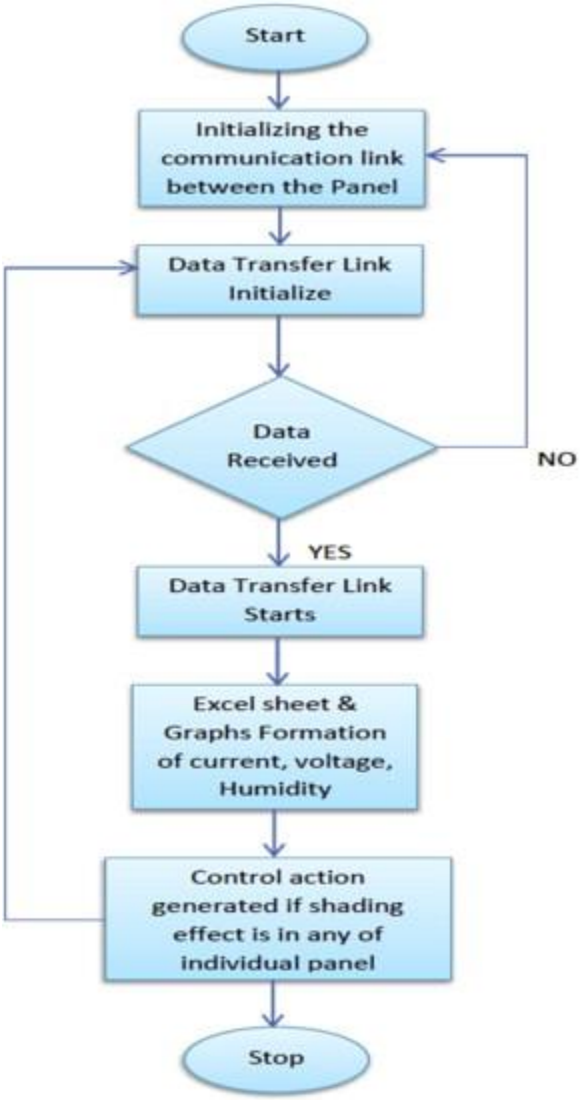


Fig 3. Flowchart

V. CONCLUSION AND FUTURE RECOMMENDATIONS

In this work, a smart WSN node is presented for early fire detection. The proposed node is efficient in terms of cost, size, and power. The hardware for the node is prepared using the PCB design of the circuit and the sensors. The fire event is detected using five sensors; flame detection sensor, temperature sensor, humidity sensor, smoke sensor, and light sensor. The cost of our final standalone node is 25$ which is lowest compared to other available nodes. In addition, the node utilizes less power compared to other state-of-the-art models. The experiments are performed in a well-controlled real-time environment. The data collected from real experiments is used to train a Bayesian classification model and test the validity of the proposed fire detection workflow. The smart node-based fire detection model achieved an excellent accuracy thus outperforming other state-of-the-art fire detection algorithms. The results showed that the proposed WSN node can efficiently detect fire events with fewer false alarms. In the next phase, we are progressing in developing IoT-enabled fire detection node. The RF transceiver on the current node will be replaced by the Wi-Fi module. The fire detection nodes, base station, and client user will be connected to the Internet. The Internet will be used as the platform to transmit real-time sensor values and other data. The data received from the sensor will be secured using a cryptographic approach before transmission. A web interface will be used to analyze real-time results. This will enable the fire department to monitor live updates and take quick action in case of fire. The work is in progress and expected to be completed within few months.

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