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A Detailed Investigation on Forest Monitoring System for Wildfire Using IoT

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Abstract. The world's forests cover one-third of the planet's land surface, and it is necessary to sustain life with this geography. There is enough food, water, and energy for us to live off of them. Forest fires have recently surpassed all other forms of environmental degradation as the leading cause of death and destruction on Earth. Wildfires in the Amazon rain forest charred hundreds of hectares of land in 2019. A well-structured forest-monitoring system has been put in place in order to keep an eye on it. Incorporating the Internet of Things (IoT) and image processing systems is a real game-changer. The wireless network has made use of both of these techniques in recent times. This paper discusses the various technologies that keep track of the forest's environmental conditions in real time and identify wildfires. Based on the information, the alerts are passed to the authorities to take action and protect the forest from further damage.

Keywords. Image Processing, internet of things, wildfire, wireless sensor network

1. Introduction

Forests are an essential part of our existence because they span one-third of the planet's surface area. They supply us with all the resources we need to live a healthy lifestyle. Forest fires have lately risen to the top of the list of environmental threats. Habitat destruction is worsened by forest fires, which decimate hundreds of trees annually in different parts of the world [1-5]. The rationale for this is that we get the warmest summer and mildest winter. Fires destroy forests, regardless of who started them or what caused them. Additionally, there have been thousands of reported forests fires each year as a result of this environmental impact. Each year, the numbers grow larger and larger [6-9]. As a result, there are numerous methods for detecting forest fires. Four major monitoring approaches have been employed extensively in recent years, such as human-based observation systems, satellite systems, optics cameras, and wireless sensor networks [10-13].

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Many businesses employ IoT technology, and it's ideally suited for data transmission in a forest. In the current era, studies into smart-cities and smart-infrastructure are on the rise. It's possible for fires to break out in a variety of places, such as parks, farmland, offices, and residences [14-18]. Unmanned Aerial Vehicles (UAV) and wireless sensor network technology are being used in the preliminary phase to detect fire. The sensing architecture is used to measure environmental characteristics such as temperature, humidity, and pressure. The sensors collect environmental data and process it using IOT-based apps. Another significant challenge in forest fire detection is power supply, as this system requires constant electricity [19-20]. Solar power is the ideal alternative because of its specific advantages and availability over other power supply systems. This paper discusses the various technologies that are used for wildfire detection [21-23]. It also analyses the advantages and disadvantages and compares the various methods based on their mode of operation. Section I consists of the introduction. Section II describes and discusses related work. The methods used to find forest fires are explained in Section 3, and the results and a summary of the different works cited in the literature are given in Section IV.

2. Related Work

A real-time surveillance and fire alarm system based on the internet of things and cloud-based drones is being developed. Drone sensors and cloud-computing are used to monitor the environment-based indicators in this work. Drones and cloud-computing systems are expensive, and they will require a lot of infrastructure costs to keep running [1] [2]. The detection system is built for early detection and reporting of forest fires and leverages the capabilities of the Internet of Things (IOT). This study is aimed at using the IoT as an alert system for identifying forest fires. This model includes a sensor for monitoring the various parameters such as temperature, smoke sensor, fire sensor, and power management unit. The major drawback is that this system doesn't describe the preventive measures [2]. A wireless-sensor-network for detecting and studying forest fire activity is designed. This system bridges the gap between sensing and fire behavior prediction systems. An alarm will sound as soon as a fire is detected so that it can be dealt with before further damage is done [3]. [2]. A formal framework for forest fire detection and prevention using wireless sensor networks is being presented. Sensors and robots are utilized to gather information about their surroundings, while the robots are utilized for carrying out activities in the surroundings. The ability to keep the repository on systems and robots as well as to investigate the grouped connections of robotic systems is the main drawback of the proposed system [4]. Novel forest fire detection using sound-spectrum analysis with IoT has been proposed. The Internet of Things (IoT) is being used to create a way of detecting wildfires utilizing spectrum analysis for differentiating between crown and surface-fires [5]. An information-delivery warning system using forest fire detection and the Internet of Things has been developed. Using multiple metrics, wireless technologies, sensors, and the Internet of Things, this proposed system utilizes cloud-computing and the IoT to deliver information about forest fires [6]. A fire detection system based on a UAV and remote sensing is designed. Forest firefighting operational processes can now be monitored using a group of aerial vehicles and remote-sensing methods. Predicting the spread of fire and smoke can be done with greater confidence and effectiveness when using tools like monitoring and control, sensing, and an approximate model [7]. A new system that integrates wireless-sensor-

network and IoT for surveillance has been developed. Using a micro-controller, the sensor node monitors the situation using parameters such as temperature and humidity [8].

3. Methodology Used

In this methodology section, the various types of detection methods using microprocessors, microcontrollers, mobile networks, GSM and autonomous navigation systems are being discussed in detail.

3.1. Wildfire detection system using microprocessor

Wild fire is detected by placing sensors like temperature sensors, smoke sensors, fire sensors, ultra-sonic sensors, and rain sensors in different zones in the forest as shown in Figure 1. The data which is collected by the sensors is transferred to the microprocessor. The data is exchanged between the microprocessor and the base station by using Wi-Fi. Solar panels are used for continuous power supply and communication. A forest-fire monitoring system consists of two major components, such as a transmitter and receiver. The transmitter includes a microprocessor, a camera, and a variety of sensors. The receiver includes computers that serve as the ground station. Sensors are used to collect information from various nodes, such as temperature, fire, and smoke. Software such as MATLAB is used to handle the above information at the station's central processing unit. When images or information are received that show flames or other signs of fire and smoke in the processed data, alerts are sent.

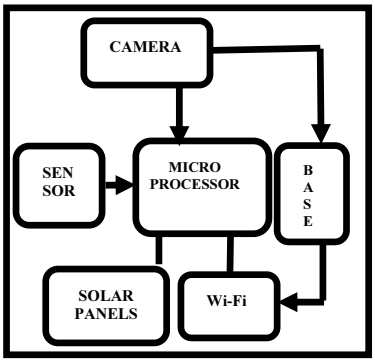

Figure 1. Microprocessor detection

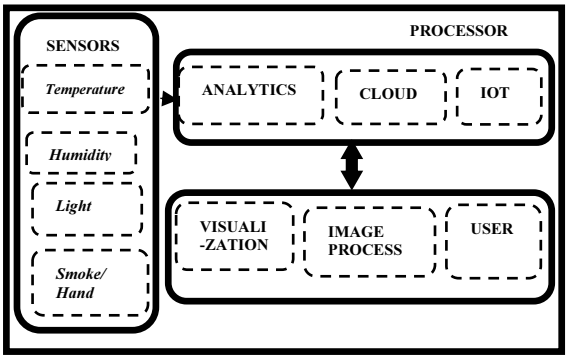

Figure 2. Controller detection

3.2. Wildfire detection system using microcontroller

The system utilizes different sensors [1] [10] for sensing the changes in the forest as shown in Figure 2. Wild fire is detected by placing sensors like temperature sensors, smoke sensors, humidity sensors, light sensors and hand-wired sensors in the forest and the collected data is sent to the processor. A temperature sensor is used for the purpose of anticipating an increase in temperature. A fire sensor is utilized to detect fire quickly and is simple to set up and activate the system. A smoke detector will alert you to the existence of the toxic gas. rain The Sensor keeps track of weather conditions in an area. Ultrasonic can keep a close eye out for intruders and also provide device security.

3.3. Mobile network wildfire detection system

Many forest-fire detection methods have been designed in the literature, but they all suffer from the problem of false-alarms. Different sensors are utilized to measure fire in this framework, such as humidity, temperature, smoke, and light [2] [9]. The proposed models consist of several layers such as sensor, network, service, and interface layers. Sensors called "sub nodes" are located in the first layer because it is on the outermost edge of the system. Several sensors, referred to as nodes in the second layer, will be set up in the center of the forest. In the final layer, there will be nodes that handle information and transfer it to the cloud applications.

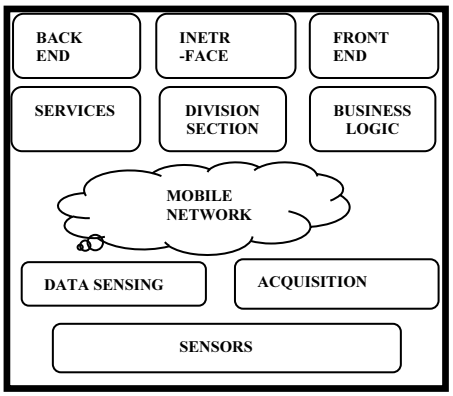

Figure 3. Mobile network-based detection

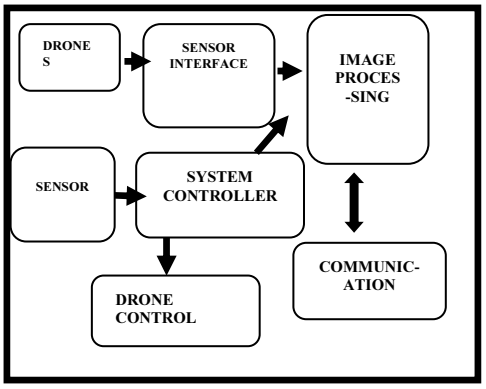

Figure 4. Autonomous navigation system

3.4. Autonomous navigation system

A four-layer architecture is proposed and the model consists of sensing, network, and service layers as shown in Figure 4. A sensing layer is placed in the forest at different regions in the forest. The data from the sensor is transferred from one device to another device by the network layer. The service layer is the intermediate layer that is placed between the network layer and the interface layer. The interface layer consists of an application front-end mechanism, an interface session, and an application layer [3] [14]. Within a certain radius of the fire, IoT devices are capable of detecting fire at any moment after it has been lit. Drones can then use such IoT devices to gather information about their surroundings [15] [17] [18]. In this model, the wildfire was detected by using IOT and an Artificial Neural Network. The micro controllers use GSM modules to locate the fire zones, and the data is stored in the database. That database is used by the forest department offices for monitoring the conditions [20].

3.5. GSM based wildfire detection system

A wireless sensor network is used for detecting forest fires and monitoring certain zones in the forest. This model has a temperature sensor for detecting the fire conditions, and that data is transferred to the microcontroller. The received data is saved in a database to help the forest department officer monitor the forest condition. Microcontroller detects the affected zone in the forest using a GSM module [12] [13] [16] [19].

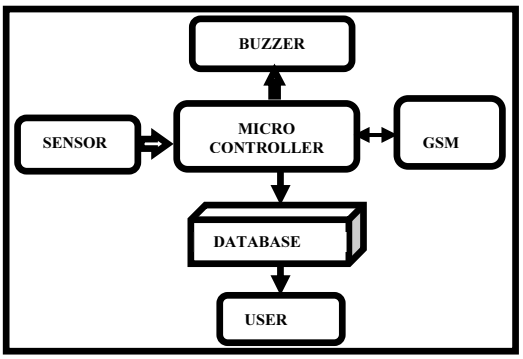

Figure 5. GSM based detection system

4. Results and Discussions

Table 1 provides a comparison of various techniques along with their advantages and disadvantages. It also provides details about the techniques and their implementation. The techniques are compared along with their performance measures.

Table 1. Comparison between detection systems

S.No	Authors	Advantages	Disadvantages	Tools Used	Dataset	Accuracy
1	Sungheetha [1]	Images of high resolution are captured	Drones cost maintenance is high with cloud processing	Temperature, fire, smoke	MATLAB	95%
2	Tomar [6]	Provides more accurate results to users.	Battery replacement requires additional cost	Rain sensors	ThingSpeak.	90.76%
3	Sherstjuk [7]	Automatic monitoring using multi drone	Sensitive to noisy data	Smoke, light, humidity and temperature sensors	Zigbee.	85%
4	Shivam Pareek, Shreya Shrivastava , Sonal Jhala [21]	Detection accuracy is high	It is bit expensive	ATMEGA328 microcontroller	MATLAB	92.5%
5	Dubey [22]	Detection in lesser time.	Needs further tuning	Sensors networks, Temperature, smoke and light sensors	ThingSpeak	97%

5. Conclusion and Future Work

Forest fires can be detected by using advanced technology, and it can provide an early warning system for protecting the forest. Using image-processing methods, the system is able to recognize and respond to a variety of different kinds of fires. Image processing will have the ability to discern between normal conditions and fires, allowing for the monitoring and protection of endangered species as well as the tracking of wildlife. Real-time surveillance and data collection are affordable and modestly conceivable.

Numerous techniques are analyzed in the paper, and it provides a detailed study of the techniques and operating capabilities. It is clear from the investigation that image processing and artificial intelligence-based techniques provide higher accuracy. In the future, sensor networks will be set up to automatically detect fire in a variety of locations.

References

[1] Sungheetha A, Sharma R. Real time monitoring and fire detection using internet of things and cloud based drones. Journal of Soft Computing Paradigm (JSCP). 2020 Jul 21;2(03):168-74.
[2] Divya A, Kavithanjali T, Dharshini P. IoT enabled forest fire detection and early warning system. In2019 IEEE International Conference on System, Computation, Automation and Networking (ICSCAN) 2019 Mar 29 (pp. 1-5). IEEE.
[3] Alkhatib AA, Abdelal Q, Kanan T. Wireless Sensor Network for Forest Fire Detection and behavior Analysis. International Journal of Advances in Soft Computing & Its Applications. 2021 Mar 1;13(1).
[4] Afzaal H, Zafar NA. Robot-based forest fire detection and extinguishing model. In2016 2nd International Conference on Robotics and Artificial Intelligence (ICRAI) 2016 Nov 1 (pp. 112-117). IEEE.
[5] Zhang S, Gao D, Lin H, Sun Q. Wildfire detection using sound spectrum analysis based on the internet of things. Sensors. 2019 Nov 21;19(23):5093.
[6] Tomar R, Tiwari R. Information delivery system for early forest fire detection using internet of things. InInternational Conference on Advances in Computing and Data Sciences 2019 Apr 12 (pp. 477-486). Springer, Singapore.
[7] Sherstjuk V, Zharikova M, Sokol I. Forest fire-fighting monitoring system based on UAV team and remote sensing. In2018 IEEE 38th International Conference on Electronics and Nanotechnology (ELNANO) 2018 Apr 24 (pp. 663-668). IEEE.
[8] Vijayalakshmi SR, Muruganand S. Challenges in integrating wireless sensor network and Internet of Things for environmental monitoring. World Scientific News. 2016;41:1-8.
[9] Bushnaq OM, Chaaban A, Al-Naffouri TY. The role of UAV-IoT networks in future wildfire detection. IEEE Internet of Things Journal. 2021 May 5;8(23):16984-99.
[10] Siddiqa SK, Apurva K, Nandan D, Kumar S. Documentation on smart home monitoring using internet of things. InICCCE 2020 2021 (pp. 1115-1124). Springer, Singapore.
[11] Rizanov S, Stoynova A, Todorov D. System for early warning and monitoring of wildfires. In2019 IEEE XXVIII international scientific conference electronics (ET) 2019 Sep 12 (pp. 1-3). IEEE.
[12] Kaur H, Sood SK. A Smart Disaster Management Framework For Wildfire Detection and Prediction. The Computer Journal. 2020 Nov;63(11):1644-57.
[13] Antunes M, Ferreira LM, Viegas C, Coimbra AP, de Almeida AT. Low-cost system for early detection and deployment of countermeasures against wild fires. In2019 IEEE 5th World Forum on Internet of Things (WF-IoT) 2019 Apr 15 (pp. 418-423). IEEE.
[14] Shilin M, Sikarev I, Baikov E, Gogoberidze G, Petrieva O. Digitalization wildfire management near smart city. InE3S Web of Conferences 2021 (Vol. 258, p. 01003). EDP Sciences.
[15] Praveena SM, Akshaya B, Devipriya BB, Divya U, Mirudhula K. Forest fire detection using drone. International Journal of Engineering Applied Sciences and Technology, 2021 6(7): 110-113.
[16] Ateeq Z, Momani M. Wireless sensor networks using image processing for fire detection. In2020 5th International Conference on Innovative Technologies in Intelligent Systems and Industrial Applications (CITISIA) 2020 Nov 25 (pp. 1-10). IEEE.
[17] Nimmakayala S, Mummidi B, Kunda P, Kumar S. Modern Health Monitoring System Using IoT. InICCCE 2020 2021 (pp. 1135-1144). Springer, Singapore.
[18] Basu MT, Karthik R, Mahitha J, Reddy VL. IoT based forest fire detection system. International Journal of Engineering & Technology. 2018;7(2.7):124-6.
[19] Saldamli G, Deshpande S, Jawalekar K, Gholap P, Tawalbeh L, Ertaul L. Wildfire detection using wireless mesh network. In2019 Fourth International Conference on Fog and Mobile Edge Computing (FMEC) 2019 Jun 10 (pp. 229-234). IEEE.
[20] Verma S, Kaur S, Rawat DB, Xi C, Alex LT, Jhanjhi NZ. Intelligent framework using IoT-based WSNs for wildfire detection. IEEE Access. 2021 Feb 19;9:48185-96.
[21] Sudeep SV, Venkata Kiran S, Nandan D, Kumar S. An Overview of Biometrics and Face Spoofing Detection. ICCCE 2020. 2021:871-81.
[22] Pareek S, Shrivastava S, Jhala S, Siddiqui JA, Patidar S. IoT and Image Processing based Forest Monitoring and Counteracting System. In2020 4th International Conference on Trends in Electronics and Informatics (ICOEI)(48184) 2020 Jun 15 (pp. 1024-1027). IEEE.
[23] Dubey V, Kumar P, Chauhan N. Forest fire detection system using IoT and artificial neural network. In International Conference on Innovative Computing and Communications 2019 (pp. 323-337). Springer, Singapore.