Forest Fire Prediction Using IoT andDeep Learning

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Abstract- The most vital component of the planet is its forests. As they give many animals food and shelter. One of the biggest issues facing humans, animals, and plants is forest fires. It harms wildlife, the environment, and living things. A fundamental requirement for reducing the environmental issue is the ability to detect or predict forest fires. This paper provides a general overview of the many methods for locating fire or smoke in the woods. IoT and deep learning-based prediction techniques are proposed. It uses the Pi camera to capture fires. Fire detection using CNN model is effectively proposed. This aids in containing and bringing the forest fire under control.

Keywords—Forest fires, Forest fire prediction, sensors, CNN,Deep learning

I.INTRODUCTION

Due to global warming, forest fires are becoming more frequent, causing severe economic losses and ecological harm. Forest fires can be caused by human error as well as natural causes. Wildfires can help the area fauna, flora, and ecosystems, but they can also seriously harm both property and people. Accidental forest fire occurrence has dramatically increased during the past few years. So, as a means of preventing the lossof forests, there has been an increase in interest in the implementation of systems for the mechanical observation and detection of forest fires.

In the past, watchtowers were used to detect forest fires, but because they relied on human observations, they were unsuccessful. Watchtowers, satellite image processing, optical sensors, and digital camera-based techniques are some of the forest fire detection methods that have been used recently and are still in use today. However, these methods have a number of constraints, including inefficiency, power consumption, latency, correctness, and performance costs.

As wildfires can start anywhere and spread quickly, it is difficult to identify and anticipate when they will occur.Nonetheless, it is possible to create early-warning systems that are consistently accurate with the aid of technical solutions integrating the Internet of Things and artificialintelligence. In our opinion, a useful approach to do this objective is to use essential sensors to measure changes in temperature, humidity, and wind speed, as well as to identifythe presence of smoke and fire. The fire detection method is divided into temperature-sensitive and smoke-sensitive categories based on sensor types and applications. For this purpose, temperature and smoke sensors are routinely employed.

Smoke detection presents unique challenges in both films and photos. A system needs to be able to distinguish between pictures that actually have fire in them and pictures that just look famous. Simple color characteristics for fire detection have greater false alarm rates. As a result, techniques based on image processing have been developed to record the properties of a fire, such as color, form, etc. Deep learning has the advantage of being able to recognize patterns that are too complicated for people to see in images. This means that deep learning networks usually outperform conventional methods for classifying images.

II.LITERATURE REVIEW

[1] In recent years, forest fires have resulted in the loss of numerous green acres. This essay investigates how Lebanon's forest fire risk is affected by climatology information, including temperature, relative humidity, wind speed, and daily precipitation. These effects require adapting specific strategies that could aid in fire prediction and help prevent their occurrence. For this, artificial neural networks have been used. For analysis, the 2012 weather data are obtained from the North Lebanon Kfarchakhna station. We looked at how the hidden layer's number of neurons and training method affected the network's effectiveness and

mean squared error.
This show that they are performing well.

[2] A technique to detect fire by smoke detection in video was put forth by Surapong Surit and Watcher Chatwiriya. This strategy is based on digital image processing with static and dynamic characteristic analysis. Finding the area of change in the current input frame in contrast to the background image isthe first step in the suggested methodology. The second step is to locate regions of interest (ROIs) by
connected component algorithm. The third step is to calculatestatic and dynamic characteristics. Using this result, we determine whether the object detected is an actual object. Theoutcome demonstrates that this technique successfully identifies fire smoke.

[3] In order to avoid forest fires, forecasts must be made to identify land areas that may catch fire based on meteorological data obtained from the sensor, which is predicted to limit the spread of fire before it starts. Temperature, wind, humidity, and rainfall are the four meteorological variables that were utilized in the study to identify the geographic regions that will be affectedby forest fires. A neural network with an Extreme Learning Machines (ELM) training model was the method used in this investigation. Many experiments will be run in this study to enhance the effectiveness of the ELM approach and produce thebest predictions possible.

[4] A new approach to smart home automation is demonstrated and published in 2017. It is recommended to use an Android phone that communicates through Bluetooth with an Arduino board, which manages the lighting, air conditioning, smokealarms, and other equipment. What is most lacking is the system's ability to act independently of the user and make decisions. Furthermore, we attempt to avoid using The solution we design relies on Bluetooth technology and demands that consumers keep their smartphones close by even inside. On the other hand, using an Arduino board is a wise choice that results in a system that is both affordable and scalable. Bluetooth is a fairly common technology in home automation, as we've already seen. It is also used in which presents a Bluetooth based client server network with a specially developed communication protocol. The main component of this system is the HAP Home Automation Protocol, in which a computer serves as Server, additional sensors, and electrical apparatus are linked as slaves. Despite communicating over shorter distances than Wi-Fi and producing less radiation, Bluetooth still adds to electromagnetic radiation, which is something we want to avoid.

[5] The method described, which uses an ArduinoUno board to power the automated system and connects all the sensors and actuators to the Arduino to block wireless connection, is the onethat is closest to achieving our goal. But, the system does includea component for smartphones—an app that communicates with the Arduino via Bluetooth, as we have seen in the majority of thepapers we have read. In this instance, long-distance system communication is also not implemented After considering the aforementioned references, it was determined that an Arduino Uno board can serve as the basis of a productive smart home automation setup. As a result, the system will be relatively affordable and highly expandable and modular. Because all of the sensors and actuators will be connected to the circuit board, the quantity of extra EM radiation that can be produced will be limited. We will use a USB cable from a computer to connect to the board for monitoring and configuration purposes. The emphasis of this essay is personal computers, which will be further investigated.

III BACKGROUND

3.1 Wireless Sensor Network (WSN)

A WSN is a network autonomous sensors that can collaboratively monitor physical or environmental factors such as temperature, sound, vibration, pressure, motion, and pollution at various locations, wireless sensor networks are made up of spatially dispersed autonomous devices that use sensors. an assortment of wirelessly communicable sensor devices. Despite the fact that wireless sensors have limited energy, bandwidth, and computing resources. It can be integrated into the physical surroundings thanks to its tiny physical size. WSN uses sensor nodes with an integrated CPU to regulate and monitor the environment of a given space. They are connected to the Base Station, which acts as the central processing node for the WSN System.

3.2 Internet of Things (IoT)

The Internet of Things. It describes the connectivity of physical objects that are implanted with connectivity, software, and sensors that allow them to connect and exchange data. Examples of such products are appliances and cars. This technology makesit possible to gather and share data from a network of devices, opening the door for more automated and effective solutions.

IoT-based technologies will provide top-tier services and essentially alter how individuals go about living their daily lives. A few examples of categorical WSN protocols used in IoT to provide a connectivity medium between IoT sensor nodes and a central gateway include advances in medicine, power, gene therapies, agriculture, smart cities, and smart homes. WSN is simply one of the many tech stacks that make up the Internet of Things.

3.2.1Sensors

In a WSN, sensors are utilised to both collect data and capture ambient variables. Electrical signals are created from sensorsignals. The B model includes options for Power over Ethernet, USB boot, and network boot. The Raspberry Pi board is the newest product in the well-known Raspberry Pi range of computers .It delivers revolutionary improvements in connectivity, memory, multimedia capabilities, and CPU speed. This device was a significant advancement in technology that made computer learning so simple that anyone could get started with it with little effort.

3.2.2Pi Camera

A lightweight, portable camera that supports Raspberry Pi is called the Pi camera module. It uses the MIPI camera serial interface standard to talk to the Raspberry Pi. It is typically employed in surveillance operations and image processing. Regular USB webcams that are linked to computers can also be used with the Pi.

3.3 Deep Learning

Using Deep Learning creates the two matrices, the first of which is the kernel, or set of learnable parameters, and the second of which is the limited receptive field. The kernel is deeper yet smaller in space than an image. A particular level of complexity has been achieved in the neural network (having multiple hiddenlayers in between input and output layers). They have the abilityto process and model non-linear relationships. It is highly reliant on high-end machines and operates with large datasets. Images are automatically processed to extract pertinent features. It is a comprehensive learning procedure. The ability to train effective models utilizing vast amounts of data is one of deep learning's main advantages. Then, these models can be utilized to carry out difficult tasks like understanding spoken language or identifying objects in photos. Due to the fact that CNNs were created specifically for processing picture input, they are more efficient than other forms of neural networks in this regard. The pooling layer then condenses these features into a more manageable set of parameters. The convolutional layer extracts features from the input data. This improves the network's effectiveness and learning potential. Additionally, the fully linked layer has the capacity to discover the connections between these properties, allowing the network to generate insightful outputs.

3.2.1 CNN

CNN is a special type of multi-layered neural network is knownas convolutional neural network. It analyses data that is laid out in a grid and then isolates key elements. A significant advantage of using CNNs is that little image pre-processing is required. Images can be appropriately identified by reducing them to theiressential components using convolutions and pooling. Convolutions will be able to take care of a lot of the hidden layerfinding for you, so you won't need as many hidden layers as youmay think. whose job it is to receive the image data. The input data are combined in the next layer, the convolutional layer. The pooling layer, which pools the input data, is the layer that comesafter this one. The layer below is the A convolutional neural network consists of an input layer, hidden layers, and an output layer. Hidden layers are any middle layers in a feed forward neural network that have their inputs and outputs hidden by the activation function and final convolution. Convolutional layers are found in a convolutional neural network's hidden layers.

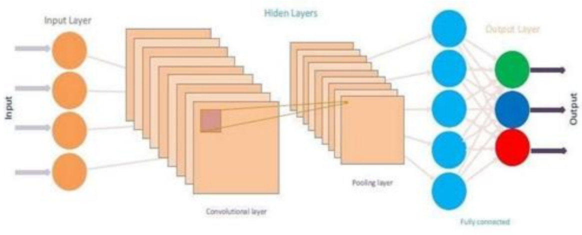

Figure 1: CNN layers architecture

3.2.2ResNet-50

A CNN with 50 layers deep is called ResNet-50. The network was trained using over a million images from the ImageNet database. The network that has been trained can categorize photos into 1000 different object categories, including keyboard, computer, pen etc.

IV METHODOLOGY

The proposed system can be installed in forests that frequently experience forest fires because it not only detects and confirms the presence of fire, but also forecasts its likelihood. A sizable number of nodes are installed to monitor environmental parameters over an entire forest region. When a fire is confirmed,it sends a message to the closest node so that the appropriate authorities can take action. Monitoring of temperature and humidity.

The two main elements that best reflect the characteristics of the forest's ecosystem prior to an early forest fire are temperature and humidity, as was previously mentioned. Initially, sensors are used to collect temperature and humidity data in order to monitor temperature and humidity. The DHT11 temperature and humidity sensor is linked to the Arduino Uno's analogue pins and has a calibrated digital output. Temperature is expressed in degrees Celsius, and relative humidity is used to express humidity (RH). The ratio between the amount of water vapor and its saturation point is known as the relative humidity. While fire creates rising temperatures as well as dry, smoky air, temperature and humiditytypically have an inverse relationship.

The Sensor are sent to confirm the fire's presence after the appropriate environmental conditions for fire ignition are discovered. PI cameras capture the images with using the CNN model, which detects the fire accurately, is used to verify the presence of fire.

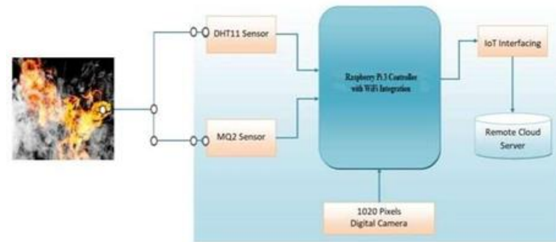

Fig 2 Forest Fire Monitoring System

The Fig 2 shows the overview of the humidity and temperature sensor is the DHT11. It has the ability to feel the air around it. The MQ series petrol sensor is the MQ2 sensor. It is a very accurate gas sensor. It is connected to an IoT interface for proper alert and communication functions. It has a link to the distant cloud server. It has a 1020pixel digital camera built in.

The Raspberry Pi controller has identified and reported the temperature, humidity, and surrounding smoke presence based on these sensors. It gathers and preserves the data about the forest that the remote cloud server environment receives from the sensor unit. The Raspberry Pi microcontroller includes builtin WiFi foracquiring internet signals and acts as a permanent bridge for remote data upkeep between the sensor unit and the server end.

V RESULTS

Two analytical methodologies are used for the data collecting forthe prediction of forest fires: threshold ratio analysis and analysis using a deep learning algorithm Data were gathered through the creation of multiple controlled fire scenarios in order to conduct these analytical methods. To capture the yearly fluctuations in the natural environment, data collection was done in several climatezones during all hours. The system monitors environmental factors such as temperature, relative humidity, light intensity, and CO level under a variety of climatic conditions. Within the sensor node, a ratio is continuously determined by reading each parameter from the corresponding sensors. The forest authorities will get to know the results through buzzers which rings when the sensors predicts whether it is fire or smoke.

VI CONCLUSION AND FUTURE WORK

This system successfully detects the presence of fire in forestarea. Using the CNN algorithm, it executes faster. It helps to find out the fire in starting stage. It results in better accuracy. Here, analysis is done on sensors, Pi camera, and raspberry pito get a more accurate result with the least amount of latency.This system focuses on observing the forests without steady human activities. For the safety and protection of the public as well as the environment, various fire detection methods have been recommended. We have provided a method of early detection of forest fires in this work to reduce the harm caused by forest fires and to manage their origin and spread. Three steps make up this approach: Calculate the forest's overall risk level, evaluate and foresee the presence or absence of fires in various locations, and notify the required first responders to contain the fires before they spread.

In the future, we can add a wind sensor to the system to help forecast the spread of a fire's direction and speed. in addition with this, we may put in place a system of automatic fire extinguishers. When a fire is detected, a sensor immediately activates the extinguisher. The nodes can be upgraded with a GPS module to determine the precise location of fire or smoke. The data can be transferred to cloud databases for archival and forecasting reasons by incorporating IOT. In addition to these, numerous additional sensors can be added based on user needs.

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