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IoT Based Forest Fire Detection System using Raspberry PI and GSM

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ABSTRACT: Forest fire causes greater havoc to forests and endangers wildlife. In this paper, an intelligent early warning fire detection system based on Image processing on IOT platform was proposed. A real time Flame detection algorithm that differentiates fire and fire colored objects is used to detect the true fire incident. Raspberry pi Microcontroller based IOT platform detects the forest fire as early as possible and takes speedy action before the fire spreads over large area. GSM modem connected with Raspberry Pi alerts the forest monitoring control room.

KEYWORDS: Raspberry Pi, IoT, GSM, Fire detection

I. INTRODUCTION

Nearly 30\% of world's land area has been covered by forest which accounts for nearly four billion hectares. Due to the dense nature of forest, unseen condition fire can spread over large area rapidly spoils the entire ecological system and endangers wild animal. This fire causes greater havoc in the environment. Recently forest fire occurs frequently due to the drought conditions. Fire in the world is increasing in recent times. This fire in the forests, farmlands and industries are owed to either natural or man-made disasters Forest fires results from natural causes such as lightening or manmade causes such as burning of unwanted materials results in a slow combustion of saw dust and leaves.

Every year the occurrence of forest fire has been increased enormously causes greater destruction to floras and faunas. Forest fire monitoring and detection system plays a significant role in preserving natural resources and safe guards humans. This attracted so many researchers to develop a significant solution to this problem. In order to sense fire at beginning and for early alarm automatic fire detection system has been proposed. But these techniques detects the fire at the scenario that it has spreader over vast area makes it difficult to control and extinguish the fire completely. The outcome of such a scenario destructs the environment and atmosphere causes irremediable damage to the ecology. Further it has a negative impact on the pattern changes in weather and global warming. It is critical to perceive the fire and its location quickly and also alerting the fire units.

According to National Institute of Space Research (INPE) 76,000 fires were happened in Brazilian Amazon. During January-October 2019 nearly 906,000 hectares of land were burnt completely. Destruction had occurred within short interval of time. Due to the feeding of fuel by ignitable materials, the fire at the central spot has increased drastically and spreads faster over large areas. Therefore timely detection of forest fire is necessary before the fire spreads over large area. A cost effective fire fighting and monitoring system is essential. Uncontrolled blazes occurred by weather, wind, and dry underbrush, can burn acres of land and consume everything in their paths which cause significant damage to natural and human resource. The objective of this work is to design a IoT based system that can detect the fire as early as possible before the fire spread over the large area and to prevent poaching.

IoT describes a system that uses wireless and wired Internet connections to interconnect different things in the physical world together with the sensors through the internet in which things in the physical world and sensors are connected to the Internet. Diverse local area networks like RFID, NFC, Wi-Fi, Bluetooth, and Zigbee can be exploited by these sensors. Also sensors can be interconnected to GSM, GPRS, 3G, and LTE wide area networks. The Internet of Things will connect all physical objects with the living things. The industrial equipment was interconnected with the internet of things in the earlier version. Now we can interconnect inanimate and living things with the help of IOT.Today, the vision of IoT vision has stretched that it has connected daily objects with industrial equipment. Location, vibration, motion and temperature conditions are monitored by sensors. In IoT, understand the output signal from the sensors. Since the mobile networks supports the persistentmconnection of smart devices better quality of service offered to the customers will be achieved by IOT.

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In this project, IOT based early warning fire detection framework senses the fire as quickly as possible and save valuable lives. Detection of fire based on color information results in false prediction. Here flame and flame colored objects were distinguished based on color and motion features. Raspberry Pi is used because of its high processing speed at low cost. Several sensors are used to collect the data and these data's were transferred to Raspberry Pi. GSM module alerts the fire monitoring station through SMS.

II. LITERATURE SURVEY

In this IoT based forest fire detection system using raspberry PI and GSM fire detection framework senses the fire as quickly as possible and save valuable lives. Detection of fire based on color information results in false prediction. Here flame and flame colored objects were distinguished based on color and motion features. Raspberry Pi is used because of its high processing speed at low cost. Several sensors are used to collect the data and these data's were transferred to Raspberry Pi. GSM module alerts the fire monitoring station through SMS [1]. In this method the hardware kit with temperature and humidity sensor is connected to the PC and it is deployed in many places in the forest area. The PC is connected with the Internet. The details collected using sensor is uploading with the fixed interval time. Then this data is uploaded to the cloud application. If the forest temperature is increased abnormally this will detect send notification to the forest authorities then the fire alarm will rung .It can also predict the fire that will be occur in future by using machine learning . This is done by using KNN algorithm. This can be used in all kind of forest and considering the effectiveness of the sensors it be also used in industrial areas [2].

Designed and implemented a fire detection system for vehicle using fuzzy logic. They used temperature, flame and smoke sensors for sensing fire. The system also can extinguish fire in 20 seconds and they used the air-conditioning system for extinguishing fire [3].

A fire alarming system based on video processing propounded. They used smoke color and spreading characteristics of smoke to detect possible fire outbreak. But processing the images is time consuming and needs sophisticated resources. In case of a garment factory, the fire should be detected as soon possible because the garments are very much susceptible to fire [4]. Presented a fire monitoring system that detects fire by the smoke that has generated by the fire. Camera is used to capture the fire image when a fire incident happens. The system remotely sends the image of the fired room on the web page and alerts the firefighter through SMS [5]. Temperature, flame and smoke sensors are used to sense fire. In this system air-conditioning system is used for extinguishing fire within 20 seconds when fire occurs [6].

A novel method to identify the flame is proposed. The pixels in the Flame calculated using Hue Intensity Saturation color model.HSI rules were used for segmenting fire regions. Fire aliases can be avoided by seperating the pixels that have low intensity and low saturation in segmented fire regions. Degrees of fire flames have been measured by binary counter images results in false positive and false negatives. This method detects fire flames from test videos within a second [7]. Presented a system using Artificial Neural Intelligence to recognize the forest fire.RGB images are transformed to XYZ color space and anisotropic diffusion is used to identify fire zones. The pixel values of color space in segmented fire regions are using radial basis function neural network [8].

In this paper, they have built fire detector using Arduino which is interfaced with a temperature sensor, a smoke sensor and buzzer. With the help of IoT technology, they have tried to make it smarter by connecting the whole monitoring process to the webpage created by the PHP tool and controlled by the Arduino programming. In this paper the system is designed and evaluated for its effectiveness as well as scalability due to the improvement of sensor technology. In this paper, the latest technology can help to reduce catastrophic accidents caused due to fire. With the improvement of IoT sensor technology, the system is more efficient and useful [9]. The objective of this project was to detect the forest fire as early as possible by measuring the level of temperature and CO2 level. They have used Temperature and smoke sensor to detect the ignition alarming temperature and the level of carbon dioxide gas (CO2) [10].

III. PROPOSED SYSTEM

In this project, we designed an IOT Infrastructure for forest fire detection system to help detect fire as soon as possible, before the fire spread over the large area. The block diagram of the paper (shown in fig 1) is quite simple which has a few basic components but it is quite efficient in producing the result as required. Solar power that is the light energy, so solar pannel it collects the light energy from the sun.solar pannel is 180W and next passed to the converter.

Solar charge controller is 12-24V 10A Digital PWM Solar Charge Controller for the lead-acid batteries connected to a solar power system. When connected to the battery, this charge controller automatically detects the battery voltage

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from 12V-24V. This charge controller has some advanced features like built-in short circuit protection, open-circuit protection, reverse voltage protection, overload protection, etc which makes it ideal for grid power systems. The DC-DC Step-Down Buck Converter Power Supply Module drives a load up to 5A with excellent line and load regulation. Here the input to converter from charge controller is 12V but and output voltage which is 5V 5A.

Battery accepts the AC supply from converter and convert the AC into 12V AC. The Raspberry Pi 3 Model B is the third generation Raspberry Pi and it is a powerful credit-card sized single board computer which consist of ARM CortexA53 1.4GHz,64bit quad-core ARMv8 CPU can be used for many applications and supersedes the original Raspberry Pi Model B+. Raspberry pi has a 1GB memory and additional memory is provided by using a micro SD card. It has 4 USB ports, 40 GPIO pins and a Full HDMI port is used to connect to a display. GSM modem looks like a mobile phone using the transmission and reception pins, gsm modem can receive and send the message. Gsm modem could be interfaced with the pc or microcontroller. Gsm modem detects the signals from all the sensors integrated with an RPI, so that if there is any sudden increase in value of sensor it will send alert notification to the forest department..

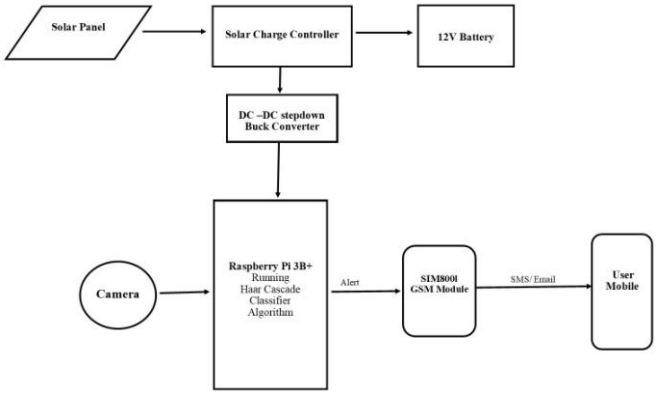

Fig 1 *block diagram of proposed system*

Haar Cascade is a machine learning object detection algorithm used to identify objects in an image or video and based on the concept of features proposed by Paul Viola and Michael Jones in their paper "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001.It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images and used to detect objects in other images. The algorithm has four stages:

- Haar Feature Selection: A Haar feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums.
- Creating Integral Images: Integral Images are used to make feature selection super fast. Among all these features we calculated, most of them are irrelevant. Therefore at this stage irrevelent images and background is deleted.
- Adaboost Training: Selection of best feature among hundreds and thousands of features is accomplished using a concept called Adaboost which both selects the best features and trains the classifiers that use them. This algorithm constructs a “strong” classifier as a linear combination of weighted simple “weak” classifiers
- Cascading Classifiers

The process is as follows.

- During the detection phase, a window of the target size is moved over the input image, and for each subsection of the image and Haar features are calculated.
- This difference is then compared to a learned threshold that separates non-objects from objects.
- Because each Haar feature is only a "weak classifier" (its detection quality is slightly better than random guessing) a large number of Haar features are necessary to describe an object with sufficient accuracy and are therefore organized into cascade classifiers to form a strong classifier.

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The cascade classifier consists of a collection of stages, where

- Each stage is an ensemble of weak learners. They are classifiers called decision stumps.
- Each stage is trained using a technique called boosting. Boosting provides the ability to train a highly accurate classifier by taking a weighted average of the decisions made by the weak learners.
- Each stage of the classifier labels the region defined by the current location of the sliding window as either positive or negative.
- Positive indicates that an object was found and negative indicates no objects were found.
  - If the label is negative, the classification of this region is complete, and the detector slides the window to the next location.
  - If the label is positive, the classifier passes the region to the next stage. The detector reports an object found at the current window location when the final stage classifies the region as positive.
- The stages are designed to reject negative samples as fast as possible. The assumption is that the vast majority of windows do not contain the object of interest. Conversely, true positives are rare and worth taking the time to verify.
  - A true positive occurs when a positive sample is correctly classified.
  - A false positive occurs when a negative sample is mistakenly classified as positive.
  - A false negative occurs when a positive sample is mistakenly classified as negative.
- To work well, each stage in the cascade must have a low false negative rate. If a stage incorrectly labels an object as negative, the classification stops, and you cannot correct the mistake.

IV. RESULT

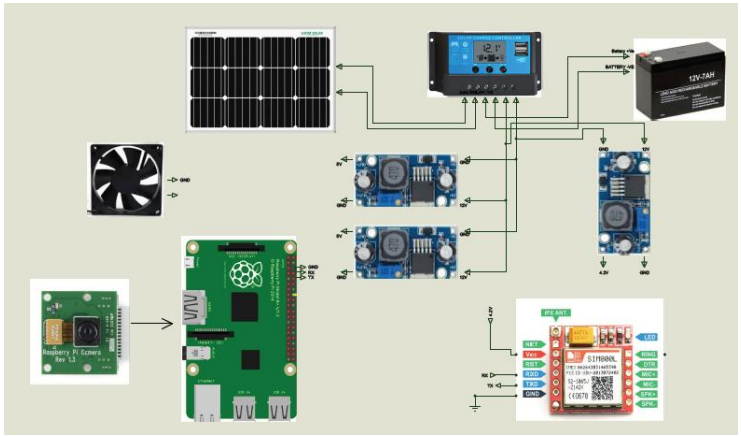

Fig.3 Circuit Diagram

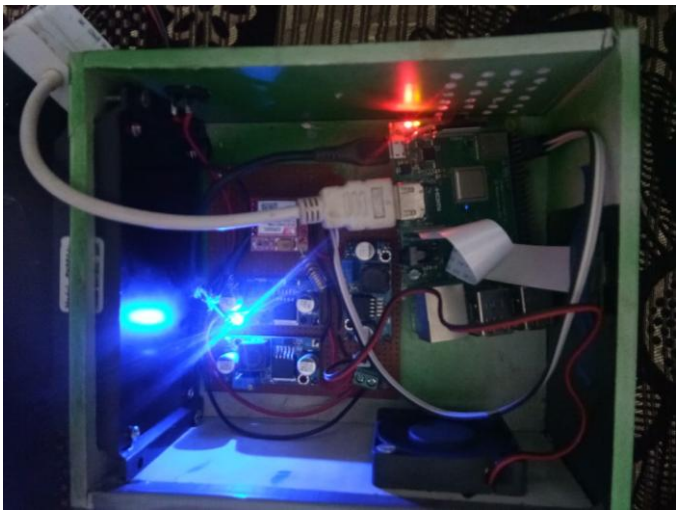

Fig.4 Hardware Setup

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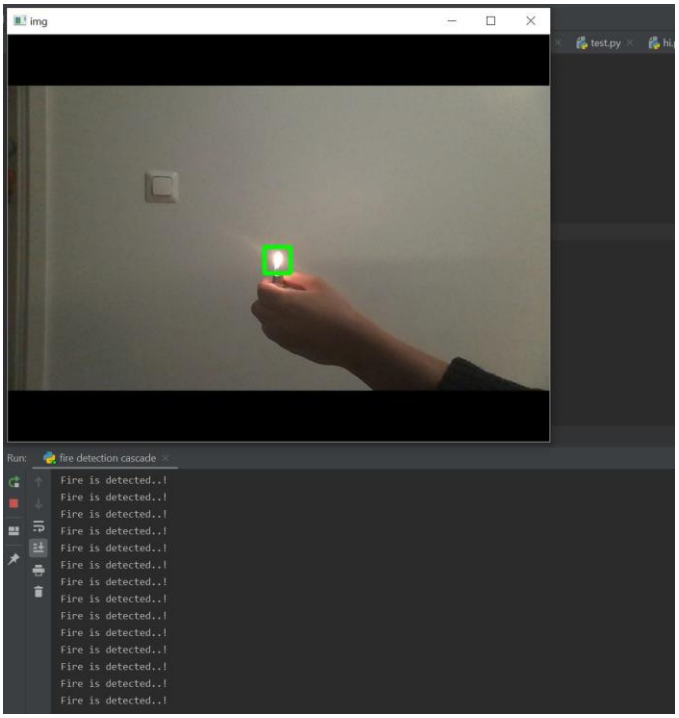

Fig.5. Fire detected

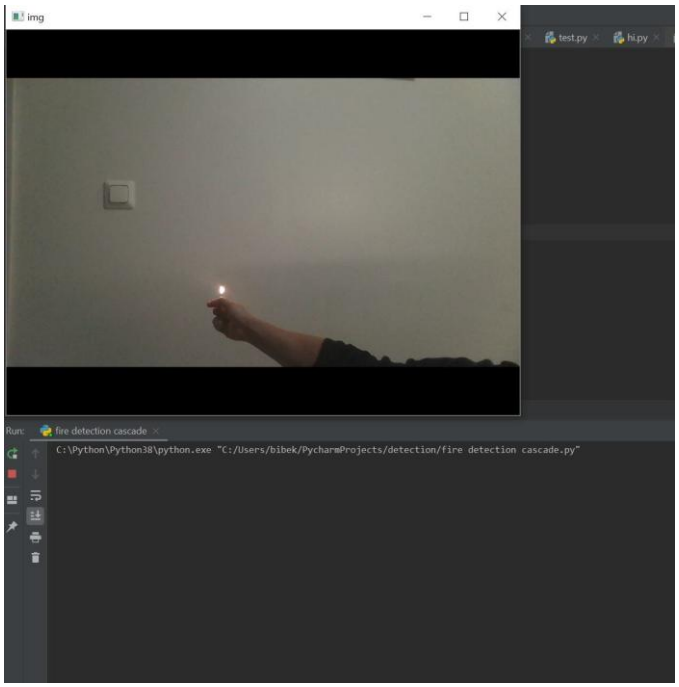

Fig.6. Fire not detected

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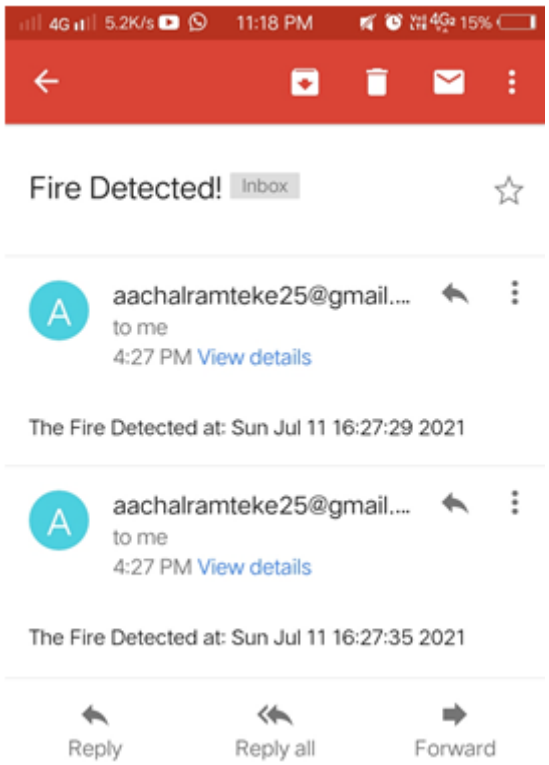

Fig.6. Fire detected alert on email.

V. CONCLUSION

In this paper early warning and fire detection system for forest fire on IoT platform is presented to detect the fire at the early stage and prototype was developed. Furthermore the proposed platform also provides a very prompt and cheaper embedded system to detect true incident of fire.GSM module automatically sends SMS to alert the control room. In future work encryption of data for security purpose should be added. The system can be modified to process the information and send mail using Wi-Fi module to the nearby fire service station with the location of the fire using GPS module. Several types of sensors can be employed in the system like Humidity sensor, soil moisture sensor, Temperature sensor, LDR sensor, Accelerometer sensor, Ultrasonic Range sensor. Early detection and prediction will lower the count of forest fires in the entire world and save our planet Earth.

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