# EFFECTIVE FOREST FIRE DETECTION SYSTEM USING VISUAL IMAGES AND UNMANNED AERIAL VEHICLE

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## ABSTRACT

*Wildfire has caused irreparable damages to local ecosystems as a natural disaster. Sudden, uncontrolled wildfires can pose a true threat to people's lives. The US National Fire Center (NIFC) data show that the burned region in the United States nearly exploded from 1990 to 2015. The total burned area reaches 6 million hectares worldwide and wildfires occur 220,000 times each year. Efficient and early intervention of wildfire is therefore extremely important. Forest fire regulation is a very important issue in which UAVs can play a major role. Forest fire monitoring is an extremely important issue. This paper discusses the application of UAVs as instruments for forest fire tracking. Fire surveillance is characterized as a real-time fire front type approximation and other possible fire propagation parameters. This paper explains how data can be gathered automatically by UAV using infrared and visual cameras on-board. In general, helicopter-like UAVs are extremely useful because they can be changed to viewpoints. It also shows how many UAVs can cooperate in the process of fire control, which enables mostly covered fires and complementary fire visions. This paper presents the findings of experiments involving a three UAV fleet which assume actual forest fire control under near-operative conditions. The UAV flies and receives aerial data, which helps users to quickly control the fire point's number and position. Software control includes features such as fire origin module, the fire location module, the fire range evaluation system, and the report development module. Cooperation among various modules improves the efficiency of operation and detection of the system.*

**Keyword: -** *Unmanned Aerial Vehicle (UAV), Prediction model Transmission Control Protocol (TCP), Wild fire, Visual Images*

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## 1. INTRODUCTION

Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work.

Through computer-based remote sensing technologies, unmanned aerial vehicles (UAVs) gradually become an appealing and practical option. In addition to being swift and compact, UAVs can continually monitor and locate forest fires at comparably low costs [1]. The sensors have been used extensively because of their cheap and easy use, but some inherent shortcomings are difficult to overcome these sensors. The next thing to do is to mount these sensors close to the fire and easily damage them at high temperatures. These are also confined to small or indoor settings. In recent years the brand new smoke detection system based on video surveillance, which has a remarkable advantage over existing sensor-based systems, has been used to address the aforementioned deficiencies of the traditional smoke detection system [2].

Effective fire control was always a major challenge to safeguard forestry, especially in vast forests, since the monitoring caused significant economic damage over time. Therefore "Early detection and Early Rescue" is the goal of forest fire prevention and control for the forestry community. Fire detection is critical to people's safety. A variety of fire detection systems were developed in order to minimize fire damage. Different techniques may be searched. Most are sensors based and are typically often confined indoors. The presence of smoke-producing particles and ionizing gas that is close to the fire is known. Model and develop visually efficient strategies for forest fire detection [3]. The main objective is i) to design and develop effective forest fire detection techniques based on visual images.(ii) Development and design of reliable forest fire warning technologies focused on IR. (iii) Investigate fusal information plans / strategies for enhancing reliability (including graphical and IR images). (iv) Design and construction of smoke detection systems for early fire detection to further enhance fire detection performance and power, saving time to fight fire and reducing property losses [4].

In order to find wilderness training, we suggested using a deep learning approach. A dense CNN six layer is included in the model proposed. The model based on transition practice did not yield good results since it only freezed 5 out of 19 layers. The database of images from various small datasets, scrapers and other search engines has been compiled, cleaned up, pre-processed [5].

## 2. LITERATURE REVIEW

The work that has already been completed is the most important thing to start a research project. More often than not, most of the engineers reinvent the wheel [6]. Learning about other people's work through dissertations and research papers gives you a clear understanding of what has been researched, what is still needed and the potential of improvements on these particular topics.

Forest is therefore recognized as one of the most significant and invaluable resources as a defender of the Earth's environmental harmony. Nonetheless, forest fire rarely occurs due to certain uncontrolled human behavior or peculiar natural factors of social activity. One of the most serious disasters is forest fire [7].

Simon Philipp Hohberg [8] demonstrated that CNNs are a very promising way to improve the camera-based system for automated camera detection by detecting wildfire smoke. Trained models can detect 88% of the smoke-induced regions in an FPR of about 1%. Almost 60% of all smoke sequences are identified instead of zones, whereas some 23% contain false alarms Sequences.

It is crucial to understand the effect of fire on the mantle, stems and treetops of the earth and the detection of underlying fire by forest fire. The sensor network should cover large areas and disperse high volumes of sensor nodes that require cost-effective sensors [9]. Viable sensitive video cameras focused on the recognition of fire and smoke during the day.

## 3. DESIGN AND IMPLEMENTATION

The aim of the research was to use Unmanned Air Vehicles (UAV) in order that a forest fire surveillance system would be established in real time. A mini processor (Raspberry Pi) is fitted with the UAV's cameras. Different kinds of sensors are employed in this system analysis. The main and major purpose of sensing the forest temperature is performed by temperature sensor and this sensor uses the Non-Contact Infra-Red Sensor [10]. This Non-Contact Infra-Red Sensor is works based on the principle of usual thermal camera, with the pixel resolution of $2 \times 2$ and the five degrees of field view.

A barometer, a GPS (Global Positioning Sensor) and a compass have an inertial measurement unit, which is also available. GPS and compass are used or the purpose of navigation system. Air pressure is determined by the barometer on the UAV height. IMU is made up of sensors used to determine the vehicle orientation of accelerometers and gyroscopes.

The RaspberryPi 3 gathers both the tempering sensor and the GPS in addition to its mini-processor. For communicating between UAV and ground stations, a 433MHz telemetry frequency interface is used. The Raspberry Pi 3 transmits data remoately and in real time to the Web server. The transfer of data shall be based on the Transfer

Control Protocol (TCP) scheme [11]. A UAV fire detection system for forestry research indoors is intended to assess the functionality of the UAV approach to forest fire detection in practical situations.

This proposed system consists of six modules:

i. Data Receiving Module
ii. Video Play Module
iii. The Fire Detection Module
iv. The Fire Source Location and Analysis Module
v. The GIS Display Module
vi. Report Generation Module

Theoretically, a ground-station command is used to search and track suspicious forest fires with a single, on-board sensor UAV. Once the blaze is detected, it will be sent to the field and firefighters ' mobile devices an explosive warning with possible fire photos to decide whether the fire occurs. Since the indoor GPS-signal is not accessible, a network of cameras will provide UAV 3D position data as a GPS. An estimate of the sensor parameter can be used every time before you take a picture of the aerial UAV [12].

The primary role of the base station control software is to provide the necessary functionality to manually perform remotely controlled flights using the aforementioned gamepad or to autonomously control them through a standalone flight algorithm intended for this project. The controller program provides an interface that helps you to set the requisite flight parameters and schedule future flights without attaching to the UAV. In addition, the files can also be exported to allow them to be used as flight profiles, selectable according to the mode of flight or the particular multi rotor configuration [13].

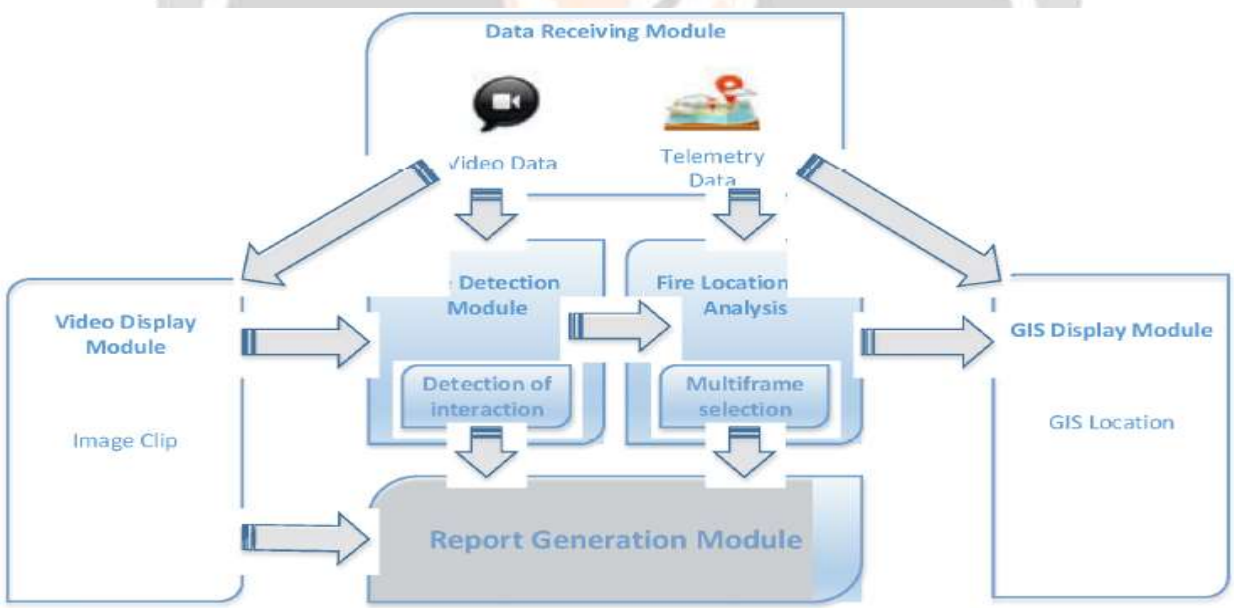


**Fig- 1:** System Architecture

### i. Data Receiving Module

The raw telemetry image information is continuously received from a fixed station via the TCP\IP protocol and then stored on a local disk in the MJ2 K format including infrared and visible light data.

**ii. Video Play Module**

This module uses 8 threads to change the configuration of the play area in the video playback system. Next, the frame for the modern mj2k video format is decoded and then transformed to an object of the same sizes and the Fire detection system is called, if it occurs it orbits the region of origin and eventually pasts into the video refresh zone. Both threads of the video update region are synchronized [14].

**iii. The Fire Detection Module**

The Fire detection system has been called previously, and based on the user interaction the operating mode of the Fire detection module can be split into automatic detection and the synthetic auxiliary detection. Automated detection mode detects the whole picture in the condition that the client does not circl the source field, segment and focus the edge of the alleged origin zone. Auxiliary identification is carried out by flame [15].

**iv. The Fire Source Location and Analysis Module**

Position and width of the fire source information are translated to latitude and longitude, scale and altitude information under the geodetic coordinates by finding and evaluating the fire origin unit. The module computes the pixel size of the target according to the location and height of aircraft telemetry data, translates the direction of the source of the fire into the geodetic synchronization and calls the orientation of the GIS display system to the device view [16].

The module also provides the frame selection function, length and latitude updates, altitude and other geographical information based on the user's successful frame verification.

**v. The GIS Display Module**

The GIS view system is implemented with technology displaying spatial information on the Earth satellite image and supplying the user with dragging, zooming and positioning and calculating [17]. The GIS module shows the fire location on the GIS screen in real time when the fire is detected, and the user can also control remote areas which are difficult to access because of the technology extending the viewpoint of the user.

**vi. Report Generation Module**

Depending on the location of the fire, the report generating module forms the fire monitoring report in detail and provides further information on the assessment: showing the geographical position of the fire, displaying in detail a fire zone; given the distance and longitude of the fire source, the fire zone, the length of the fire line, etc.,

**Fire State Detection Platform**

GIT indicates the fire position of the fire in the satellite map in the fire zone, real-time display at altitude, pitch angle and other remote sensing aircraft data as well as the latitude and longitude and other geographic information detected by the central station, performs UAV aerial image analysis pro fire detection, video area and report of the fire detection results [18]. In real-time video area it can monitor in real time a wide range of woods and found the impending forest fire quickly and accurately and help staff to end the secret risks. UAV Aerial Technology is going to grow in many fields in future, including agriculture and forestry, etc. The image processing technology based on UAV will significantly encourage the growth of these sectors and expand the scope of UAV industry [19].

**Eliminating image vibrations**

Taking stationary capability UAVs into account, inevitable control errors, turbulence and vibrations lead to camera position changes due to image movement This movement can have an impact on the algorithms listed above and should therefore be canceled. Electro-mechanical instruments can be used to remove vibrations, but typically are voluminous, expensive and residual to vibrate. Image processing strategies may be used for data-based photo motion calculation and cancelation [20].

The apparent motion between consecutive images can be measured. An algorithm matching method defines a sparse object movement area in the process. A limited field of motion is used to approximate the whole motion structure of the object. Eventually, both pixels are added to change the current image into a standard frame, removing the ambient distortion between the present and last images. Through the analysis of the fire front evolution in pixel coordinates, stabilized images can be obtained.

## 4. RESULTS AND DISCUSSIONS

The instrument described in the paper has been tested by a group of small UAV's. These fire control exercises were part of a more general fire fighting mission to demonstrate the effectiveness of a UAV team, planned in this type of scenario. The UAV images have been analyzed in the manner described in this article. The UAV stabilizes the images collected locally and processes the results obtaining a pixel co-ordinate approximation of the fireside position.

The system allows for the measurement to include a forecasting stage so that fire propagation models can be included. The spread of fire is affected by many aspects, including terrain slope, vegetation humidity content, weather conditions and air humidity. The paper is not directed at discussing these issues. The prediction model considered in this experiment is very simple, close to that of EMBYR and takes into consideration two separate relations: a time association and an interaction between cells. The main objective is to incorporate a buffer into the measuring process so that the flame does not "backward" through the places already visited. A space review is also carried out to ease the predicted devolution of fire fronts.

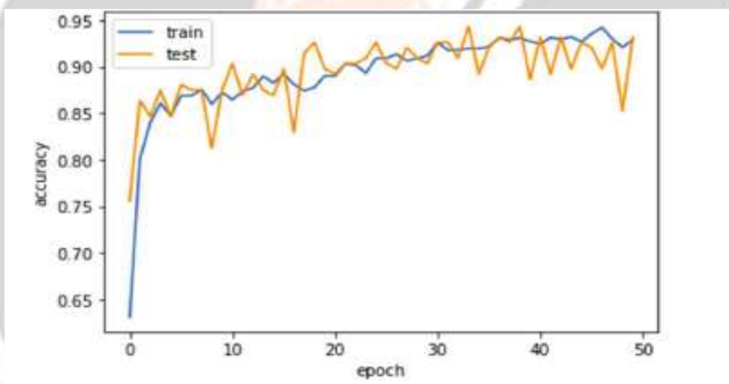


**Chart – 1:** Model Accuracy

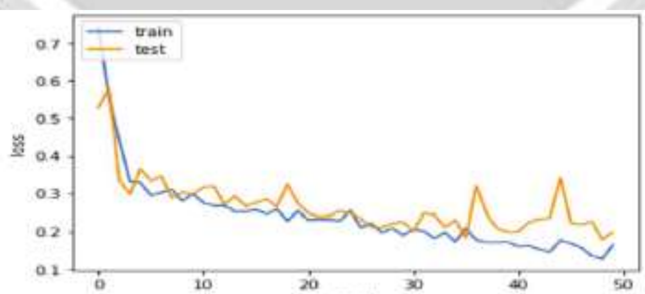


**Chart – 2:** Adam optimizer

In this chart 2 the ' Adam ' optimizer is fine, resulting in a final accurate test range of 93,18% and 92,88% precision in the training set and 0,18 loss for learning and 0,20 loss for testing. The UAV's detected hotspots coordinates will appear in Figure 5 above. The distance from the actual position of the fire point is approximately 1 meter. This remains in the GPS precise range since GPS is used with a precision of 2,5 metres.

The performance design for the regulation over any of the current stabilizers in the industry must be capable of transmitting this information via a set of outputs to the stabilizer as a radio receiver. Radio recipients use manufacturer-specific configuration to direct the transmission of data but retain a quality of connection by using 3 pin connectors for each network. The only exception is the Futaba manufacturer, with a proprietary protocol for the transmission of information through a single 3-pin connector from all radio channels. However, all controls comply with the above standard. To execute these tasks, we used a microcontroller for Raspberry PI 3.

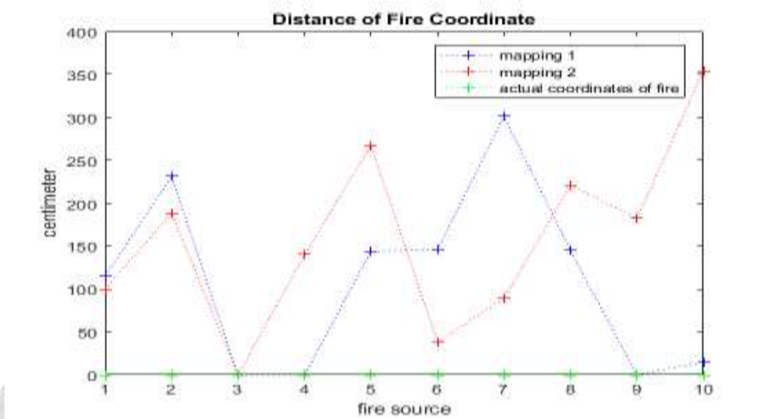


**Chart- 3:** Comparison of distance errors for mapping

In this analysis 10 hotspots were performed in an area of 40 m x 40 m with the experimental set-up. A mission plane decides the direction of the flight to fly autonomously the UAV. The routes of the aircraft, which have a dia size of 0.4 meter and the height level of 0.5 meter.

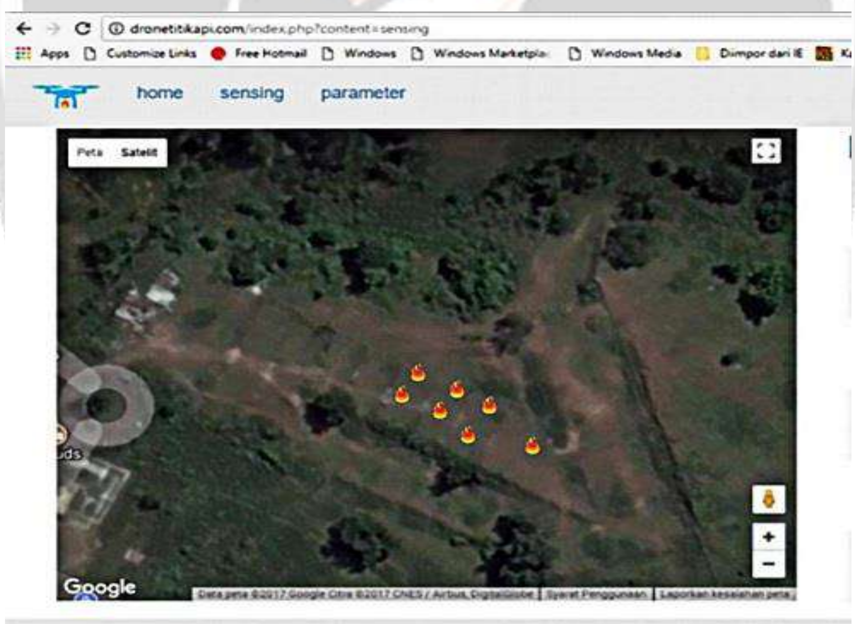


**Fig - 2:** Real Time Website Visualization

The real-time view of the UAV location on the website is shown in Fig 2 above. When the drone detects the temperature in a certain coordinate that exceeds the limit, an indicator is shown on the website.

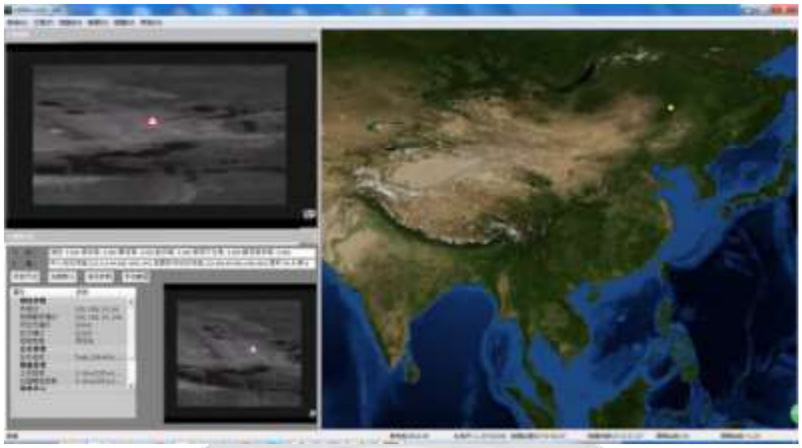

**Fig -3:** Fire Detection Platform

In the Fire Operations Area, the central station and the moving station will be detected in real time as a display altitude, pitch angle and other remote sensors for aircraft and latitude and longitude and other geoponic information; in the Fire Operations Area the central station and moving station will see the results of the Fire detection. The geo positioning system stores the specifics of the corner co-ordinates in image metadata in a transparent way for the user without even the client understanding it as no outside files are used but as the metadata in the image are included.

**Fig- 4:** Forest Fire Original Image

**Fig- 5:** Color Detected Result

**Fig - 6:** Tracking Result

Fig 4, 5, 6 experimental results of the proposed fire detection method used to process a video from a real forestry fire scene. Colour-segmented screening and morphological tests of optical flow analysis shows that most non-fire artifacts, such as trees and smoke are exempted, whereas the remaining pixels which have been taken by color-based decisions are excluded. Regulations are known as a motion detection system following optical stream methods to further study as a candidate flame point. Specify the moving / stationary fire painted analogy, including smoke, building and wood tracks, can be identified by the moving area identification principle after further review of the segmentation effects through optical flow analysis and morphological operations. Eventually, fires are tracked completely using a blob counter through red rectangles.

**Fig -7:** Color Based Fire Segmentation

Various segmentation results can generally be obtained using different color models. Many existing light-based fire-detection systems, depending on this principle, use the RGB display template and merge it with HSI. Type RGB is most widely used because almost all of the cameras are available.

The fig 9 indicates that low temperature fires have high saturation colors while the colors that are low in saturation represent high temperature fires. The fire color is a lighter intensity than the fire color of no light source during the day or with the additional light source. Fire fires usually show reddish colors, varying from red to yellow during the burning process. The difference in fire color in color models can therefore be interpreted as a different red / yellow value.


**Fig -8:** When No Fire


**Fig -9:** Low Temperature Fire

## 5. CONCLUSION

Fire forest systems have been developed in real time with Unmanned Air Vehicle (UAV) and Drone. The surface temperatures are sensed by the drone at the distance of 20 meters above ground level. The drone flies constantly at 5 meters per second. The measured data on a forest fire information system website is send by drone to a web server for presentation. The data also indicate that hotspots in drone detection positions are approximately 1 m away from the current co-ordinates of the fire. The system also uses a GPS system in standard GPS with 2.5 m distance resolution. One of the future studies will be to minimize loss of data while transmitting drugs.

In addition, it is planned to raise the standard and render better annotations using computer graphics engines for the construction of artificial software for example. The experimental fire detection system on UAVs for forest fire monitoring in the real world is also being developed. Forest fire prediction the best choice is paired with sensitizations techniques and artificial vision in UAV.

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