Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 05, May -2018

FIRE IDENTIFICATION AND USER NOTIFICATION USING CLOUD COMPUTING AND INTERNET OF THINGS

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Abstract: *This paper deals with Fire detection using Image processing concepts and user notification based on Cloud Computing. It is a novel method towards fire and flame detection. It uses Image data captured by an ordinary camera monitoring an open scene, which combined with fire flicker and color clues to reach a final decision. HSI and RGB color models are considered for image processing. Based on these flame features, regions with fire-like colors are roughly separated from an image. Besides segmenting fire flame regions, background objects with similar fire colors or caused by color shift resulted from the reflection of fire flames are also separated from the image using the color masking technique.*

It includes an advanced end user notification system about the fire detected. This warns the concerned person and notifies him about the fire intensity, its area acquisition amongst the total area under surveillance and also the time. There is also an added feature to provide the address information about the fire location to the concerned person for easy and quick steps to be undertaken for cases of wild-fires in forests. This will help the concerned persons to take immediate actions. The SAP HANA like cloud platform will be used for the notification system. This will help faster end user notification and will consider latest technologies for its development. Hybrid Applications will also be developed on which the end user will be notified over his mobile handheld devices.

1. Introduction

Fire detection at an early stage is a positive means of fire control. At present fire is detected mainly through the smoke, temperature and light characteristics information. Conventional mechanisms such as temperature sensors, smoke sensors have weaknesses in the coverage area and response time in the detection of fire. These methods cannot play its role in the outdoor big space and harsh environments. Suppression efforts became difficult because of the fire which appeared already too large, so we need a mechanism with faster response time and can monitor a wide area.

Fire detection technology based on image processing mainly uses camera to uptake the image sequence. Fire is detected according to the characteristics of the flame image. The HSI model is considered to get the area of fire because it is how humans perceive the colors. Based on the various values of Hue, Saturation and Intensity, the fire flame area is detected. The Area of fire after detection is cross examined using methods like color masking. So, it results into appropriate fire area detection.

The Project considers Fire detection on Images input to the system and also the Video inputs. Also, real time image capture and processing is also considered. When Fire is detected in either of the cases, then the end user or any concerned person is notified of the detected fire with the Fire Image and details.

For the Notification the concepts of Cloud computing and Internet of things are considered. The data is sent out to Cloud and this data is later pushed forward to the application developed. The Fire Image along with the Location details and the Time details are sent over to the application and by which the concerned person is notified. The fire details and the GPS location details are also sent over to the Concerned person through mail applications. The application gives the time and location details.

2. Literature Survey

As can be seen from the referenced papers, the Analysis of fire flame and its detection can be undertaken from the knowledge of the flame color. This is clearly explained in the reference papers. Also, various methods and algorithms vary to give the Fire detection outcomes.

The reference paper [1] titled "Fire Detection Based on Flame Color and Area", focuses on accurate threshold based color model analysis of the input image. The whole focus is color model based threshold values that will be used for accurate output. The reference paper [2] titled "Fire Alarm System Based-on Video Processing", focuses on the fire flame movement detection. It focuses on color model based fire area detection and later fire flame motion detection using wavelet analysis.

The reference paper [3] titled "Fire and flame detecting method based on video", focuses on fire area detection based on the HSI as well as RGB color model analysis. Later based on the compared value, fire area are detected. The reference paper [4] titled "A New Image-Based Real-Time Flame Detection Method Using Color Analysis", explains the fire region detection based on flame color features analyzed in HSI color model system. Based on these values, the fire regions are detected and to eliminate any color shifted regions from the image, color masking technique is used.

The paper also approaches on the flicker detection. The reference paper [5] titled "A Flame Detection Method Based on the Amount of Movement of the Flame Edge", explains a method to get hold on the proper information about the movement of the flame, which helps to get the accurate information on fire flame movement based on wavelet analysis.

Based on the literature survey, we conclude that the available methods of Fire detection will definitely help and assist in the development of the proposed system. But, there is no system considering all the features of the Fire detected. Thus, the proposed system considers all the merits of the above mentioned fire area detection. Also, no system proposed in the above papers has user notification action undertaken.

3. Problem Statement

The proposed methodology aims at development of a system which detects Fire using HSI and RGB color model based image processing and later intends to notify the concerned person with the fire detected information using HANA like platform based cloud computing, at the custom application developed. The location details along with time details are provided to the user.

4. Objectives & Scope

4.1.Objectives

1) To develop Fire area detection system using image processing.
2) To develop Fire detection system which avoids false Fire region detections and only actual fire region be considered.
3) To generate a valid notification if fire is detected.
4) To send the notification over to SAP HANA like cloud.
5) To develop User friendly application.
6) To send the data from HANA like cloud to user application.

4.2.Scope:

Scope of the proposed work can be outlined as below:

1. Digital Images with optimum quality captured using digital camera are expected as input.
2. The digital Image requirement is about 2048*1536 pixel for optimum performance.
3. MATLAB like software is used to carry out the processing on the input image.
4. For the processed data about the Fire flame existence, the networking part will be undertaken using the HANA like platform as a cloud to store the data.
5. The Applications which the user will use to get the relevant data about the Fire Flame detected is developed using open source software.

5. Methodology

❖ **Bloack Diagram and Execution :**

Below is the block diagram for the Fire detection system.

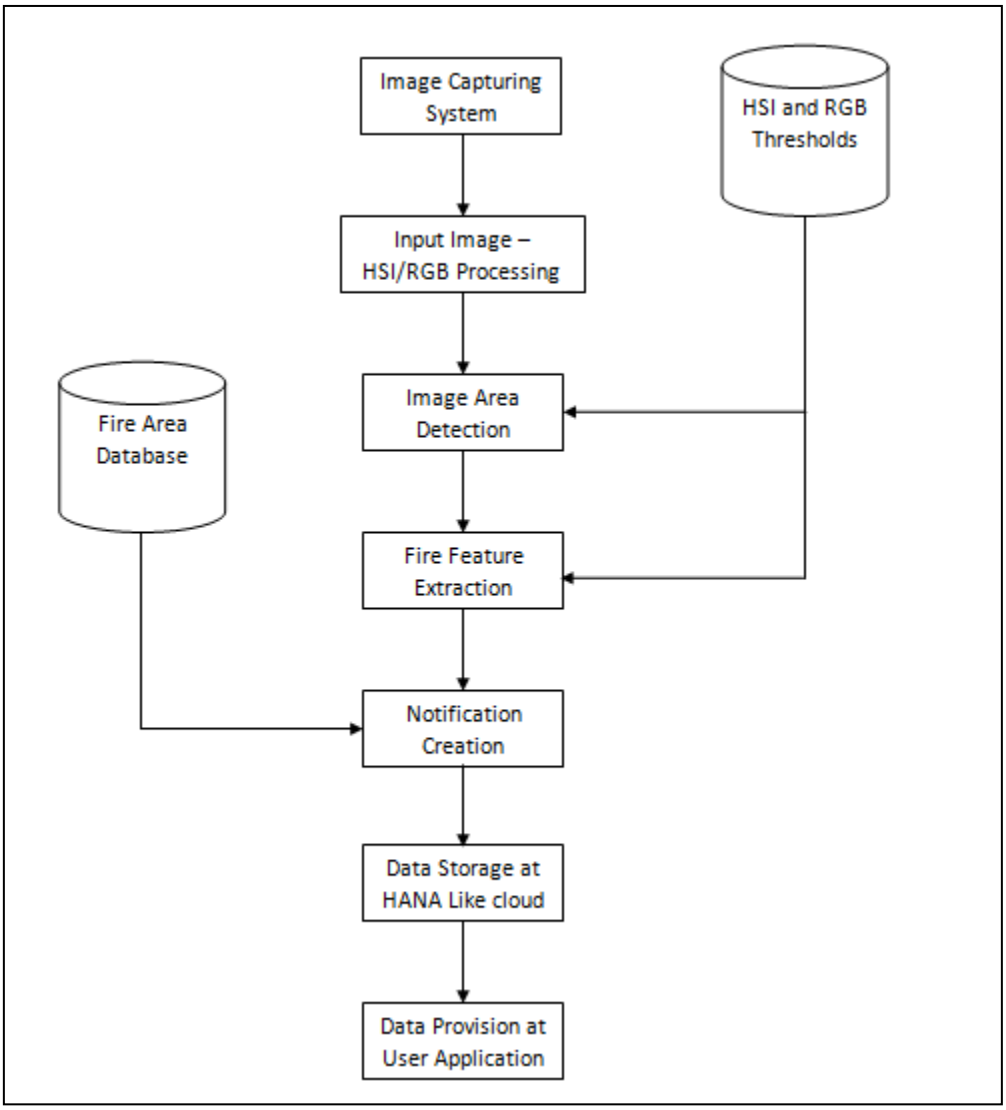


Figure 1: Block Diagram for the system

The block diagram consists of total 9 blocks.

Block 1: Image Capturing System - The input data is a digital image with optimum quality. Hence, the input data capturing system will be digital camera.

Block 2: Input Image HIS/ RGB processing - This is for the Color based analysis of the input image. The Processing will include of image processing considering it in HSI color model and RGB color model.

Block 3: Image area detection - Based on the color information in HSI and RGB color model, the Image area which match the threshold values will be treated as the Fire regions.

Block 4: HIS / RGB Thresholds - This is the HSI and RGB threshold value database. These values are very important, because based on the accuracy of these values the exact fire area can be detected. The values for these database are actually found from pre-analysis of series of fire regions.

Block 5: Fire feature extraction - This stage is executed after it is confirmed that there exists fire region in the input digital image. There are various features of the fire that exists. Some of the features that will be detected here are

1) The temperature detection of fire: The temperature detection of the fire is detected based on the color values of the pixels in the fire regions of the input image.
2) The fire flame motion detection: This feature helps to get the direction in which fire is spreading and the motion of flicker. The Fire motion related information is obtained based on the wavelet analysis of the successive input images.

Block 6: Notification creation - Based on the details of fire features fetched above and also the fire area detected, now notification data is prepared. This is the information which will be sent over to the concerned person.

Block 7: Fire Area database - This block holds the data relevant to the digital image capturing system. It holds address information relevant to the image capturing system which holds as an added information as a notification, which will be sent over to the concerned person.

Block 8: Data storage at HANA like Cloud - This block represents important stage which holds for the notification details to be passed over to HANA like cloud. This is a cloud platform based data storage. Thus which adds to scalable data handling. It also adds to data communication speed, hence this block represents important stage in the proposed system.

Block 9: Data provision at user application - It include the custom application development stage. Here, a user friendly application will be developed. The notification data available onto the HANA like cloud will be pushed onto the Application present at the handheld device present with the concerned user.

- **Flow Graph and Execution:**

Step 1: The first step in the project execution is the input image fetch. The input image fetched will be taken from the Digital camera. The Image will be kept in color mode itself. This will be the foundation stage, since its quality leads to the correct final conclusion of the Fire flame existence.

The region under consideration will not only be under the effect of fire, but there will be byproducts of Fire flame too. These byproducts will be factors like smoke. If the quality of the input image is good, then the smoke and other noise that effect the Fire flame detection process will be easily reduced and a proper fire flame detection be undertaken.

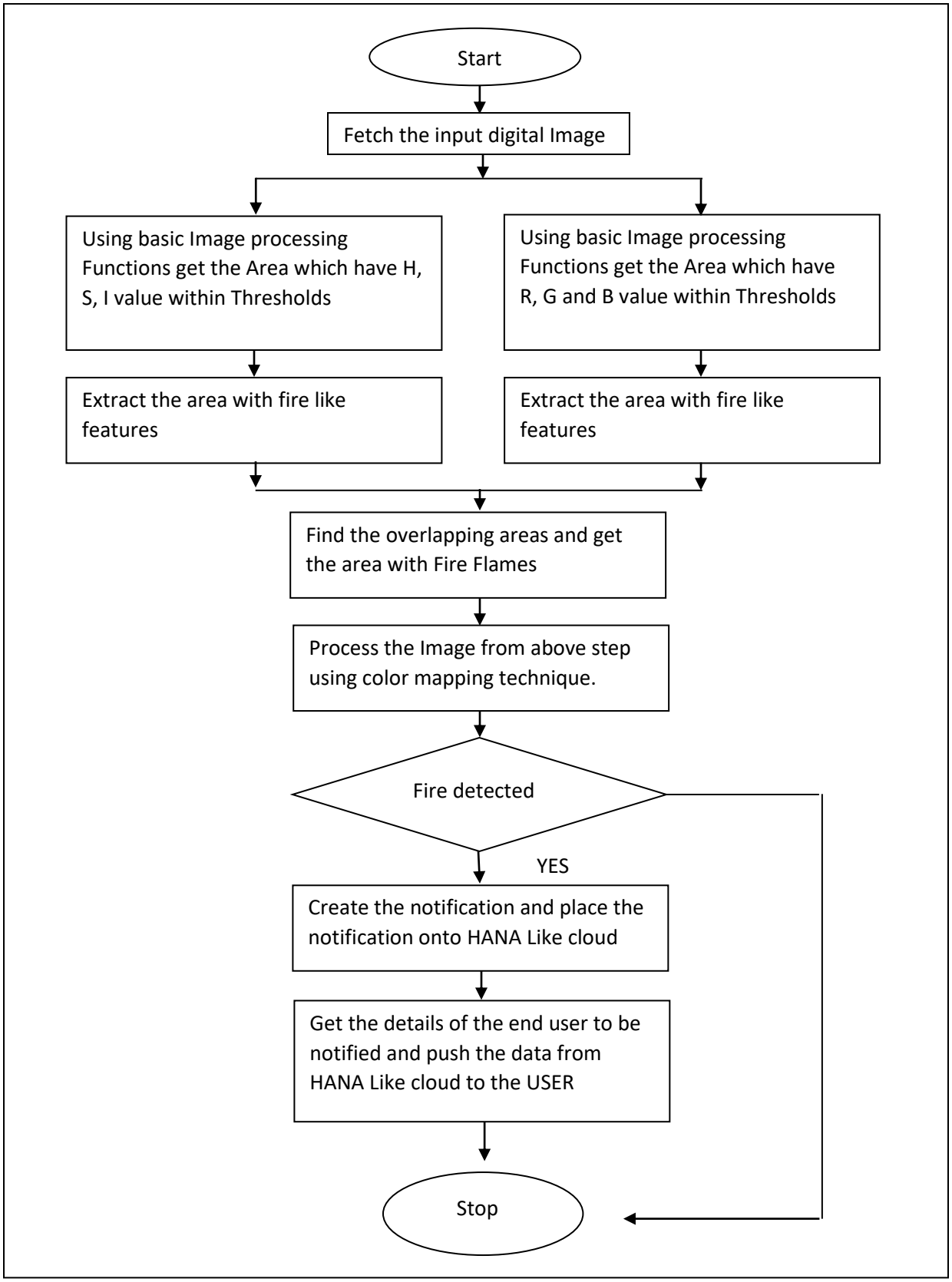


Figure 2: Flow-graph of the Project execution steps

Step 2: Based on the Input image and processing of multiple images, certain thresholds are created for the various values of H, S, I and also for the R, G, B values. These values are the ranges for valid fire region pixel values.

If the pixels lie within the range than the pixel will be assumed to be a fire pixel. The input image is processed based on these thresholds values, the pixels which lie in the range are retained to the pixel value and the regions which do not fall into this range are termed to be background regions.

The process to identify the background regions is important since it is the one that results to focus certain area as a fire region. The background identification will increase the speed of operation for the next steps. The better this step is undertaken, the better is the processing.

Step 3: Based on the above pixel comparison, the fire regions are figured out and are considered for further processing. This is the case for both HSI and RGB processing.

Step 4: The independent Images with the located fire regions are then sent on to comparisons for the Fire regions detected. The fire regions that seems to overlap are the ones that show up as the final considering Fire regions. The fire regions finalized in this step amount to the existence of Fire in the input image. This step results into more precise fire regions to be considered. Many unnecessary flicker areas may be exempted from consideration.

Step 5: Further Color masking techniques will be used to get the exact fire locations. The unwanted noise and Smoke areas can be eliminated using the color mapping techniques. This stage is the important stage because it concludes if fire exists truly in the region of which the Image is undertaken. If fire existence is determined finally and if it gets decided to take further the steps to notify the user of the fire, then few more additional information can be provided to the person about the fire under consideration.

Step 6: The above steps result into final detection of fire existence. If above steps result into existence of fire like region, then we go on to create notification about fire existence. If no fire like region is detected, then no further execution takes place for the input image.

Step 7: The notification will have to be sent to the concerned person. For this step to be undertaken, the medium chosen will be Internet. The data will be stored onto the SAP HANA like cloud platform. HANA like cloud will act as an intermediate data storage space.

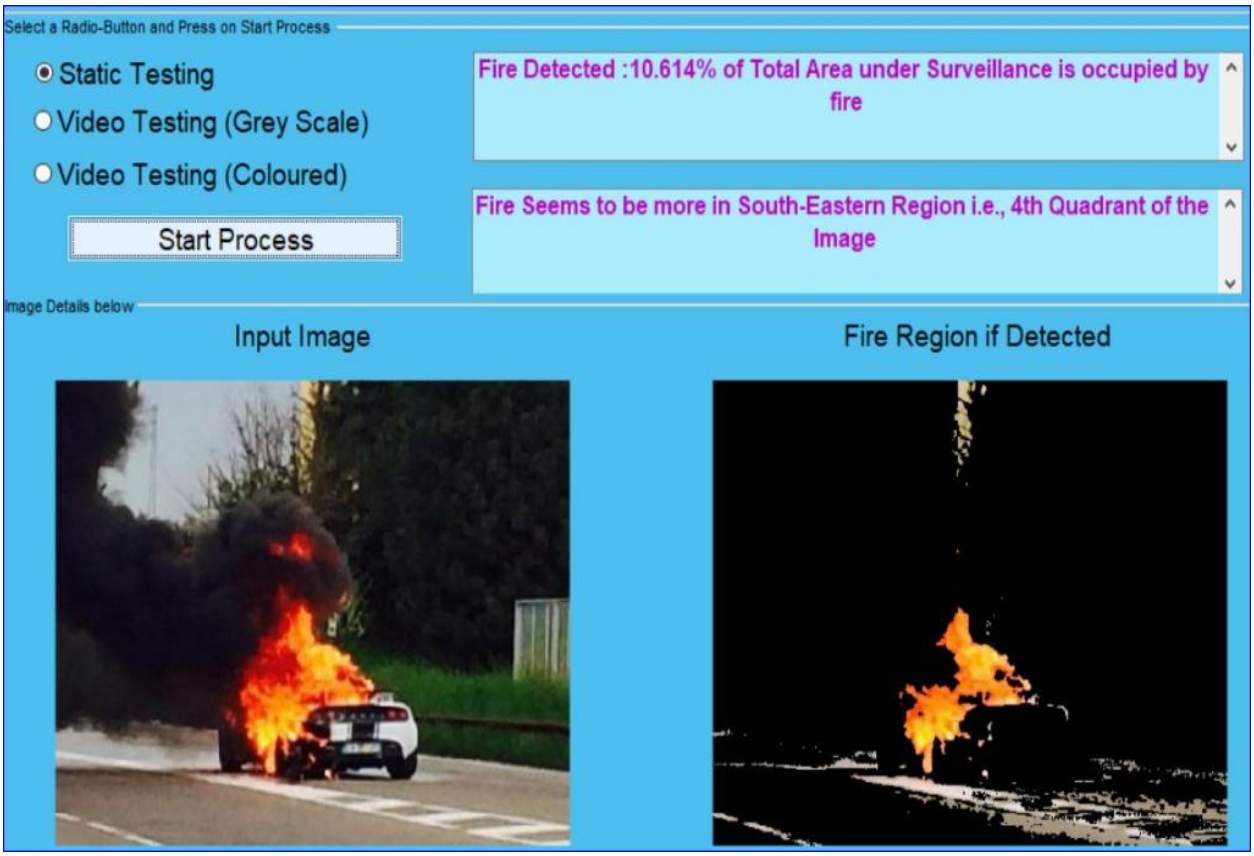
The use of using Cloud computing will place in the inclusion of modern technology of data sharing into the project execution. This Cloud platform data communication will result into saving of time, increased speed for data communication. The data can be sent to any user under consideration.

Step 8: The concerned person is selected and the notification will be sent to him. For the user to get the notification, the user will have to download the application onto his mobile device which will be custom made. The application will be developed using open source software. The user interface can be developed as per convenience and which will help the user in the easiest way to get the notifications.

Due to the use of the applications, it will be easy for the user to get the information as a notification and also he can be warned with the disaster at the early stage. The notification will be sent to the user from the HANA like cloud to the application. These are the steps in which the complete project will be executed.

- **Project Execution Details :**

The Graphical User Interface for the project execution is as shown in the below figure.

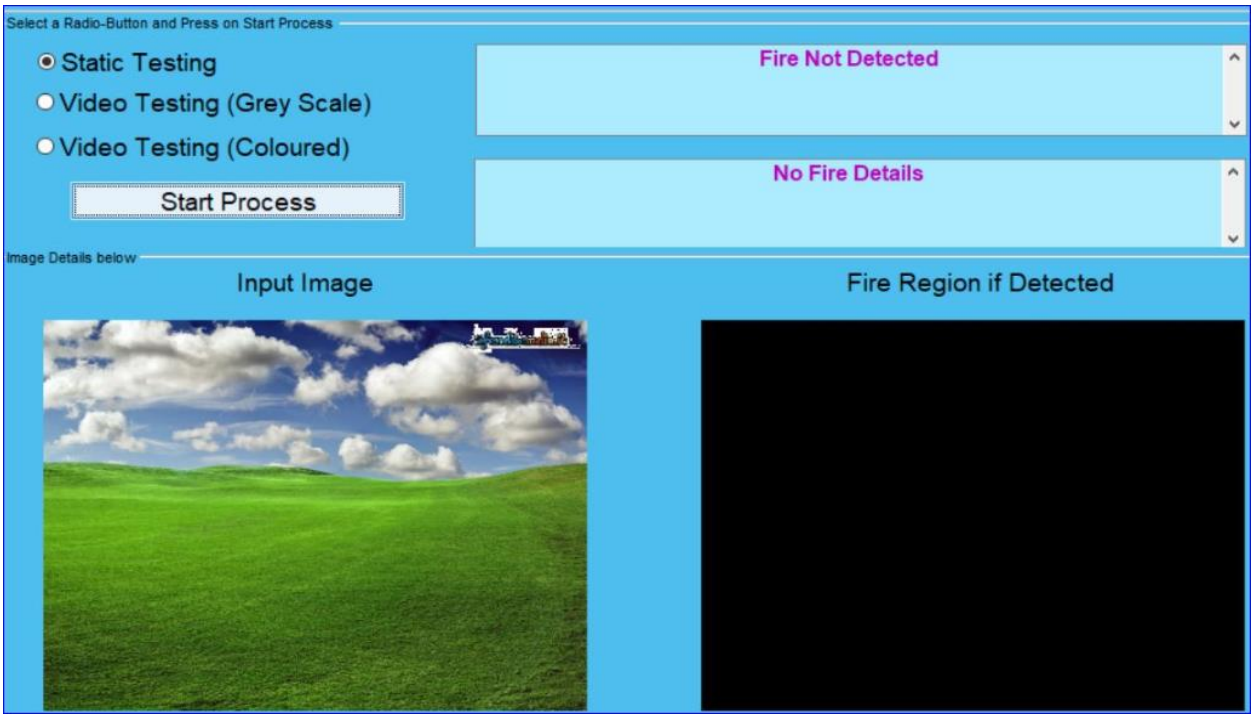


The Images shown in the GUI will not be populated and will be blank initially. The user can select any of the radio button based on what he wants to execute and later he can click on the Start Process button.

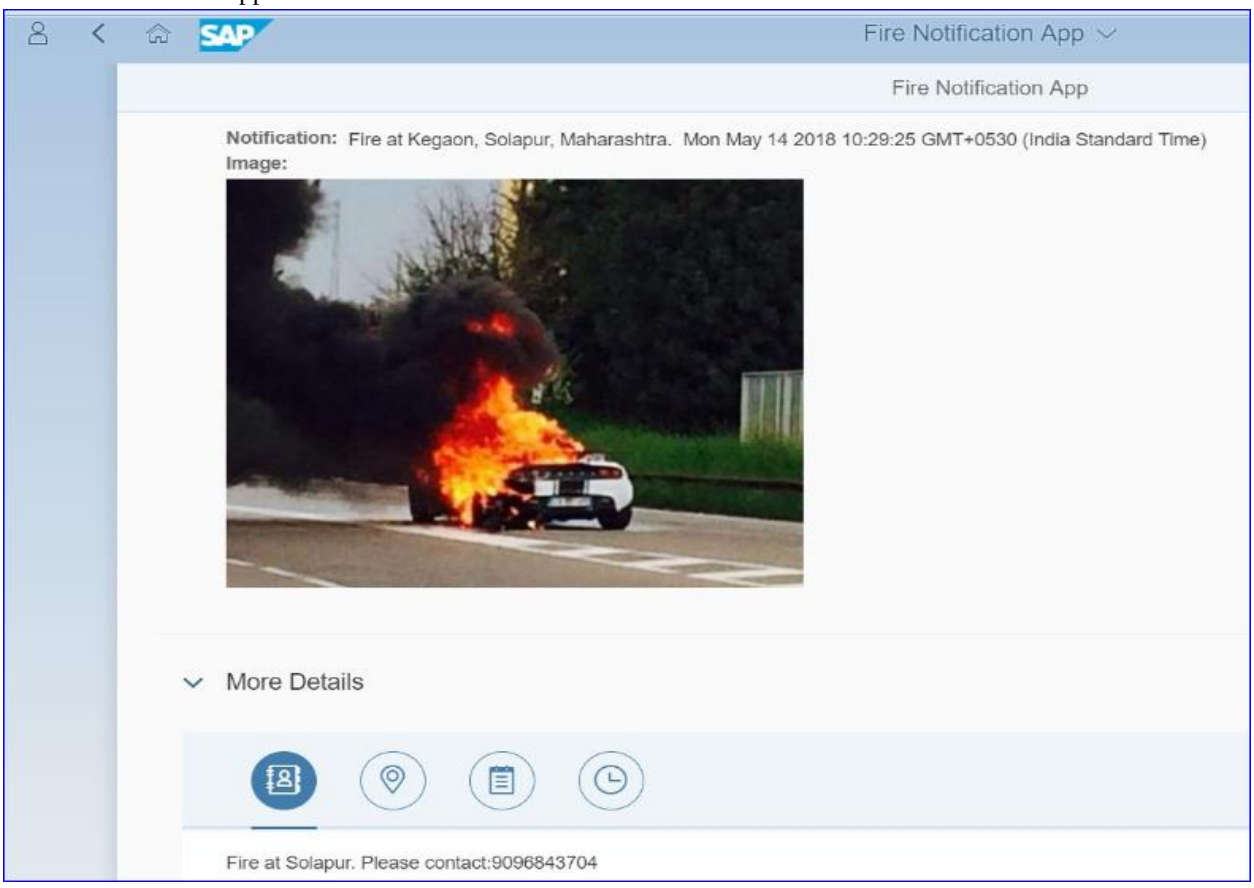
The user will get a pop-up to select the Image or Video which he wants to process. Based on the selection the Image or video will get reflected on the Input Image Axes. And the Image is further Processed. If fire region is detected it is further displayed in Second Axes and the fire regon is highlighted and rest is made to appear black.

The Fire related details like the region where fire seems to be more is written in the Second Section of the Text. The Fire percentage is also displayed in the first text section.

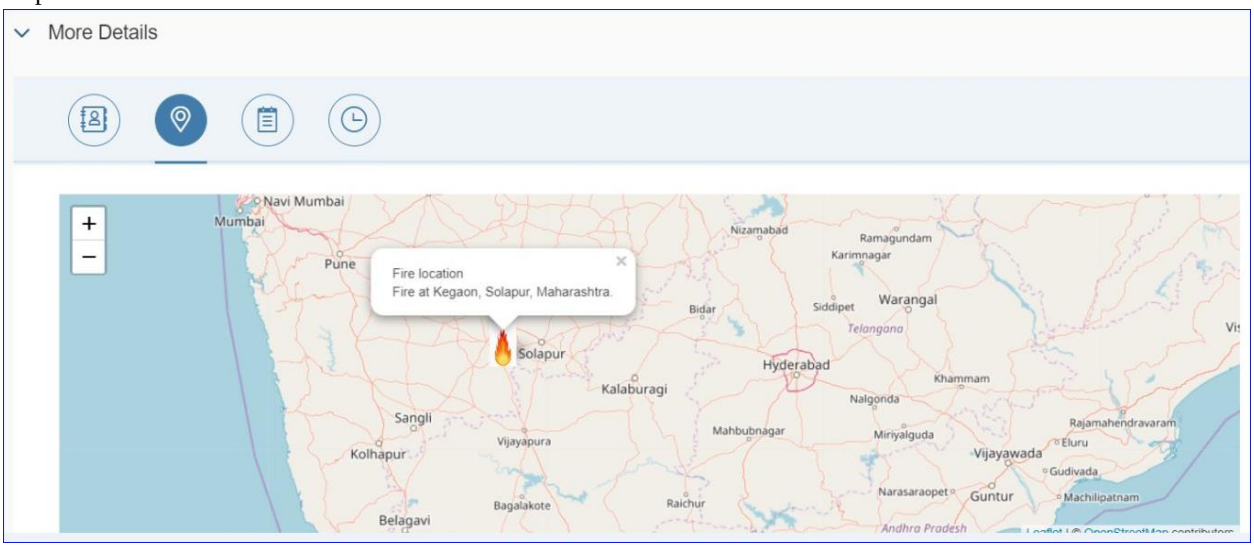
The Process is similar for Video processing too. Again, if Fire is not detected, then the Second axes does not show any region and will be as shown below.



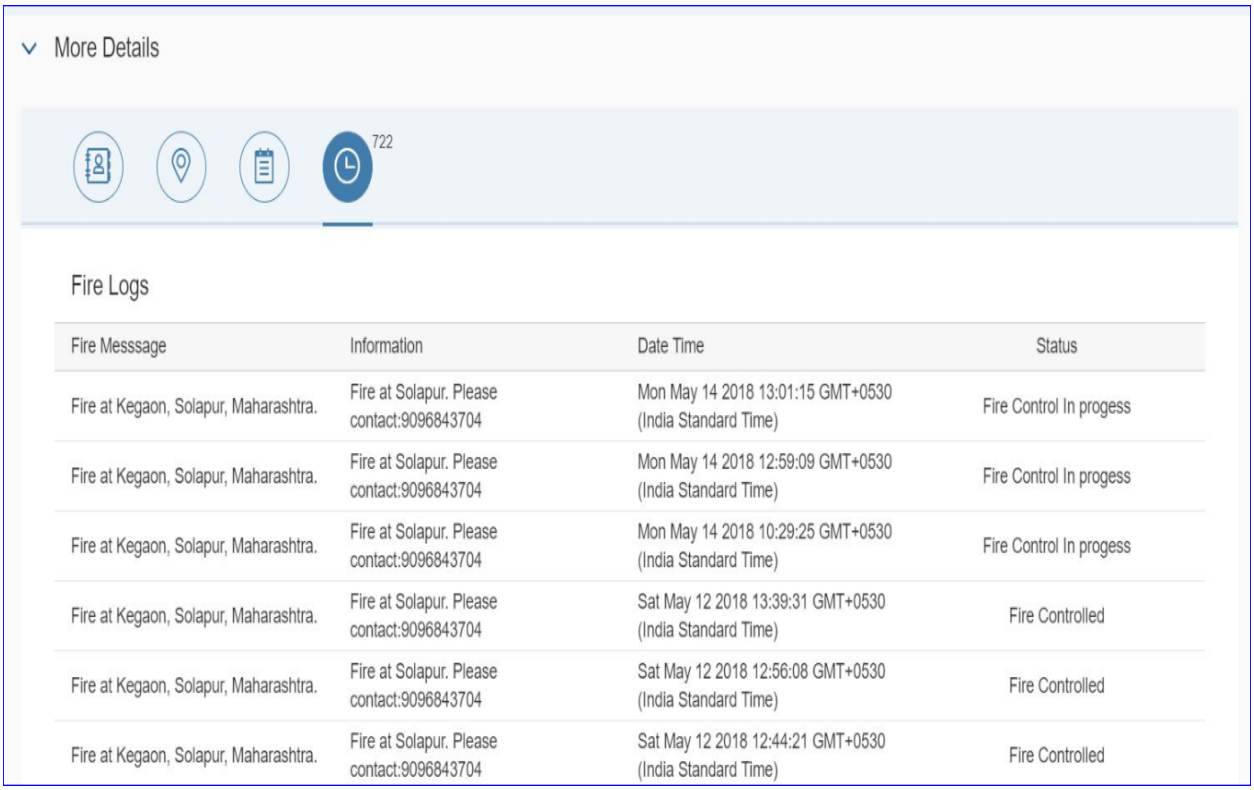
The Fire details are passed on to the Application which is custom made. The Fire Image is displayed on the application. The User Interface remains same for mobiles and Desktop. The Application also hold the Time and Date details in the Notification section. The application looks like as shown below.



The application also has many added features like the map details embedded to it. The map shows the location of the Fire. The map is as shown below.



The Application also stores the details of the fire detected in previous instances. So, this data can be used for future analysis.



Fire Messsage	Information	Date Time	Status
Fire at Kegaon, Solapur, Maharashtra.	Fire at Solapur. Please contact:9096843704	Mon May 14 2018 13:01:15 GMT+0530 (India Standard Time)	Fire Control In progess
Fire at Kegaon, Solapur, Maharashtra.	Fire at Solapur. Please contact:9096843704	Mon May 14 2018 12:59:09 GMT+0530 (India Standard Time)	Fire Control In progess
Fire at Kegaon, Solapur, Maharashtra.	Fire at Solapur. Please contact:9096843704	Mon May 14 2018 10:29:25 GMT+0530 (India Standard Time)	Fire Control In progess
Fire at Kegaon, Solapur, Maharashtra.	Fire at Solapur. Please contact:9096843704	Sat May 12 2018 13:39:31 GMT+0530 (India Standard Time)	Fire Controlled
Fire at Kegaon, Solapur, Maharashtra.	Fire at Solapur. Please contact:9096843704	Sat May 12 2018 12:56:08 GMT+0530 (India Standard Time)	Fire Controlled
Fire at Kegaon, Solapur, Maharashtra.	Fire at Solapur. Please contact:9096843704	Sat May 12 2018 12:44:21 GMT+0530 (India Standard Time)	Fire Controlled

6. Conclusion

The proposed system result into a more precise fire detection system using image processing system. Along with fire detection, the system provides features of the fire detected. The system takes modern cloud computing approach for notification data to be communicated to the end user. The end user will be notified using custom application. So, the system will overall lead to efficient fire detection and modern networking system for user notification.

7. References

[1] Wenhao Wang , Hong Zhou: " Fire Detection Based on Flame Color and Area" IEEE Transactions 2012.

[2] Tjokorda Agung Budi W, Iping Supriana Suwardi : "Fire Alarm System Based-on Video Processing" IEEE Transactions 2011

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[5] Hongke Xu, Yanyan Qin, Yong Pan, Hao Chen : "A Flame Detection Method Based on the Amount of Movement of the Flame Edge" IEEE Transactions 2013

