***Mini Project Report on***

**“Fire Detection using Image Processing”**



By

**Siddharth Gautam (201900084)**

**Ankit Kullu(201900089)**

**Raveesh Achantani (201900140)**

*In partial fulfillment of requirements for the award of the degree*

**Bachelor of Technology (Information Technology)**

(2019-2023)

*Under the guidance of*

|  |  |
| --- | --- |
| Internal Guide  Ms. Naiwrita Borah  Assistant Professor |  |

**DEPARTMENT OF INFORMATION TECHNOLOGY**

**SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY**

MAJITAR, RANGPO, EAST SIKKIM – 737136

**Abstract**

More recently, fires have become a problem and the damage caused by these incidents is enormous in nature and in human interest. After realizing this the need for a fire detection request increased. However, maximum models available are expensive and have many limitations like in an existing fire detection system that uses temperatures or smoke sensors take time to respond and do not work when detectors are far from fire. The limitations later led to creation of new techniques such as computer vision, image processing techniques. Surveillance cameras to detect to alert people of a fire can be one of the most inexpensive methods. The proposed research work suggests how to monitor fire incidents anywhere within the camera range using surveillance cameras. The idea is to determine the boundary of a moving region in an image and then it is separated by color and then we calculate the number of fire pixels in the area. So, it helps to save lives and property from fire hazards, a fire detection system was built based on this effective fire detection method.

Using image processing for fire detection can be implemented at most of the households and buildings using only a CCTV camera. In this model we will be extracting frames from a video and will then blur the unnecessary colours present in the frame. Only orange, red, and yellow colour will not be blurred from the videos as the intensity of these three colours will help us determine the presence of fire using HSV colour model. A minimum of 15,000 pixels will be set as the threshold to assume that any fire less than that may not be an actual fire and can be a fire ignited by a matchstick or a lighter. In this case the system should not detect fire and not ring the alarm.

In this project we have shown the various outcomes by changing the total number of pixels taken under consideration and how our system reacts in those conditions.



**SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY**

*(A Constituent College of Sikkim Manipal University)*

**Department of Information Technology**

**CERTIFICATE**

This is to certify that that Mr. Siddharth Gautam (201900084) , Mr. Ankit Kullu (201900089) and Mr. Raveesh Achantani(201900140) students of Bachelor of Technology, VII Semester, Department of Information Technology of Sikkim Manipal Institute of Technology, have pursued the Mini Project titled “Fire Detection using image processing” under the supervision Ms. Naiwrita Borah and the report has been submitted in partial fulfilment of requirements for the award of the degree, Bachelor of Technology in Information Technology by Sikkim Manipal University in the Year 2022

|  |  |
| --- | --- |
| *Internal Guide*  Ms. Naiwrita Borah  Designation: Assistant professor  Date: -------------- | Head of the Department  Prof. (Dr.) Udayan Baruah  Date: ------------ |
|  |  |



**SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY**

*(A Constituent College of Sikkim Manipal University)*

**Department of Information Technology**

**CERTIFICATE**

This is to certify that Mr. Siddharth Gautam (201900084) , Mr. Ankit Kullu (201900089) and Mr. Raveesh Achantani(201900140) students of Bachelor of Technology, VII Semester, Department of Information Technology of Sikkim Manipal Institute of Technology, have pursued the Mini Project titled “Fire Detection using image processing” under the guidance and supervision of Mrs. Naiwrita Borah and the report has been submitted in partial fulfillment of requirements for the award of the degree, Bachelor of Technology in Information Technology by Sikkim Manipal University in the Year 2022

External Examiner

Signature and Date:

Internal Examiner

Signature and Date:

**Acknowledgement**

We have a deep sense of gratitude and are thankful to our guide Ms. Naiwrita Borah whose supervision and guidance throughout the course helped us to shape our work to how it is right now.

We pay our deep sense of gratitude to Prof. (Dr.) Udayan Baruah, H.O.D, Information Technology Department, Sikkim Manipal Institute of Technology for giving us the opportunity to work on this project and provided all support required.

We would also like to thank any other staff of Information Technology Department, Sikkim Manipal Institute of Technology for giving us continuous support and guidance that has helped us in completion of our project.

**Index**

|  |  |  |
| --- | --- | --- |
| TOPIC | | PAGE NO. |
| 1.Introduction | | 1-6 |
| 1.1 Overview of the Problem | | 1-3 |
| 1.2 Literature Survey | | 4-5 |
| 1.3Analysis of the Problem | | 6 |
| 2. Software Requirement Specifications | | 7 |
| 3. Design | | 8 |
| 4. Implementation Details | | 9 |
| 5. Result and Discussions | 10-13 | |
| 6. Summary and Conclusions | | 14-15 |
| 6.1 Summary of achievements | | 14 |
| 6.2 Major difficulties encountered | | 14 |
| 6.3 Limitations | | 14 |
| 6.4 Future scope of the work | | 14 |
| 7. Conclusion | | 16 |
| 8. Bibliography | | 17 |
| 9. Plagiarism report | | 18 |

**CHAPTER 1. INTRODUCTION**

1.1 Overview of the Problem

Fire either big or small can occur at any undesirable place, situation, or time. Currently we have smoke detectors as the most common and widely used mechanism to detect and deal with fire. But they are not so reliable because till smoke reaches the detector, a good amount of time had already passed due to which there are chances that damage has already been made. Thus, a system that detects early fire is needed**.**

Fire detection using image processing can be a relatively cheaper and better option for households and buildings. No external hardware is required as it will use CCTV cameras to detect any signs of fire. We have developed a system which works on python language and uses OpenCV to detect fires from pre-existing datasets which provides videos from various CCTV cameras.

We are using a model based on HSV colour spectrum which helps to separate yellow, orange and high brightness light from the background and then checking the hue, saturation value of these lights. If they are greater than a certain threshold value (which is set to 15,000 pixels in this case) then our system will detect fire and ring the alarm.



Figure 1: HSV COLOR SPECTURM

We have decided to build this project using Python language. It is a high-level programming language which is easy to work with and is user friendly and has easy to understand syntax for codes. It also has a lot of pre-defined libraries like OpenCV, NumPy, and other functions which can deal with all the tasks of image processing by using only a few functions.

OpenCV which stands for Open-Source Computer Vision Library is a computer vision and machine learning library which is used for object detection, human face detection, movement detection and many more tasks.

HSV (hue, saturation, value) are the main properties of any image which helps us to differentiate between different between different colours. Hue contains 3 main colours: - blue, red and yellow and 3 not-primary colours: - orange, violet and green. It means the pure colour which can be seen in the colour spectrum. Saturation means the intensity and purity of a colour shown in an image and colour value represents the darkness or brightness of any colour.

Gaussian Blur which is named after a French mathematician is used to reduce noise and detail from an image and is also used to improve image structures at different scales. It is a pre-defined function in OpenCV which can be called using Gaussianblur () and is a part of imageproc class. It consists of a source image provided by the use, the result image or the output image and kernel size of the image.



Figure 2: Gaussian Blur

The image obtained after gaussian blurring is then converted to HSV format using cvtColor which is also a pre-defined function of OpenCV. It is used to change the colour space of an image. It takes an image as input from the user and returns the desired output after performing colour space conversion

**1.2Literature Survey**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| SL NO. | Author Name, Journal Name, Vol., Year, Page | Title of the Paper | Inference of the paper | Research Gap | Relevance with the present work |
| 1. | [Jareerat Seebamrungsat](https://ieeexplore.ieee.org/author/37085411358)  [Suphachai Praising](https://ieeexplore.ieee.org/author/37085414774)  [Panomkhawn Riyamongkol](https://ieeexplore.ieee.org/author/37640340100)  Third ICT International Student Project Conference  2014 March   (pp. 95-98) | Fire detection in the buildings using image processing.  [1] | Detecting fires using light detection and its analysis is discussed in this paper. | Does not mention about hsv colour models and motion detection. | Overview about image processing to detect fire |
| 2. | Turgay Celik  *ETRI journal*  2010  Vol 32(6)  (pp. 881-890) | Fast and Efficient Method for fire detection using image processing.  [2] | How to use color modelling for detecting fire and motion detection is discussed in this paper. | Does not include detailed analysis of light detection. | Description on fire colour modelling and motion detection |
| 3. | Kumaraguru Poobalan, Siau Chuin  AICS 2015  pp. 160 -168. | Fire detection algorithms using image processing techniques.  [3] | Algorithms for fire detection which are based on image processing techniques. | Motion detection not mentioned and not developed using on python. | RGB colour model to detect the colour of the fire |
| 4. | Awa Ali Ahmad  Osman Sharif Osman  2021  Vol 8 - 1 | Image processing techniques – based fire detection.  [4] | Growth of fire is analyzed and calculated using difference between frames. | No proper framing technique used to detect fire for a specific frame. | use of hsv and YCbCr color models |
| 5. | Thou – ho Chen  Ping – Huseh Wu  Yung – Chuen Chiou  2004  Vol. 3  (pp. 1707-1710) | An early fire-detection method based on image processing.  [5] | Research on early fire detection and alarm system is discussed. | Not so accurate as cannot distinguish between a small and large fire. | iterative checking on the growing ratio of flames, a fire-alarm |
| 6. | [Malik Mohamed Umar](https://www.inderscienceonline.com/doi/abs/10.1504/IJSISE.2017.084566)    [Liyanage C. De Silva](https://www.inderscienceonline.com/doi/abs/10.1504/IJSISE.2017.084566)  [Muhammad Saifullah Abu Bakar](https://www.inderscienceonline.com/doi/abs/10.1504/IJSISE.2017.084566)    [Mohamad Iskandar Petra](https://www.inderscienceonline.com/doi/abs/10.1504/IJSISE.2017.084566)  2017  Vol 10 (1-2), pp. 22-30 | State of the art of smoke and fire detection using image processing.  [6] | Different smoke and fire detection techniques which deal with image processing are discussed in this paper. | No mention about motion detection and light detection. | models involve in detection techniques such as RGB and HSI models for detecting smoke and fire |

**1.3Analysis of the Problem**

Fires in household and buildings has become a common issue nowadays. Smoke detectors are expensive to install and are not so efficient. Physical detectors are not able to detect motion and are not so reliable as it takes for the smoke a lot of time to reach the detector which may or may not be present at the location of the fire. Furthermore, it is not optimal for early fire detection as it only notifies us when the fire has led to the formation of smoke which in most of the cases signifies that the fire has caused a lot of damage to the surroundings.

Thus, a system is required which is both more reliable and efficient. To achieve this, image processing algorithms can be used along with the CCTV cameras in and around our houses and buildings.

Image processing is already being widely used in other fields like agriculture, shopping markets, traffic signals, etc. Due to its high accuracy and less expensive implementation approach, it is becoming very popular and can be used for fire detections too. It can help us to detect early signs of fire and can notify us before much damage has been done to our property.

The pixels present in the image can be easily manipulated to any desirable contrast and density thus helping us to know the details of the cause or the source of the fire. Images can be easily stored and can be provided to third party users easily too which is a reliable way to notify the person about fire if he/she is not available at the location when fire occurred.

**Chapter 2. Software requirement and Specifications**

**Hardware:**

1) Minimum RAM: 8GB

2) Hard Disk: 250GB

3) Processor: Intel Core i5

**Software:**

1) Programming Languages: Python

2) Libraries: OpenCV

3) Operating System: Windows 10

**Chapter 3. Design**



**Chapter 4. Implementation Details**

**HSV Algorithm** : In the HSV representation of color, hue determines the color you want, saturation determines how intense the color is and value determines the lightness of the image. We want to convert the image to HSV because working with HSV values is much easier to isolate colors.

Color isolation is achieved by picking out a hsv value from the image. The main steps of the algorithm are: -

1) RGB to HSV Conversion

2) Applying a Threshold Mark.

Algorithm

Step1 - Import the video using OpenCV.

Step2 - Grab each video frame.

Step 3 – Resize the grabbed frame.

Step 4 – Use Gaussian blur on the frame.

Step 5 – Converted the blurred frame to HSV using cvtColor.

Step 6 – Set the lower and upper limit of the color spectrum.

Step 7 – Perform masking on the HSV frame with respect to the lower and upper limit.

Step 8 - Count the number of non-black pixels using countNonZero.

Step 9 – Ring the alarm if nonzero pixels greater than 15,000.

**Chapter 5. Results**

Frame after using Gaussian blur

|  |  |
| --- | --- |
| Input frames | frames after Gaussian blur |
|  |  |
|  |  |
|  |  |

Frames after applying HSV

|  |  |  |  |
| --- | --- | --- | --- |
| Input frame | Lower limit | Upper limit | Output frame |
|  | [15, 50, 50] | [35, 255, 255] |  |
|  | [10, 50 , 50 ] | [25, 255, 255] |  |
|  | [5, 50, 50] | [45, 255, 255] |  |
|  | [20, 50, 50] | [55, 255, 255] |  |

Now keeping Lower = [15, 50, 50] and upper value = [35, 255, 255] and changing values of non-black parameter.

|  |  |
| --- | --- |
| Threshold value | Frames after changing threshold value |
| nonblack = 5000 |  |
| nonblack = 10000 |  |
| nonblack = 15000 |  |
| nonblack = 20000 |  |

When we are changing the upper and lower limit for the HSV colour model then our system is detecting more variations of colours yellow, orange and red which can be clearly seen in the first 4 images. This may lead to inaccurate results thus changing the lower and upper limit should not be allowed.

When the total number of pixels are being changed from 15,000 to 5000 then the system is detecting only a small amount of fire which will not trigger the alarm. In the second scenario when the number of pixels is being increased from 15,000 to say 20,000 then the system is detecting other colours present in the frame as fire and in this case the alarm will always ring.

Thus, the most optimal results are available at when: -

Lower limit = [ 15,50,50]

Upper limit = [35,255,255]

Number of non-black pixels = 15,000

**Gantt Chart**



**Chapter 6. Summary and Conclusion**

**6.1) Achievements**

It uses a low-cost camera, so it is economical.

We do not require any hardware components.

The system is up and working and can detect fires from the video frames provided to it as the input.

**6.2) Difficulties encountered**

In real time system it sometimes gives false results.

**6.3) Limitations**

Cannot distinguish between small and large fires.

Motion detection cannot be achieved.

Does not depend on the intensity of the fire.

**6.4) Future Scope**

To increase accuracy the use of Machine learning algorithms like YOLO (You Only Look Once), TensorFlow, Keras algorithm, neural network like CNN, RCNN, which act as an advanced method for the current algorithm can be used in this project. An email alert system can also be integrated in this project. The proposed Fire detection system accuracy can be increased with further research and analysis. The problem of false alarm detection can be reduced by implementing better algorithms. Further modifications can be made to the system by using an better camera with Raspberry Pi which helps to cover more area than the actual place.

**Conclusion**

This system based on techniques which use image processing can be a good alternative in place of physical fire detectors. It can be used in both buildings and a household at a cheaper cost. As it does not depend on smoke detection it can be more accurate than physical detectors.

This system is based on basic image processing techniques which can be further improved by using various algorithms like YOLO (You only Look Once) or using CNN (Convolutional neural networks).

Further, by using better camera for recording videos and deep learning can also be used to teach the system from previous data the difference between an actual fire and fire lit by a matchstick or a lighter the systems accuracy can be increased.

We can also integrate this system with a real alarm present in a household or a building to apply it for real usage.

**Bibliography**

[1] Seebamrungsat, J., Praising, S., & Riyamongkol, P. (2014, March). Fire detection in the buildings using image processing. In *2014 Third ICT International Student Project Conference (ICT-ISPC)* (pp. 95-98). IEEE.

[2] Ahmad, A. A., & Osman, O. S. (2021). Image Processing Techniques-based fire detection. *Sulaimania Journal for Engineering Sciences*, *8*(1)..

[3] Umar, M. M., Silva, L. C. D., Bakar, M. S. A., & Petra, M. I. (2017). State of the art of smoke and fire detection using image processing. *International Journal of Signal and Imaging Systems Engineering*, *10*(1-2), 22-30.

[4] Celik, T. (2010). Fast and efficient method for fire detection using image processing. *ETRI journal*, *32*(6), 881-890.

[5] Poobalan, K., & Liew, S. C. (2015, October). Fire detection algorithm using image processing techniques. In *Proceedings of the 3rd International Conference on Artificial Intelligence and Computer Science (AICS2015)* (pp. 160-168).

[6] Chen, T. H., Wu, P. H., & Chiou, Y. C. (2004, October). An early fire-detection method based on image processing. In *2004 International Conference on Image Processing, 2004. ICIP'04.* (Vol. 3, pp. 1707-1710). IEEE.