International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

# Detecting Fire using Low - Cost Digital Camera

**Hamad Hamdan Sayyah**

**Abstract:** ***The aim of this article is to study the tools and methods that will improve the video smoke detection with high accuracy and eliminating the fault alarm which may occur because of fogs and weather conditions.***

**Keywords:** Fire, Video smoke detector, IR, NIR, Thermal Cameras, DSLR, Fire alarm system, Low - Cost Fire Detection

## 1. Introduction

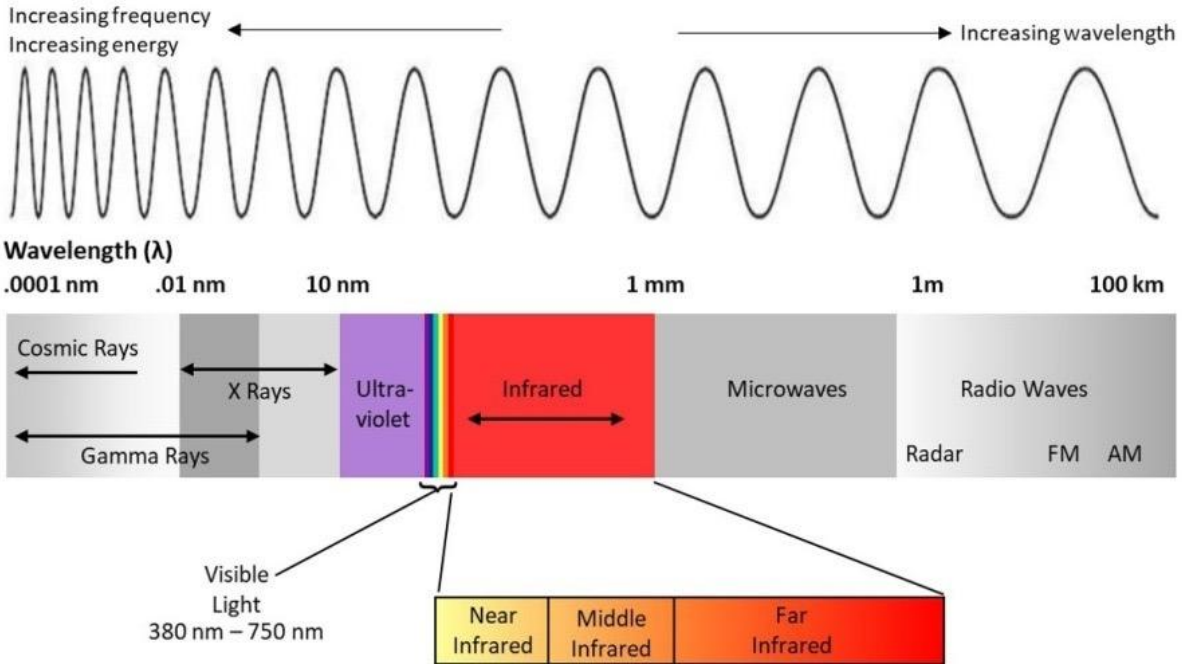
Fire is one of the most popular public safety issues in the environment outdoors or indoors. Fire causes life lost and properties lost, which may costly damage the infrastructure and economic crisis, therefore detecting smoke at an early stage plays a big role to eliminate those damages. The lesser the property damage, the shorter the downtime to reopen businesses and allowing them to return and recover quickly.

The time taken from the fire to the sensor is important to achieve the early video smoke detection, which is the time taken from the fire movement to the sensor, as well as the accuracy of the data to avoid fault alarms (15) (13).

A large amount of Video smoke detector methods were conducted and studied in the past 9 years, such as Thermal cameras, smoke pattern, fire detection algorithms as well as RGB techniques. (1 - 3 - 10).

## 2. Research Design

The aim of this thesis is to analyse the tools that can be used to detect the smoke at early stages in variant conditions outdoors and indoors in different weathers. This can be used by image smoke detector (ISD) or video smoke detector (VSD). The cost is to be reduced by eliminating the asset damages and time by reconstruction the assets that were damaged by the occurred fire, before going deep to near infrared radiation, wavelength radiation concept is elaborated as shown below:




A study by Hu, Y., Lu, X. using a low - cost near - infrared digital camera for fire detection and monitoring using specific ranges of wavelengths to control and have better visual of smoke comparing to human visualization system (HVS) since the wavelength range is limited by 380 - 750 Nanometers. Nowadays near infrared (NIR) is popular within industrial markets as a cost – saving method for conducting materials wavelength.

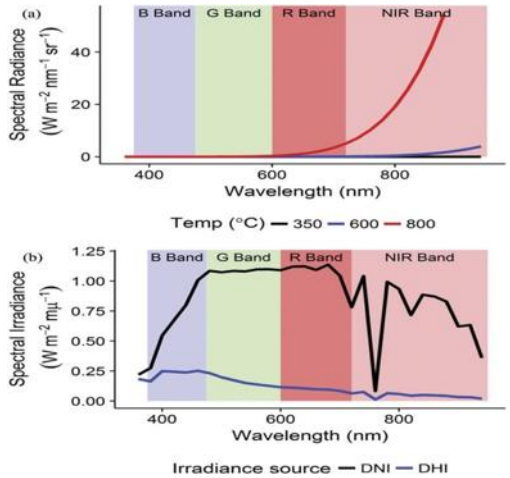



**Figure 1:** The outputs of the wavelengths between 830 and 1000 nm of NIR,

The pictures below indicate the lack of sensitivity of the near - infrared (NIR) sensor to smoke occlusion. However, the white and gray plumes are most visible in RGB images most. The flames in the near - infrared (NIR) image are distinct from other image features and appear almost white. Hence, fire in RGB images showed shades of red and yellow. The effectual of distance on the ability of the near - infrared (NIR) to see through smoke was not directly tested. The experiment shows that burning fire is clear in the infrared images when no fire but can be detected in RGB As shown in the figure below. The near - infrared (NIR) Images contrast ratio fire to the background was between 1.28 and 2.40 compared to RGB which is between 0.86 and 1.58 near - infrared (NIR) ratios are always higher, as shown below:

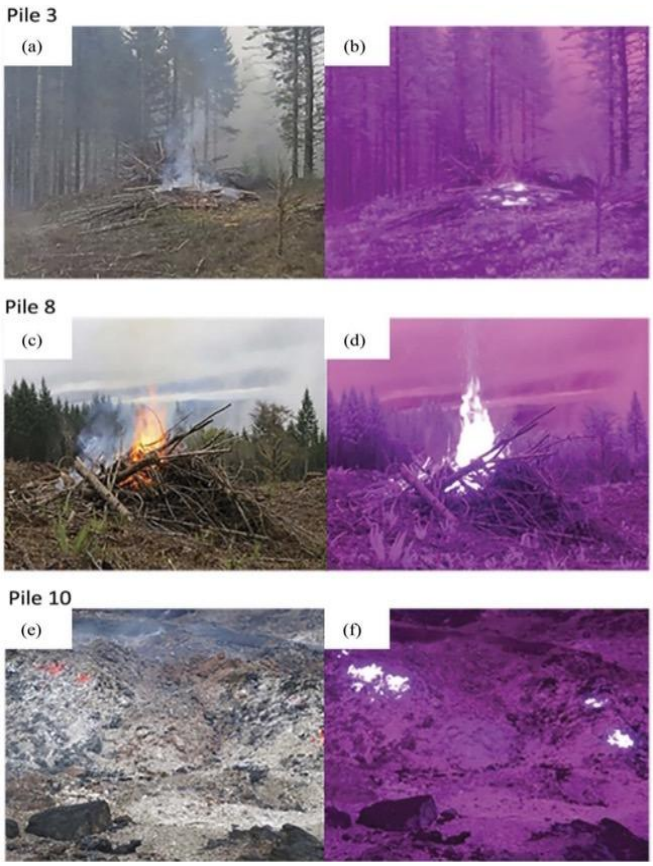



**Figure 2:** Comparison of near - infrared (NIR) and RBG images considering contrast Studies have shown that near - infrared (NIR) cameras (Right side) are more sensitive to the presence of flames than RGB cameras (Left side).

The near - infrared (NIR) improved in consumer camera effectively penetrates smoke and provides high - resolution output in this experiment (4000 × 3000 pixels). The low - cost option of using this technology showed thermal sensors being attractive. Near - infrared sensors will never achieve flame detection Efficiency of IR Sensors, yet, it is More Affordable for consumer. The near - infrared camera is a good choice. (12)

## 3. Planned Experiment

The planned experiment will be divided into more stages to ensure the reliability and quality of the detection rate avoiding fault alarm. Stage 1 is choosing the suitable low budget camera by understanding the market pricing to make it affordable for the end users. Stage 2 is collecting many smoke and non - smoke images such as fog, rain and dust images to train the dataset to recognize the fire, since it is very important in gulf regions to detect and avoid triggering false alarm, the sample photos will be taken in fog, dust and rainy weathers in multiple angles and views, then start testing the detector in order to conduct the study and enhance of any points need to be modified. In case of any false alarm, which means detector triggered alarm without any real fire a re - modification need to be setup in the dataset training which is stage 3. The other test will be indoor, which will be a minor challenge comparing to the outdoors because there are no any dust, fog and Rain indoor. The result can go backward and forward to ensure the quality and accuracy. More scenarios should be tested since many challenges can occur outdoor. The testing should not be limited to a specific equipment since it can use any outdoor or indoor applications. The challenges that may be faced during testing is the battery life of the camera, originally DSLR battery usage is not meant to be long life battery, which is DC battery supply, but the testing may take several days to get the result, an external spare battery can be a solution but in the final stage transforming DC battery supply to AC supply can resolve the problem if it's possible

## 4. Expected Results

After taking multiple pictures in various conditions, the Expected outcome of this test is the consideration of more sample pictures in the future since weather conditions can't be predictable. To have an accurate readings and fast detection response the dataset requires a sufficient sample picture.

## References

[1] He, L., Gong, X., Zhang, S., Wang, L., & Li, F. (2021). Efficient attention based deep fusion CNN for smoke detection in fog environment. Neurocomputing, 434, 224 - 238.
[2] Asiri, N., Bchir, O., Ismail, M. M. B., Zakariah, M., & Alotaibi, Y. A. (2021). Image - based smoke detection using feature mapping and discrimination. Soft Computing, 25 (5), 3665 - 3674.

[3] Li, C., Yang, B., Ding, H., Shi, H., Jiang, X., & Sun, J. (2020). Real - time video - based smoke detection with high accuracy and efficiency. Fire Safety Journal, 117, 103184.
[4] Wu, Y., Chen, M., Wo, Y., & Han, G. (2020). Video smoke detection base on dense optical flow and convolutional neural network. Multimedia Tools and Applications, 1 - 15.
[5] Jia, Y., Chen, W., Yang, M., Wang, L., Liu, D., & Zhang, Q. (2021). Video smoke detection with domain knowledge and transfer learning from deep convolutional neural networks. Optik, 240, 166947.
[6] Wu, X., Lu, X., & Leung, H. (2018). A video based fire smoke detection using robust AdaBoost. Sensors, 18 (11), 3780.
[7] Hu, Y., & Lu, X. (2018). Real - time video fire smoke detection by utilizing spatial - temporal ConvNet features. Multimedia Tools and Applications, 77 (22), 29283 - 29301.
[8] Vijayalakshmi, S. R., & Muruganand, S. (2018, January). Fire alarm based on spatial temporal analysis of fire in video. In 2018 2nd International Conference on Inventive Systems and Control (ICISC) (pp.104 - 109). IEEE.
[9] Abdullahi, Z. S., Dalhatu, S. H., & Abdullahi, Z. H. (2018, April). Development of Fire Detection Algorithm at Its Early Stage Using Fire Colour and Shape Information. In IOP Conference Series: Materials Science and Engineering (Vol.344, No.1, p.012021). IOP Publishing.
[10] Nam, Y. C., & Nam, Y. (2018). A Low - cost Fire Detection System using a Thermal Camera. KSII Transactions on Internet and Information Systems (TIIS), 12 (3), 1301 - 1314.
[11] Töreyin, B. U. (2018, September). Smoke detection in compressed video. In Applications of Digital Image Processing XLI (Vol.10752, p.1075232). International Society for Optics and Photonics.
[12] Burnett, J. D., & Wing, M. G. (2018). A low - cost near - infrared digital camera for fire detection and monitoring. International journal of remote sensing, 39 (3), 741 - 753.
[13] Appana, D. K., Islam, R., Khan, S. A., & Kim, J. M. (2017). A video - based smoke detection using smoke flow pattern and spatial - temporal energy analyses for alarm systems. Information Sciences, 418, 91 - 101.
[14] Lin, G., Zhang, Y., Zhang, Q., Jia, Y., Xu, G., & Wang, J. (2017). Smoke detection in video sequences based on dynamic texture using volume local binary patterns. KSII Transactions on Internet and Information Systems (TIIS), 11 (11), 5522 - 5536.
[15] Liu, T., Cheng, J., Yuan, Z., Hua, H., & Zhao, K. (2020). Video smoke detection with block DNCNN and visual change image. KSII Transactions on Internet and Information Systems (TIIS), 14 (9), 3712 - 3729.