A MOBILE FIRE AND SMOKE DETECTING TELEMETRY SYSTEM BASED ON UAV MODEL

Ali Akbar Siddiqui, M. Umar Khan, M. Tahir Qadri

Abstract *—In recent times, due to a rapid growth in infrastructure, the probability of fire accident has increased exponentially. Although fire alert systems are installed indoors in many places but there is a loop hole when it comes to an accident at the place that is almost impossible to monitor at all times for accidents such as forest fires and road accident on the highway. For such task we proposed a system based on Unmanned Aerial Vehicle (UAV) model to monitor forest fire and alert the authorities as soon as possible so it may not spread and cause some serious damage. UAV is equipped with an IP camera capable of transmitting the live video feed from remote location; we extract a frame and apply the color based algorithm for detecting both the fire and smoke.*

Keywords: Color based detection; image processing, Unmanned Arial Vehicle (UAV).

I. INTRODUCTION

Due to the rapid enhancement in digital camera technology and certain development in video processing algorithms have lead the researcher to utilize them and introduced various different fire detection system. There are a lot of systems based on digital image processing in which a color based recognition algorithm of fire or smoke is implemented. Such kind of system are sensor less and completely dependent on a camera mounted on any vehicle or place. According to the research conducted by National Fire Protection Association, U.S. fire department responded to an estimate of 1,345,500 fire incidents occurred in the year 2015 alone resulting about 3,280 civilian fatalities and estimated $14.3 billion of property damage.

Manuscript Received:12-01-2018 ; accepted: 2018; date of current version June- 2018

Ali Akbar Siddiqui is with Department of Telecommunication Engineering, Sir Syed University of Engineering & Technology, Karachi, Pakistan (Email:ali124k@hotmail.com)

M. Umar Khan is with is Department of Electronic Engineering, Sir Syed University of Engineering &Technology, Karachi, Pakistan (Email:umarkhan@gmail.com)

M. Tahir Qadri is with Department of Electronic Engineering, Sir Syed University of Engineering & Technology (Email:mtahirq@hotmail.com)

Approximately 639,500 outdoor fire incidents are reported and some of them are related to forest fires. The reason for such loss is due to the lack of quick response needed to tackle these kinds of situations. Fig-1 clearly displays the occurrence of the fire based incidents. Approximately 48% of the fire incidents are outdoor incidents [1].

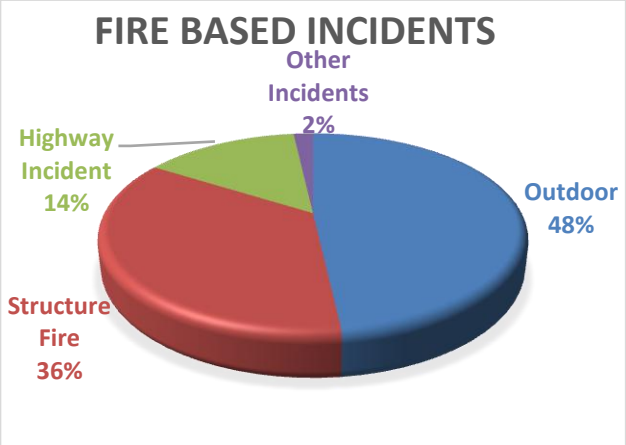

Figure.1: Fire based incident for 2015

Enhancement in the quality of digital camera have lead the researcher to use them in their image processing based application using color based detection of smoke and fire [2][5]. Algorithms based on neural networks are also utilized in developing modern fire alert systems [6]. An extensive amount of research has been conducted using fuzzy based algorithm for fire and smoke detecting systems. Rule based approach is an efficient means for data processing [7][14].

In our proposed work we have implemented an algorithm based on color based detection of fire or smoke and mounted on a UAV capable of monitoring terrain like forest for fire or smoke. Our system is independent of sensor as it uses camera for real time data acquisition and for image processing. In recent times image processing has played a major role in technological advancement. It emulates as a human brain to recognize different characteristic and features that an eye can perceive. Proposed system is capable of identifying smoke or fire and alerts the concerned authorities to prevent any further damage.

ISSN 1816-613X

II. SYSTEM HARDWARE MODEL

An unmanned model we are using is a quad-copter, it possess four motors controlled by an electronic speed controllers (ESC) which are interfaced with an APM ArduPilot control unit. ArduPilot provide the pulse width modulation (PWM) to the ESC in turn provide the appropriate signal to the motors.

An IP Camera is also mounted on UAV to provide live video stream from remote location. Global Positioning System (GPS) is interfaced with an ArduPilot to identify the present location of UAV. RF transceivers are also used to provide the waypoints which it will follow.

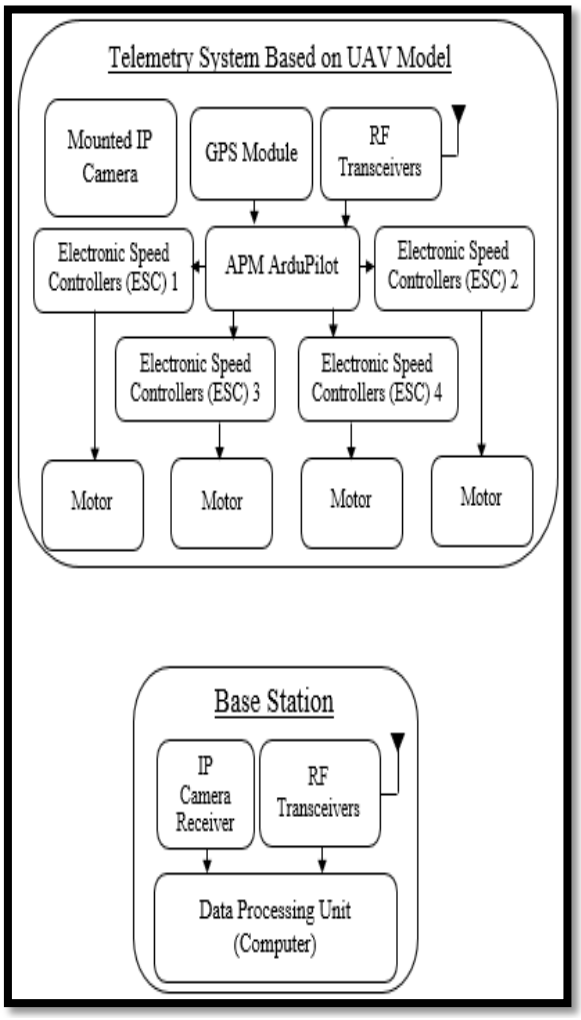

Figure.2**:** System Hardware Model

III. SYSTEM SOFTWARE MODEL

After the initialization of the system, an image acquired from a live video stream is converted into intensity to identify the area where the color composition of red and yellow colors is high. Color that resembles fire is basically a combination of both red and green, which makes a cyan shade resembling the shade of a fire.

Before the implementation of morphological operators, we convert an image to Red, green and blue individually and all three images are of unit8 format which means that they can only store data 255 bits per pixel. Blue color has a very low intensity when it comes to fir shade so we subtract the blue intensity image from an actual grayscale image to get shade that closely resembles the fire.

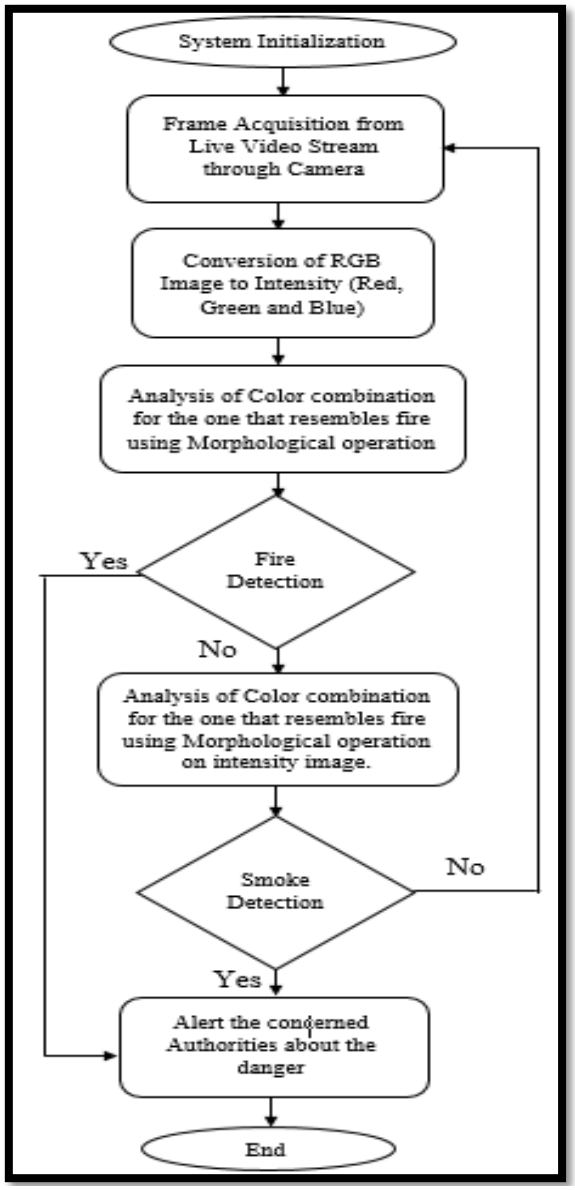

Figure.3: System Software Model

A median filter is utilizes to further remove unwanted spots on an image. At this point, the image is converted into binary format to sort the bright spots to identify the region of fire. Now a post filter is applied to further reduce the information that is not important.

ISSN 1816-613X

After fire detection algorithm, smoke detection was also implemented in case of fire not been detected by the camera. It is possible for a camera not to detect forest fire due to huge clouds of smoke. We utilize an algorithm to detect white smoke due to the reason that white and grayish smoke is usually moisture and on the other hand black smoke is caused due to the burning of carbon based compounds. For forest fire there is no need to detect black smoke.

The author know that white color has a maximum values that is close to 255 for unit8 image and for the black color they are close to zero. For smoke detection, we identify the regions of all three separated images (Red, Green and Blue) having the values close to 255 in unit8 image format. We selected the region with values more than 237 for all three images and add them to enhance the smoky area, it will become brighter and can be easily detected by converting into binary format with proper threshold levels.Fig-3 is basically a representation of a software based model implemented to alert the authorities in case of fire.

IV. RESULTS & DISCUSSION

In an original frame of Fig-4, there is a fire at the top of the building and to properly identify it eliminate the blue color from the frame so we can brighten the area closely resembles a color of fire. Third image of Fig-4 highlights the area of fire with proper threshold values applied to the second image of Fig-4. Fig-6 is another example where the fire is in forest area rather than on the building top.

Figure.5 and 7 are the images for detecting smoke. White smoke contain heavy traces of blue color and almost no trace of red color so it is better to remove red color for enhancing the area possessing white smoke as in second image of Fig-5 and finally we have third image showing the actual smoke with proper threshold level. Binary images in all frames have their threshold levels set for both fire and smoke separately so our telemetry system will monitor them sequentially.

Figure.4**:** Images of Fire Detection in Building

Figure.5: Images of Smoke Detection

ISSN 1816-613X

Figure.6**:** Images of Smoke Detection

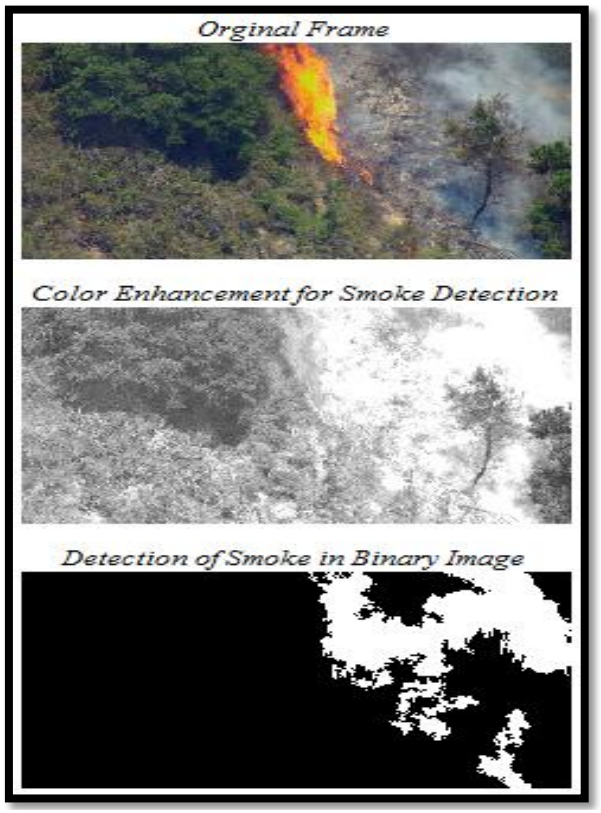

Figure.7: Images of Smoke Detection

V. CONCLUSION

In conclusion, we detected fire and smoke using vision based detection. It detects and recognizes the areas of both fire and smoke separately. The performance was tested on both occasions and our proposed system detects them accurately. Our system achieved maximum positive results alarm rates and to alert the concerned authorities about the danger. The computational cost of our proposed system is cheap and ubiquitous to use which automatically lowers the complexity level.

REFERENCES

[1] HyltomJ.G. Haynes, “Fire Loss in the United States During 2015”, conducted by National Fire Protection Association (NFPA) September 2015.

[2] Foggia, Pasquale, AlessiaSaggese, and Mario Vento. "Real-time fire detection for video-surveillance applications using a combination of experts based on color, shape, and motion." IEEE TRANSACTIONS on circuits and systems for video technology, vol. 25(9) ,2015,pp. 1545-1556.

[3] Dimitropoulos, Kosmas, PanagiotisBarmpoutis, and Nikos Grammalidis. "Spatio-temporal flame modeling and dynamic texture analysis for automatic video-based fire detection." IEEE transactions on circuits and systems for video technology , vol.25(2) ,2015,pp. 339-351.

[4] Mahdipour, Elham, and ChitraDadkhah. "Automatic fire detection based on soft computing techniques: review from 2000 to 2010." Artificial intelligence review vol.42(4) ,2014, pp. 895-934.

[5] Chiu, Chen-Wei, et al. "Performance assessment of video-based fire detection system in tunnel environment." Tunnelling and Underground Space Technology, vol.40, 2014, pp. 16-21.

[6] James, Micky. "Flame and Smoke Estimation for Fire Detection In Videos Based on Optical Flow and Neural Networks." International Journal of Research in Engineering and Technology , vol.3(8), 2014.

[7] Ko, ByoungChul, Ji-Hun Jung, and Jae-Yeal Nam. "Fire detection and 3D surface reconstruction based on stereoscopic

ISSN 1816-613X

pictures and probabilistic fuzzy logic." Fire Safety Journa, vol. 68 ,2014, pp. 61-70.

[8] Garcia-Jimenez, Santiago, et al. "Forest fire detection: A fuzzy system approach based on overlap indices." Applied Soft Computing ,2016.

[9] Schröder, Thomas, Klaus Krüger, and Felix Kümmerlen. "Image processing based deflagration detection using fuzzy logic classification." Fire Safety Journal, vol. 65 ,2014, pp.1-10.

[10] Ammar, Mohsen Ben, and RachidSouissi. "A New Approach based on Wireless Sensor Network and Fuzzy Logic for Forest Fire Detection." International Journal of Computer Applications . vol.89(2), 2014.

[11] Jin, Shan, et al. "AF-DHNN: fuzzy clustering and inference-based node fault diagnosis method for fire detection." Sensors, vol. 15(7), ,2015, 17366-17396.

[12] Dutta, Mamata, SumanBhowmik, and ChandanGiri. "Fuzzy logic based implementation for forest fire detection using wireless sensor network." Advanced Computing, Networking and Informatics-Volume 1. Springer International Publishing, 2014, pp. 319-327.

[13] Maksimović, Mirjana, et al. "Developing a fuzzy logic based system for monitoring and early detection of residential fire based on thermistor sensors." Computer Science and Information Systems 12(1) , 2015, pp.63-89.

[14] Caballero, Rodrigo E., et al. "System and method for ensuring the performance of a video-based fire detection system." U.S. Patent No. 8,538,063. 17 Sep. 2013.

 ISSN 1816-613X