Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (2): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

Image Processing Technique by Multi Scale Retinex Algorithm to Flame Characteristics Investigation

Maysoon Khazaal Abbas Maaroof[1]

1. Computer &Mathematic Dept., Basic Education College, University of Babylon, Iraq

maysoonalmaroof@gmail.com

Article Information
Submission date: 20 /5 / 2020
Acceptance date: 23 /6/ 2020
Publication date: 31/ 6 / 2020

Abstract

Image processing algorithms was more effected in modern processes to evaluate the flame characteristics such as height, length and thickness by taking digital image for flame by high speed camera for three different fuel types diesel, biodiesel and biofuel of jet flame by depend upon more variables effect such as mass flow rate, diameter of nozzle and compressed pressure. We will be applying two different mathematical methods in order to measuring some characteristics of diffusion flame. Where one depend upon Wiens distribution of a black body with MSR math-lab processing and another depend upon the intensity of the flame. These operations target to enhancing the exactitude of image segmentation and resolution. Secondly, feature extractions of the visible and infrared line images are performed, and the recognition of the target image is further completed. Finally, image fusion is performed by weighted averaging of the targets detected by visible light and infrared images The image properties are investigating by increase the knowledge of the color and resolution of digital image and enhancement the origin image by applying the concern algorithm and less the noise. The results show that the algorithm of retinex is suitable to analysis the digital image and not distortions on it .

Keyword: Multi Scale Retinex, Wien's distribution, high-speed camera.

1. Introduction

In the current work the image processing field can be a very accurate digital method for finding the flame diagnostics. Image processing technique will be applying to evaluate the characteristics of a three types of fuels by jet flame. A flame type that which depend on testing is diffusion. The fuels are diesel, biodiesel and biofuel path from a nozzle. Depending on internal surface of jet when fuel will mix with oxidizer part and

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (2): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

make up the reaction area. Very thin layer will be real location where the air fuel ratio for mixture is unity, the temperature is equal to 1800°C.

Evaluation of characteristics of flame can be difficult to evaluate. High temperature of the combustion cannot real by the measurement instruments. The study done by Schefer et al [1] a total of three tests were run to determine the flame length on large-scale vertical hydrogen jets. The spouting pressure on the fuel cylinders were set to approximately 155 bars, but decreased rapidly during the blowdown. The fuel was run through a narrowing at 3.175 mm to a 7.94 mm diameter 7.6 m straight pipe before it was ignited at the end of the pipe. Visible, infrared (IR) and ultraviolet (UV) recordings were executed details by Trindade et al [2]. Because of the falling pressure all the video images were taken in the first five seconds, this was to capture the highest flame. The visible, IR and UV recordings were averaged to determine the flame length. Photos from five successive frames were averaged to determine the final flame height. Shortly released their study on large-scale vertical hydrogen jets , they published another study with a higher pressure range by Yan et al[3]. Also in this study a total of three blowdown tests were run. Vertical jets were ignited with the highest spouting pressure at 438 bars. A stagnation chamber was mounted just before the jet exit, this was done to achieve a controlled, well-defined flow into the jet. Temperature and pressure were measured continuously in the stagnation chamber explain by Zhang et al[4]. By utilizing the low pass filtering technique so as to perceive the infrared acknowledgment, picture preprocessing will be apply high pass sifting, middle separating and spatial low-pass IIR filtering by He et al[5]. Limit and geometry adding to moving of picture attributes will investigation .Roberts administrator, Sobel administrator, Vigilant administrator and Laplace administrator are generally utilized in edge discovery [6–7]. On the off chance that the advanced picture investigation by moving succession, at that point more ways can be advantage to estimated the properties, for example, optical way and different picture hubs model. to accomplish the objective cooperation's Bai et al[8], the proposed strategy a component rely on the technique for sharpness derivation framework for infrared picture jumbling. It utilized the unimodal edge and morphological handling to assess the adjoining spatial highlights of the computerized picture, and afterward utilized the fluffy thinking framework to finish the division by Liu et al[9]. Presented a proficient infrared picture division strategy for fire picture recognizable proof. The technique comprises of two subroutines: iterative picture division and network target assurance. So as to lessen the impact of commotion by Wei et al[10], recommended a Gaussian middle sifting system where Moirés clamor was expelled in advanced picture from camera Moallem et al[11], proposed an improved versatile Gaussian channel to decrease the intermittent commotion in computerized pictures, and the boundaries of the channel were controlled by locale developing technique. In moving objective identification Z and C[12], proposed a moving objective recognition strategy dependent on infrared picture grouping in a perplexing foundation. In the strategy, the objective was extricated from

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (2): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

foundation assorted variety attributes of target and foundation decent variety. Furthermore, the direction of the objective moving was additionally extricated by irregular projection channel. In the measurement pass discovery Qin et al[13], proposed a methodology for recognizing a sort of infrared moving faint little objective in picture space dependent on the hugeness recognition. It utilized nearby versatile examination activity to assess time essentialness maps and spatial noteworthiness maps in the time space. In view of the benefits of the above techniques in infrared objective discovery and acknowledgment, this paper uses the perfect high-pass channel and direct Laplace administrator to finish the picture preprocessing, and uses the between outline contrast strategy to done the moving interface location and picture highlight extraction Kang et al[14].

The flame length was recorded using two digital cameras, which stored the images at a 30 fps frame rate. Multiple images were averaged together to determine the flame length. The flame length was recorded over the entire duration of the blowdown (600s). To determine the time average flame length, five successive frames were averaged. Where they investigated the flame length of a horizontal, homogenized mix of fuels. Nozzles with an inner diameter of 4, 7 and 10 mm were applied. The pressure was measured close to the nozzle. The video images were stored at 25 fps. Right after ignition, the flame length is too high for the camera angle details by [15-19] .The modeling of image processing is very accurate and can be applying by low cost and time with suitable reading results in the investigations about flame dimensions and propagation when its formatting by combustion of fuels as details by Lundberg et al [20].The uncertainty of the flame length is assumed to be approximately 10%. The nozzle diameters were from 1 mm to 8 mm. Each burner was mounted at the end of a settling chamber with an internal diameter of 152 mm. The flame length was identified from still photographs and averaged.

Figure 1. Sketch of flame .

Image processing technique was generating to estimate and calculate the temperatures distribution. These studies based upon image processing on Wien's distribution law. In present study, three types of fuel flame are investigated. By the visual locations the flame radiated yellow/blue/orange. A color high speed camera and resolution of pixels will be using in order to take the testing images. The characteristics are investigating by MSR algorithm by MATLAB codes -was used as a platform.

2. Experimental Technique

Experiments were developed when the pressure of fuel at 25 MPa from a container of it and pressure controlled with a range from 1.0 to 12 MPa. Testing data that which gated by the instruments devices, such as flowmeter, pressure and temperature sensors, were applied with the camera and analysis at 2500 Hz. Then 1250 images and 6000 points of data for each of the other sensors was stored for each experiments. The flame dimensions were evaluated to be from the jet exit to the tip of it. Image processing algorithm MSR code is applied to the flame in order to find the flame characteristics by analysis of images. When the code is operating the red color will be coring and generate the virtual matrix that which constructed adding to green and blue colors. After this point the image processing will be stated by applying the multi scale retinex to remove the foggy and increase the resolution of digital image ,this mean reduce distortion in image and high recognizing.

(a) (b)

Figure 2. a) Image of fuel jet. b) Original image .

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (2): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

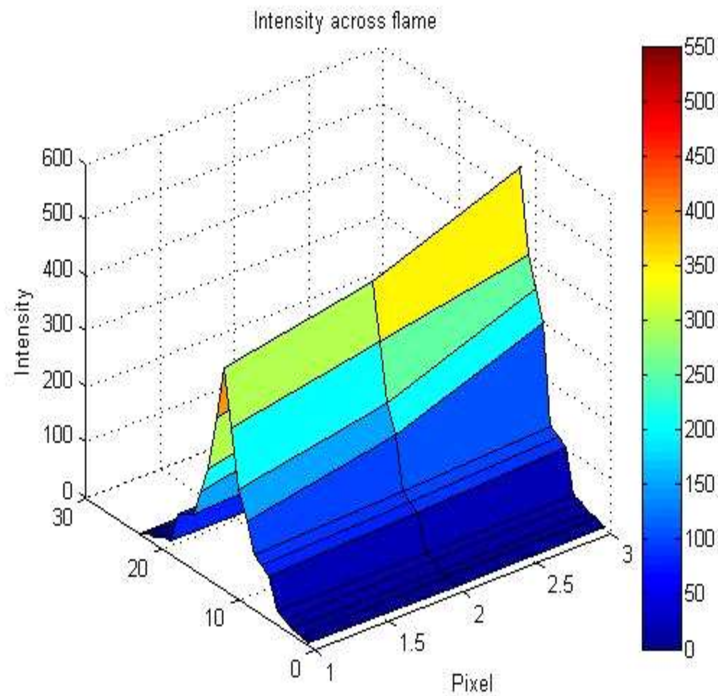


Figure 3. Intensity of line flame.

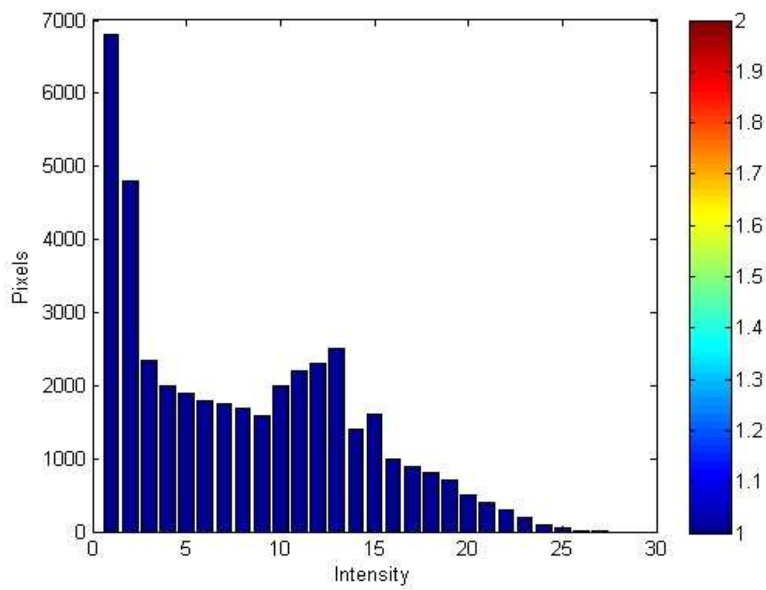


Figure 4. Intensity of pixel.

Mogi et al. [21] evaluated the emissivity for a fuel flame to be $\epsilon = 0.03$ which is low. In order to imagination the temperature distribution process in the flame core and boundary infrared camera was tested. Different expression based on Wien's distribution can be using;. To separate the flame body and measure length characteristic finding in a MATLAB, script framework was being applied.

a b c

Figure 5. a) Diesel, b) biodiesel and c) biofuel- Original images of a fuels flame.

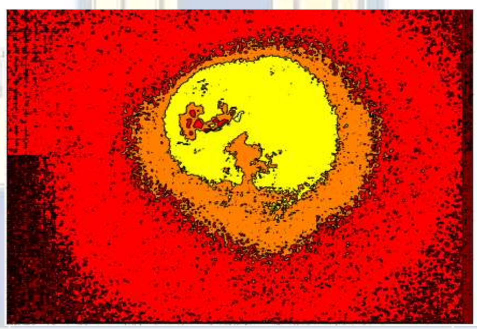


Figure 6. Calculate image of a flame.

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (2): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

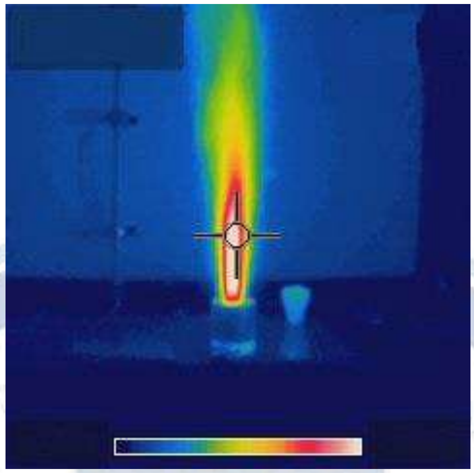
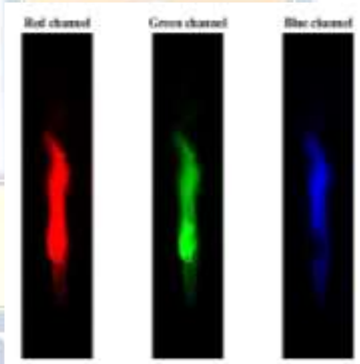


Figure7. Infrared image of fuel jet flame



Red Green Blue

Figure8. RGB-Color channels for image of a flame

3. Image Processing Techniques

In the present study, the principle project was to find a way to calculate the characteristics of flame such as length and thickness by using image processing algorithms. Devices of imaging like camera depend on coupled of digital charge . In the experiments we observe that the MSR technique can have overall acceptable results on images. It provided a good constancy of color and high visual quality. One approach we now commonly use is involving a gain offset method of those pixels with big range different values of lightness, in which case, it is shown little information is lost. Our intuitive idea is to eliminate the uncertainty of the value range of the result from the beginning, where we used to take the logarithm of the ratio between more one value of intensity. 1/256 to 256 ratio range, the logarithm makes distribution as very loosy across

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (2): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

its range, M.K. Maaroof[22]. We set the higher and lower threshold of the gain offset method empirically. in order to replace the logarithm function with the sigmoid function, which has a certain range of output. This certainty is obtained by compressing process to the extreme pixels. Combined with other methods discriminating between areas of the image-processing tool is explained in subsequent steps.

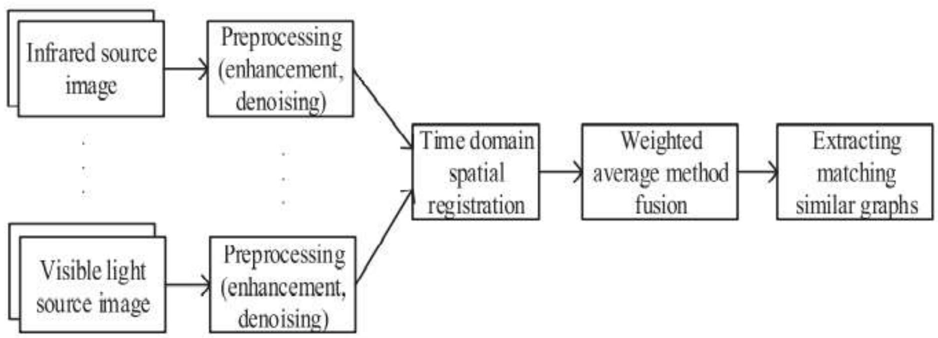


Figure 9. Infrared/visible image flowchart.

The characteristics for the flame was collected and stored as a numerical value. Because of the method used in the MATLAB code there are some deviations at the beginning of the series, but considering the amount of measuring points in one series that which was acceptable. The scaling of the pixel values to meter is also a possible source of error. If the ruler is not placed correctly when taking the snapshot, this error will influence all the tests in the project. It is however not possible to state how large this error Because of the blurriness obtain in the image it was possible to miss read the all number of pixels by more one pixels. To estimate evaluation for how high influence this error could have on the mean flame height project was run by altering the scaling factor by two pixels. The average flame length for the selected test altered with no more than ± 0.0020 m. This was assumed to be a negligible error.

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (2): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

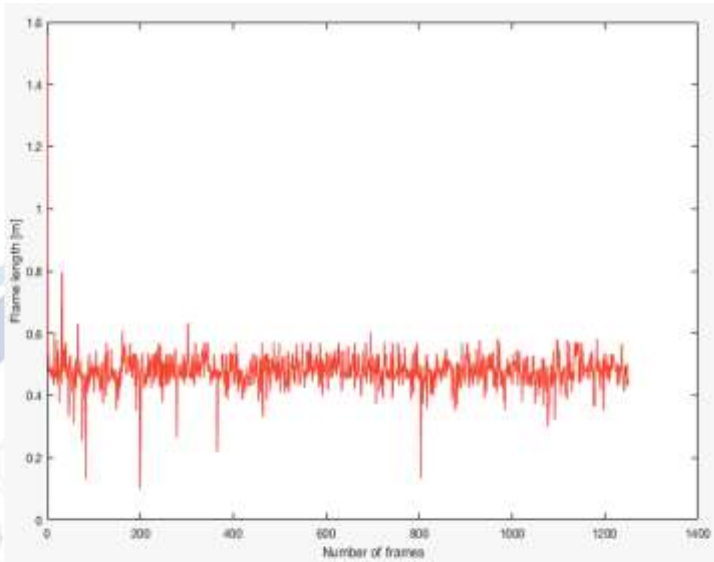


Figure 10. Length of flame when threshold value of 0.20.

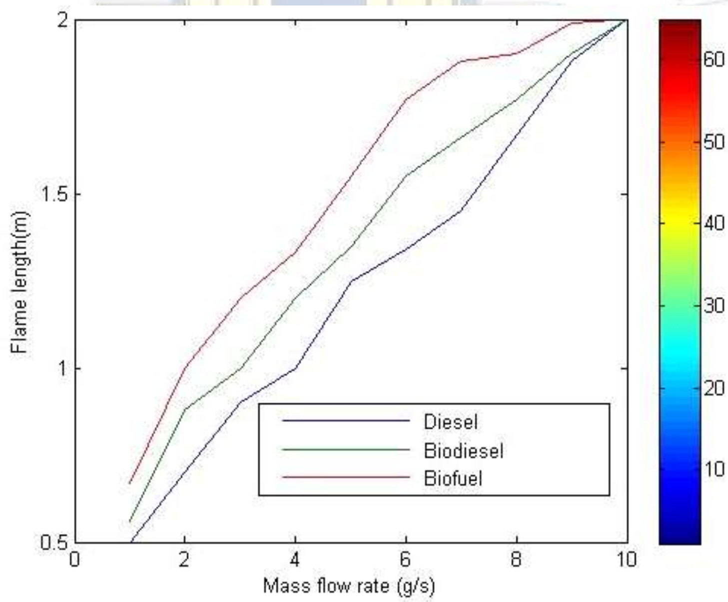


Figure 11. Flame length evaluate.

4. Results and Discussion

The main objective in this study construct a method to evaluate the characteristics of a fuel jet flame by using multi scale Retinex algorithm in image process techniques. Two different procedures of image processing techniques were considered, one depend on Wien's distribution with multi scale Retinex and other consider the intensity. The technique considers an intensity in multiscale Retinex algorithm was used and compared to visual considerations of the flame and gives convergent results with the flame characteristics mode for length and thickness.in the Fig.4and Figure.5 we notice the intensity of the pixels for the taken and supply image by camera that explain the high values of biodiesel kind of flame. This mean it has more characteristics such as length if compare it with other different kind of flame. High resolution by applying the retinex algorithm illustrating in Figure.6 and high convergent resolution for pixels if compare with the analysis of Maaroof &Lade [23]. the length of flame is illustrate by Figure 10,when threshold is 0.2 we notice again the length of flame intensity between the 0.4 - 0.6 and converge in length values along the path. In the Figure 11, notice that the flame length increase by increase the mass flow rate of fuel and the biofuel is high magnitude of length if compared with other kinds of using fuels .The accuracy and efficiency of this study is suitable if compared with the study by Dia et al [24], when they illustrated the accuracy and IR range of values.

5. Conclusion

A multi scale Retinex algorithm in image processing technique was accurate to evaluated flame characteristics of a fuels by using the MATLAB 8.5 coding during all post processing. The procedure was depending upon the flame intensity and multiscale Retinex technique in order to obtain on the accurate characteristics of flame for three types of fuels. The results show the suitable methods to evaluate the properties and dimensions of fire. When retinex algorithm applied notice the very loosy in resolution and prevent distortion that which occurs in the other technique. The good accuracy and less distortion in the proposal study and the noise is removed. The flame length of biofuel is longer than the length of others using fuels. When creating the complex nozzle geometry, it is concluded that the upstream nozzle calculation the mass flow while the downstream nozzle also has an impact on the flame length. The downstream nozzle is more significant at lower flow rates and helps to stabilize the flame after the combustion process started. Air fuel ratio (oxidizer/fuel) it's very important variables that which affected upon the flame characteristics and the numbers of carbon atoms take place on the distribution process of different colors of flame.

Conflict of Interests.
There are non-conflicts of interest .

Reference

1. Schefer.R. W., Houf ,W. G., Williams ,T. C., Bourne ,B., and Colton ,J.," Characterization of high-pressure, under expanded hydrogen-jet flames, "International Journal of Hydrogen Energy,2007, vol. 32, pp. 2081-2093, 8//.
2. Trindade .T., Ferreira .A., Fernandes .E.." Characterization of Combustion Chemiluminescence": An Image Processing Approach, Proc. Tec., 2014,17, 194-201.
3. Yan .W., Zheng .S., Zhou .H., "Experiments investigation on 2D distribution of soot temperature and volume fraction by image processing of visible radiation", Applied Thermal Engineering, 2017Volume 124, Pages 1014-1022.
4. Zhang .Y., Hui .S., Zhang..Y Y. "The Research of Flame Combustion Diagnosis System Based on Digital Image Processing", CSEE 2011, pp. 225 – 230.
5. He K, Sun J, Tang X ,"Guided image filtering. IEEE TransnPattern" Anal Mach Intell. 2013;35(6):1397–1409.
6. Wang. Y.D. "Methods of SAR image terrain recognition based on heat kernel features". Syst ,Eng Electron.2015;37(5):047–1054.
7. Guo HX. "Infrared image edge detection algorithm based on improved canny algorithm. Fire Control Command Control. 2014;39(7):95–97. (in Chinese).
8. Bai X, Liu M, Wang T,"Feature based fuzzy inference system for segmentation of low-contrast infrared ship images". Appl Soft Comput. 2016;46(6):128–142.
9. Liu Z, Zhou F, Chen X, "Iterative infrared ship target segmentation based on multiple features". Pattern Recognit. 2014;47(9):2839–2852.
10. Wei Z, Wang J, Nichol H," A median-Gaussian filtering framework for Moiré pattern noise removal from X-ray microscopy image". Micron. 2012;43(2–3):170–176.
11. Moallem P, Masoumzadeh M, Habibi M. "A novel adaptive Gaussian restoration filter for reducing periodic noises in digital image". Signal Image Video Process.2015;9(5):1–13.
12. Z.Wang , C.Wang . "Interframe difference and edge detection-based moving object detection algorithm". J Nanchang Univ. 2017;41(1):42–46. (in Chinese).
13. Qin H, Han J, Yan X,"Infrared small moving target detection using sparse representation-based image decomposition". Infrared Phys Technol. 2016;76:148–156.
14. Kang MA, Cui ZG, Gan ZL. "Backlight image enhancement algorithm of Retinex based on image fusion strategy". Comp Technol Develop. 2017;27(8):73–78. (in Chinese).
15. W. Li, C. Lou, Y. Sun, H. Zhou. ,"Estimation of radiative properties and temperature distributions in coal-fired boiler furnaces by a portable image processing system", Exp. Therm. Fluid Sci. 35(2), 2011,416–421.
16. Huang, H.W., Zhang, Y." Flame color characterization in the visible and infrared spectrum using a digital camera and image processing". Measurement Science and Technology 2008;19(8):085406.

17. Huang, H., Zhang, Y. "Digital color image processing based measurement of premixed ch4 + air and c2h4 + air flame chemiluminescence". Fuel 2011; 90(1):48 – 53. doi: 10.1016/j.fuel.2010.07.050.
18. Kohse-Hoinghaus, K., Barlow, R., Alden, M., Wolfrum, J. "Combustion at the focus: laser diagnostics and control. Proceedings of the Combustion",2005; 30(1):89 – 123. doi:http://dx.doi.org/10.1016/j.proci.2004.08.274.
19. Ballester, J., Garc´ıa-Armingol, T. "Diagnostic techniques for the monitoring and control of practical flames". Progress in Energy and Combustion Science 2010; 36(4):375 – 411. doi: 10.1016/j.pecs.2009.11.005.
20. Lundberg .Joachim, Henriksen .Mathias, Gaathaug ,André. "Using Image Processing for Flame Diagnostics". Department of process, energy and environmental technology, University College of Southeast Norway, Norway, 2017.
21. T. Mogi,T. Imamura, S. Hamada, Y. Wada, S. Horiguchi, A. Miyake, "Experimental investigation on the thermal properties of hydrogen jet flame and hot currents in the downstream region,"International Journal of Hydrogen Energy, vol.33,2008, pp. 3426-3435, 7//.
22. M. K. Maaroof,," Image enhancement by seam carving/MSR algorithm", International Journal of Civil Engineering and Technology (IJCIET)Volume 10, Issue 04, April 2019, pp. 2329-2336, Article ID: IJCIET_10_04_242.
23. Maaroof .Maysoon Khazaal, Lade .Sangita.G., 2015, H264 Video Compression Technique with Retinex Enhancement, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 4 Issue 05, May-2015.
24. Dai .Xuefeng, Jianqi Zhao & Dahui Li ," Effective detection by fusing visible and infrared images of targets for Unmanned Surface Vehicles", Automatika, 2018,59:3-4, 323-330.

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (2): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

الخلاصة

خوارزميات معالجة الصورة كانت ذات تأثير فائق في احتساب ومعرفة خصائص اللهب مثل الارتفاع، الطول والسمك والتي في اغلب الأحيان لا يمكن قياسها في الظروف التشغيلية وذلك من خلال اخذ صورة رقمية للهب او الشعلة بواسطة كامرة فائقة السرعة لثلاث أنواع من الوقود المستخدم في توليد الشعلة باستخدام نفاث وقود معد لسريان الوقود ومن ثم انتاج الشعلة والذي يعتمد على عدة متغيرات مثل معدل تدفق الوقود, قطر النفاث ومقدار الضغط المسلط.

في هذا البحث تم تطبيق طريقتين رياضية لتمثيل البيانات لغرض قياس خصائص ومواصفات اللهب المتكون من نوع الانتشار . الأول كان تطبيق توزيع (Wien's) للجسم الأسود مع ملف المعالجة الخاص ببرنامج الماثلاب , والثاني يعتمد على مناطق شدة اللهب. ان الهدف من هذه الاختيارات هو لتحسين الصورة من حيث التقطيع ومعالجة التشوه الحاصل من ذلك والحصول على دقة عالية. كذلك دراسة تأثير الأشعة تحت الحمراء على مخرجات الضوء المرئي والحصول على الصورة النهائية. اخيرا فان الصورة المندمجة والتي سوف تتشكل بواسطة المعدلات الوزنية سوف تكتشف بواسطة الضوء المرئي والأشعة تحت الحمراء لتوهج اللهب. ان خواص الصورة الناتجة والتي سوف تدرس بواسطة الحفاظ على الألوان والدقة العالية للصورة الرقمية من خلال تحسين الصورة الأصلية وتقليل الضوضاء.

النتائج بينت ان خوارزمية *Retinex* أكثر ملائمة ومتقاربة في تحليل الصورة وتقليل التشوه الذي يحصل عليها وان الصورة المتولدة من اللهب ذات دقة ووضوح عال وان استجابة خوارزمية الرتنكس في التوزيع الوزني لتوهج الألوان الناتجة من شعلة الوقود الحيوي تبين انها ذات خصائص أعلى من الأنواع المستخدمة الأخرى.

الكلمات الدالة: خوارزمية *Retinex* ذات المقياس المتعدد-توزيع Wien's – كامرة عالية السرعة