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Image Enhancement Work of Liquid Crystals of Different Side Chain and Terminal Groups

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Abstract

In the present manuscript the Polarizing optical Microscope technique is employed to record optical textures and transition temperatures of the liquid crystalline samples 1.P-Cyanobenzylidene P- Nonyloxyaniline 2.P-Decyloxybenzylidene P-Toluidine. Both the sample shows the Nematic threaded marble textures, But in Smectic phases the first Sample exhibit sanded texture of Smectic- A and that of other sample shows Focal conic fan textures. The transition temperatures are also measured using Differential Scanning Calorimetry (DSC) for confirmation. To enhance the quality of textural images histogram equalization technique is employed. This method preserves the input brightness and output image with a significant contrast enhancement.

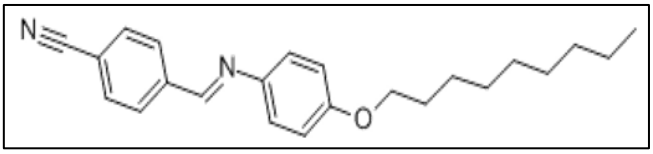
Keywords: *Liquid Crystals, Optical Textures, Nematic, Smectic, Histogram.*

I. INTRODUCTION

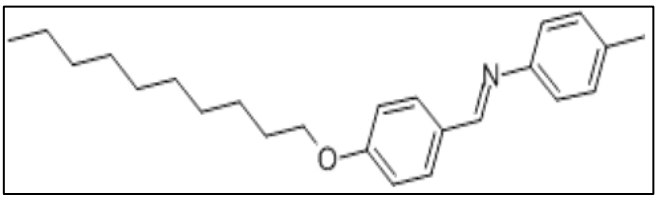
The profile of liquid crystals contains a unique combination of optical anisotropy due to the property of being soft they are very useful in electro-optics. In the present days its applications in the branches of science, engineering and pharmaceutical are increasing [1-3]. Homeotropic alignment of liquid crystals has applications in liquid crystal display technology such as high information display devices, large area LCD TVs' and digital display devices used in digital medical imaging [4]. Both human and computer vision contrast enhancement is an important area in image processing. Image enhancement is a process of making output image look better by changing the pixels intensity of input image [5]. The main purpose of image enhancement is to bring out details that are hidden in an image. By using brightness, preserving bi-histogram method [6] the contrast can be enhanced. Similarly the contrast of the image is enhanced by using block over lapped histogram equalization technique [7] by other histogram based methods [8-11]. The textures of Nematic and Smectic phases of above liquid crystalline samples are observed in (POM) Polarizing optical microscope. The textures are having less brightness in order to increase the contrast of image of textures histogram equalization technique is implemented.

The molecular structures of the Liquid crystalline compounds are represented below.

(C1) P-Cyanobenzylidene P-Nonyloxyaniline



(C2) P-Decyloxybenzylidene P-Toluidine



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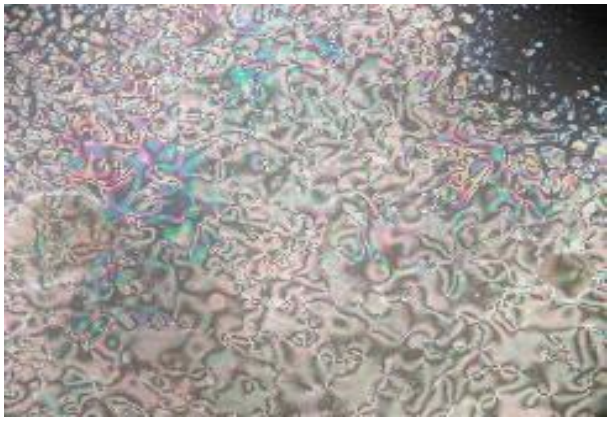
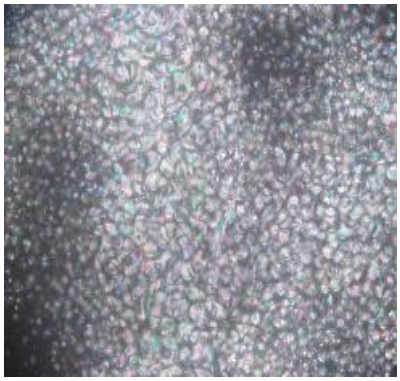


Threaded marble texture of Nematic Phase @103.4 º C of the compoundP- Cyanobenzylidene P-Nonyloxyaniline

Sanded texture of SmecticA Phase @ 96.7 º C of the compound P-Cyanobenzylidene P-Nonyloxyaniline

Fig 1 Optical Textures of Compound C1



Nematic droplet texture of compound P-Decyloxybenzylidene P-Toluidine@ 76 º C

Threaded marble texture of compound P-Decyloxybenzylidene P-Toluidine@ 74.9 º C

Arced focal conic fan texture of compound P-Decyloxybenzylidene P-Toluidine@63.5 º C

Fig 2 Optical Textures of Compound C2

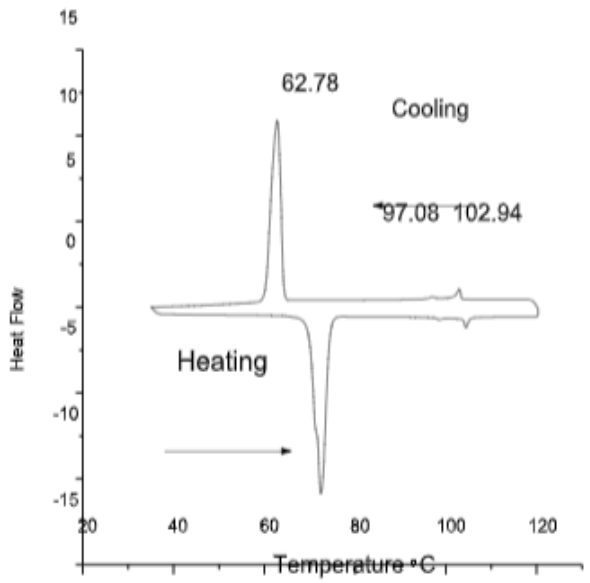


Fig 3 DSC Thermograms of Sample1

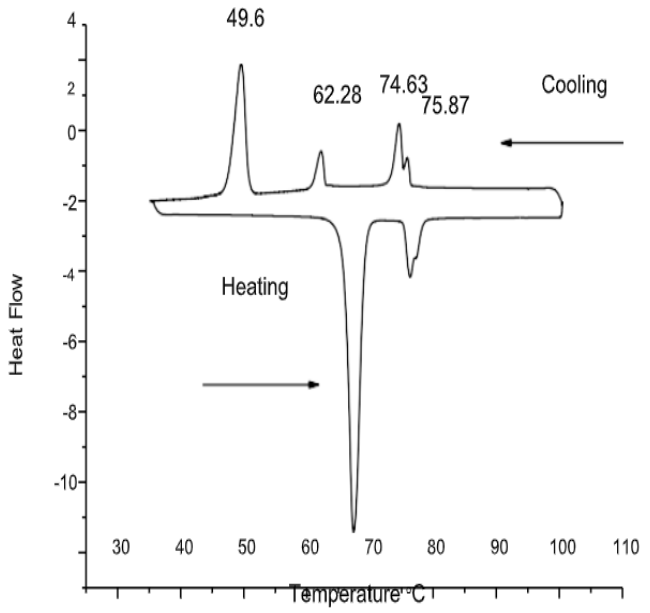


Fig 4 DSC Thermograms of Sample C2

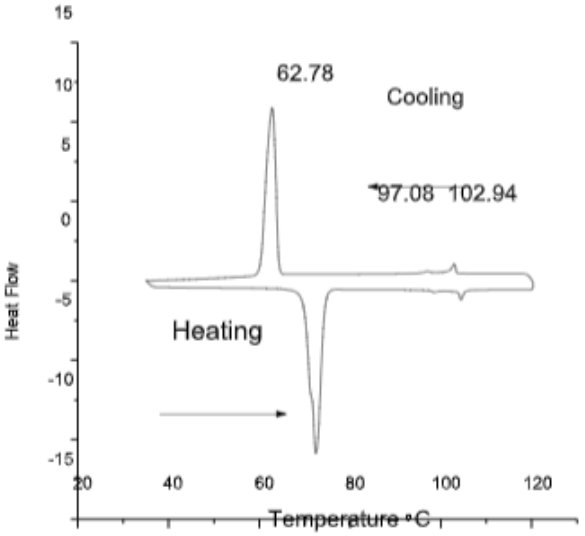


Fig 3 DSC Thermograms of Sample1

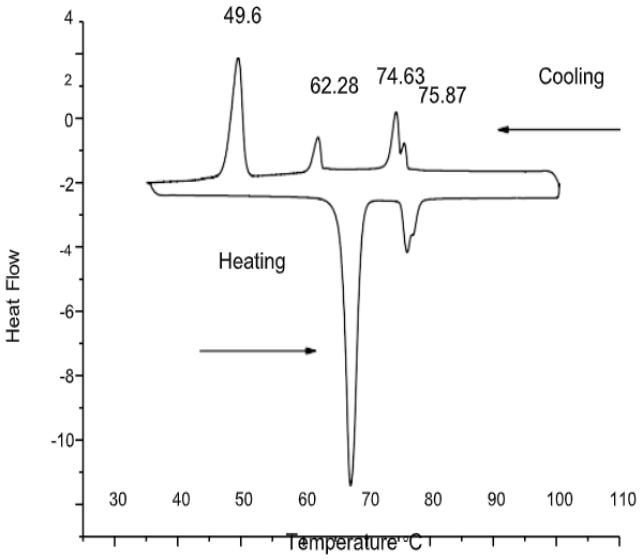


Fig 4 DSC Thermograms of Sample C2

Table 1 Phase Transition Temperature and Phase Variants Observed in DSC and Polarizing Optical Microscope

Sl. No.	Compound	DSC/POM	Transition temperature in °C				Thermal Range	
			I-N	N-Cr	N-SmA	SmA-Cr	ΔN	ΔSmA
1	C1	DSC	102.94	--	97.08	62.78	5.86	34.3
		POM	103.4	--	96.7	62	6.7	34.7
2	C2	DSC	74.63	--	62.28	49.6	12.35	12.68
		POM	74.9	--	63.5	49	11.4	14.5

➢ *Image Enhancement by Histogram Equalization:*

Various methods are evolved to enhance the quality of textural images like gray scale manipulation, filtering and Histogram. Histogram equalization technique is a simple method for image enhancement. To enhance the contrast image phases of liquid crystalline compounds by considering global and local image information preservation of the input brightness of the textural image is required to avoid the generation of non existing artifacts in the output image. This method preserves the input brightness on the output image with a significant contrast enhancement. This method is used to identify the uniform regions and to detect the defects which are not clearly observed from the textures recorded by POM. First time the histogram equalization studies are carried out by considering optical textures of the compound as input.

For true implementation of histogram equilization the following procedure is used.

Let Pr (rj), j= 1,2…..L, denotes the histogram associated with the intensity levels of a given image and recall that the values in a normalized histograms are approximations to the probability of occurrence of each intensity level in the image. For discrete quantities we work with summations and the equalization transformation becomes [12-15]

$$Sk = T(rk)$$

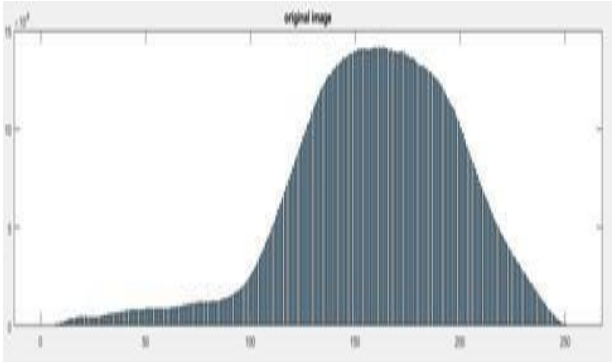
$$k = \sum_{j=1} Pr(rj)$$

$$k = \sum_{j=1} \left(\frac{nj}{n} \right)$$

For k = 1,2….L, where it is the intensity value in the output image corresponding to value rk in the input image. Histogram equalization is implemented by X=histogram (I , LEV)

Where I is the input image, and LEV is the number of intensity levels specified for the output image. If LEV is equal to 'L' i.e., the total number of possible levels in the input image, then histogram equalization implements the transformation function, T(rk), directly. If LEV is less than'L', then histogram equalization attempts to distribute the levels so that they will approximate a flat histogram. The default value in histogram equalization is LEV = 64. For the most part, we use the maximum possible number of levels (i.e., 256) for LEV because this produces a true implementation of the histogram equalization method.

(a)



(b)

Fig 5(a) Isotropic-Nematic at Temperature 103.4 ^{0}C from Thermal Microscope. (2437 x 1919 Pixels):
Fig 5(b) True RGB colour Histogram Image of Original Texture 5(a).

Fig 6(a) Red region optical texture got using histogram technique

Fig 6(b) Red region optical texture for histogram equalization

Fig 6(c) Red region optical texture for Adaptive histogram

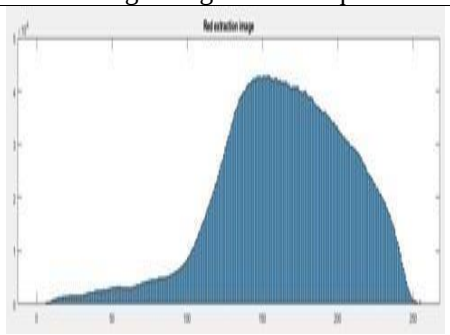


Fig 6(d) Red region histogram image

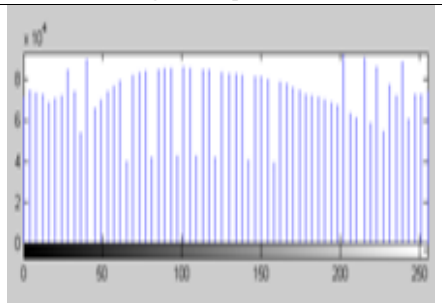


Fig 6(e) Red region histogram equalization image

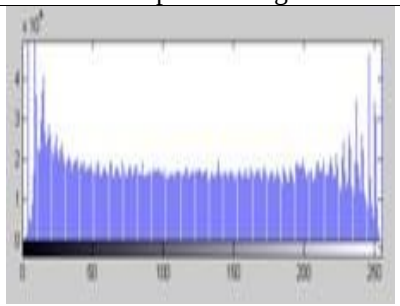


Fig 6(f) Red region Adaptive histogram image

Fig 7(a) Green region optical texture got using histogram technique

Fig 7(b) Green region optical texture for histogram equalization

Fig 7(c) Green region optical texture for Adaptive histogram

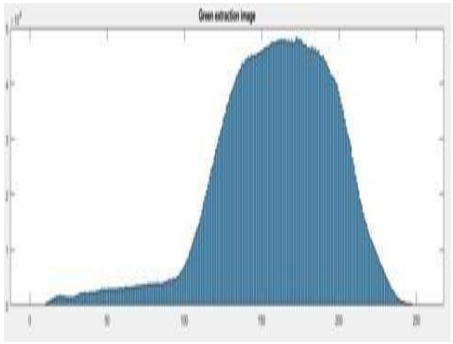


Fig 7(d) Green region histogram image

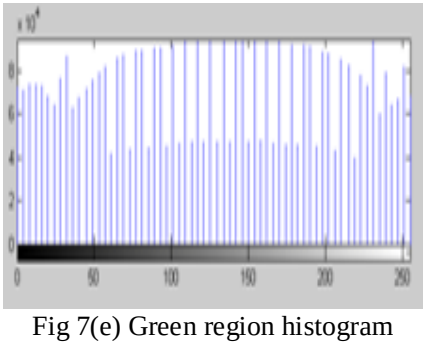


Fig 7(e) Green region histogram equalization image

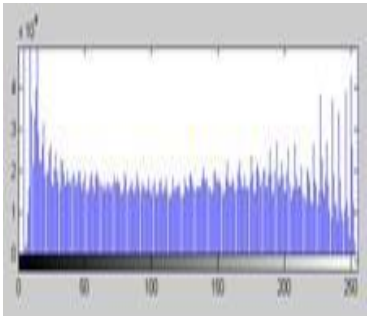


Fig 7(f) Green region Adaptive histogram image

Fig 8(a) Blue region optical texture got using histogram technique

Fig 8(b) Blue region optical texture for histogram equalization

Fig 8(c) Blue region optical texture for Adaptive histogram

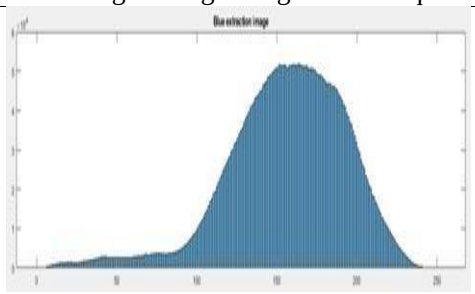


Fig 8(d) Blue region histogram image

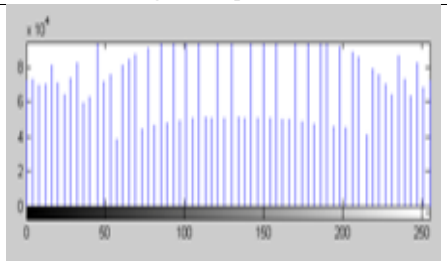


Fig 8(e) Blue region histogram equalization image

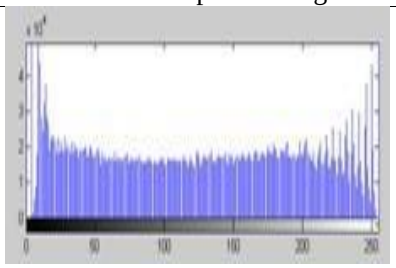
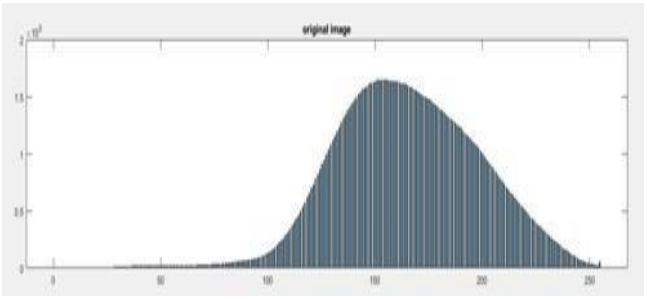


Fig 8(f) Blue region Adaptive histogram image

(a)



(b)

Fig 9(a) Smectic A phase at temperature 96.7 ^{0}C from Thermal microscope. (2437 x 1919 pixels):
Fig 9(b) true RGB colour Histogram image of original texture 9(a).

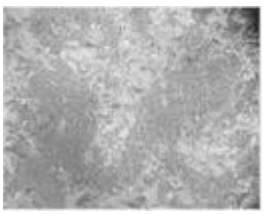


Fig 10(a)Red region optical texture got using histogram technique

Fig 10(b) Red region optical texture for histogram equalization

Fig 10(c) Red region optical texture for Adaptive histogram

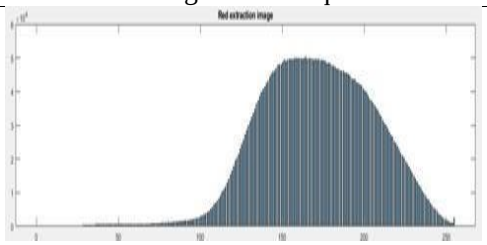


Fig 10(d) Red region histogram image

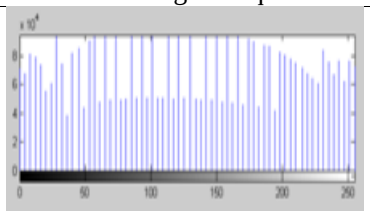


Fig 10(e) Red region histogram equalization image

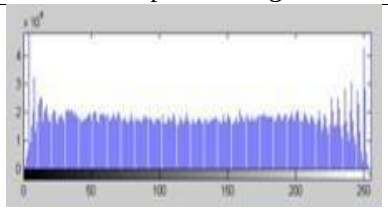


Fig 10(f) Red region Adaptive histogram image

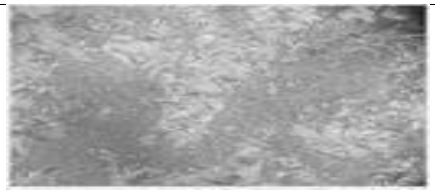


Fig 11(a) Green region optical texture got using histogram technique

Fig 11(b) Green region optical texture for histogram equalization

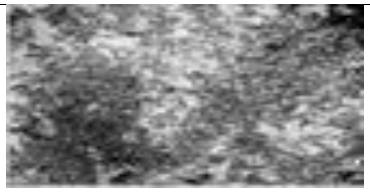


Fig 11(c) Green region optical texture for Adaptive histogram

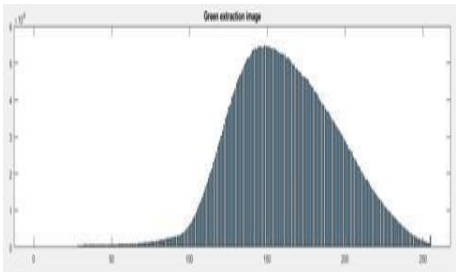


Fig 11(d) Green region histogram image

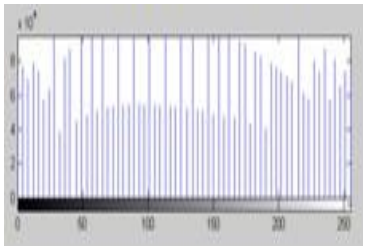


Fig 11(e) Green region histogram equalization image

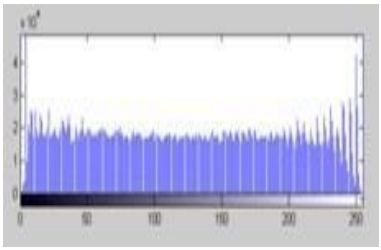


Fig 11(f) Green region Adaptive histogram image

Fig 12(a) Blue region optical texture got using histogram technique

Fig 12(b) Blue region optical texture for histogram equalization

Fig 12(c) Blue region optical texture for Adaptive histogram

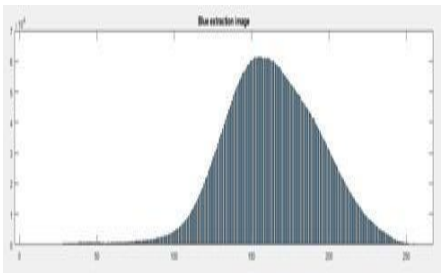


Fig 12(d) Blue region histogram image

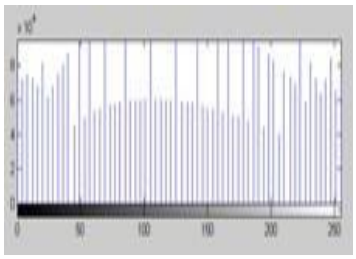


Fig 12(e) Blue region histogram equalization image

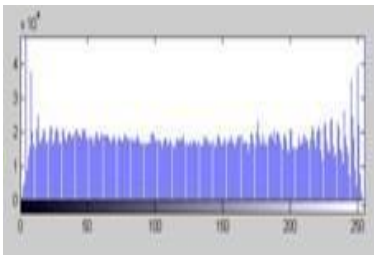
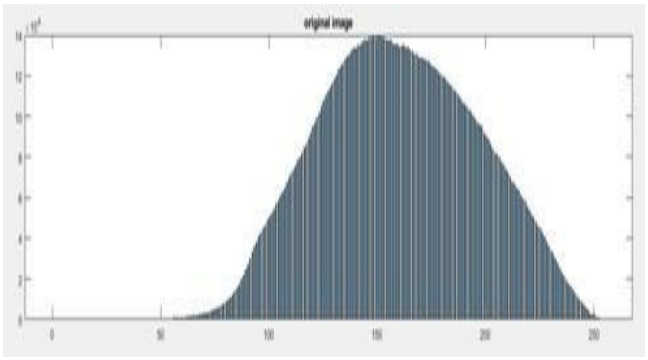


Fig 12(f) Blue region Adaptive histogram image

(a)



(b)

Fig 13(a) Isotropic to Nematic at temperature 74.9^{0}C from Thermal microscope. (2437 x 1919 pixels):
Fig 13(b) true RGB colour Histogram image of original texture 13(a).

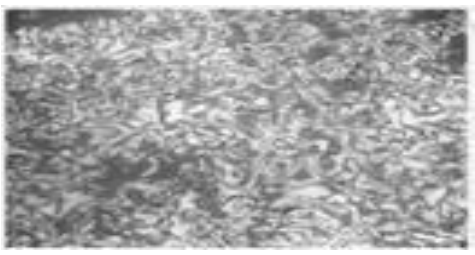


Fig 14(a) Red region optical texture got using histogram technique

Fig 14(b) Red region optical texture for histogram equalization

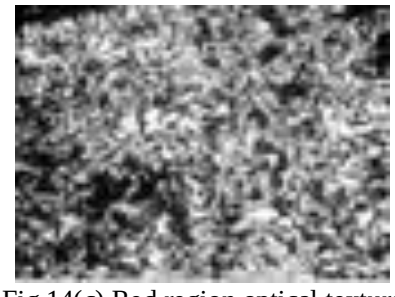


Fig 14(c) Red region optical texture for Adaptive histogram

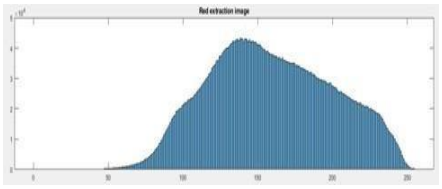


Fig 14(d) Red region histogram image

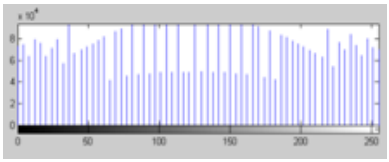


Fig 14(e) Red region histogram equalization image

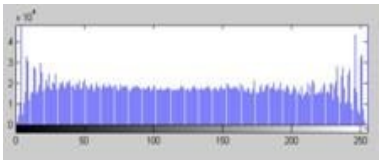


Fig 14(f) Red region Adaptive histogram image

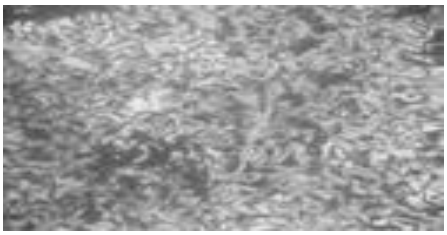


Fig 15(a) Green region optical texture got using histogram technique

Fig 15(b) Green region optical texture for histogram equalization

Fig 15(c) Green region optical texture for Adaptive histogram

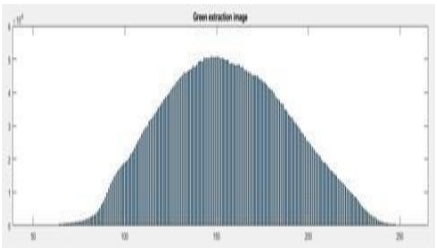


Fig 15(d) Green region histogram image

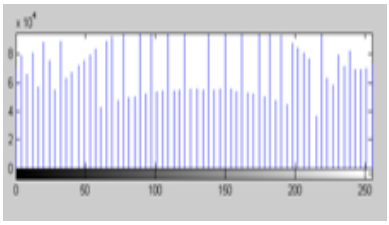


Fig 15(e) Green region histogram equalization image

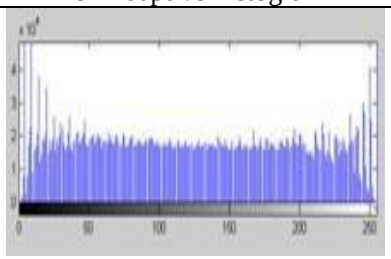


Fig 15(f) Green region Adaptive histogram image

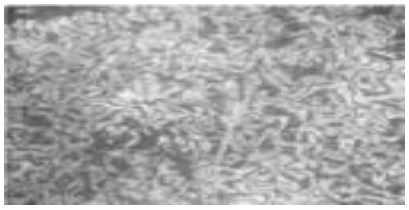


Fig 16(a) Blue region optical texture got using histogram technique

Fig 16(b) Blue region optical texture for histogram equalization

Fig 16(c) Blue region optical texture for Adaptive histogram

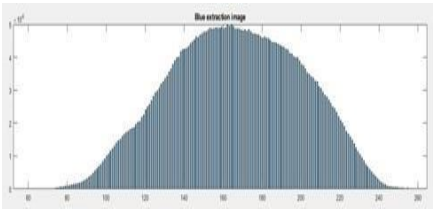


Fig 16(d) Blue region histogram image

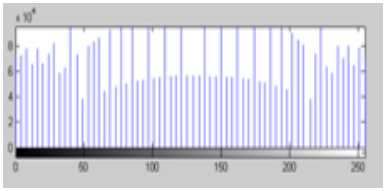


Fig 16(e) Blue region histogram equalization image

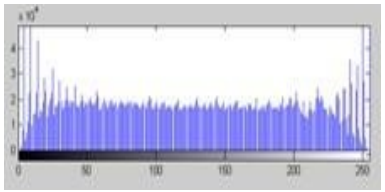
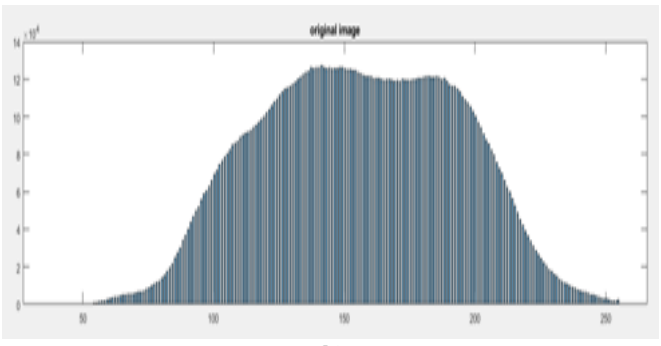


Fig 16(f) Blue region Adaptive histogram image

(a)



(b)

Fig 17(a) Nematic to Smectic at temperature63.5^{0}C from Thermal microscope. (2437 x 1919 pixels):
Fig 17(b) true RGB colour Histogram image of original texture 17(a).

Fig 18(a) Red region optical texture got using histogram technique

Fig 18(b) Red region optical texture for histogram equalization

Fig 18(c) Red region optical texture for Adaptive histogram

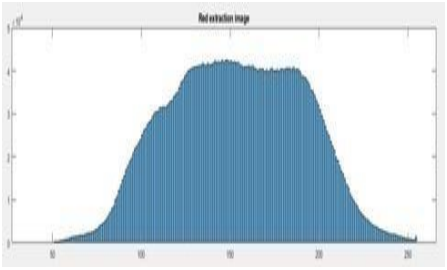


Fig 18(d) Red region histogram image

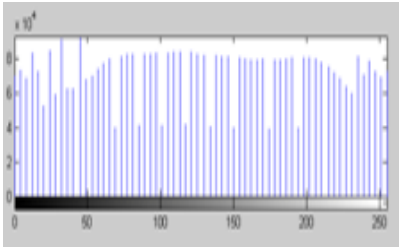


Fig 18(e) Red region histogram equalization image

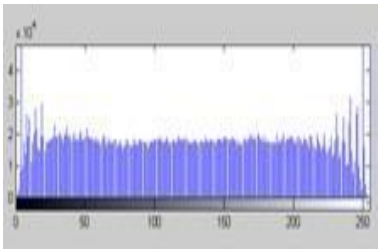


Fig 18(f) Red region Adaptive histogram image

Fig 19(a) Green region optical texture got using histogram technique

Fig 19(b) Green region optical texture for histogram equalization

Fig 19(c) Green region optical texture for Adaptive histogram

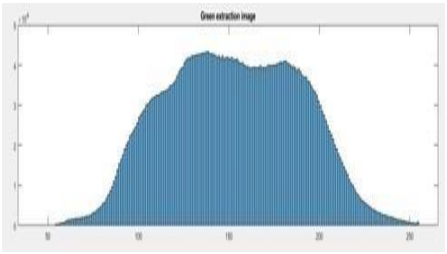


Fig 19(d) Green region histogram image

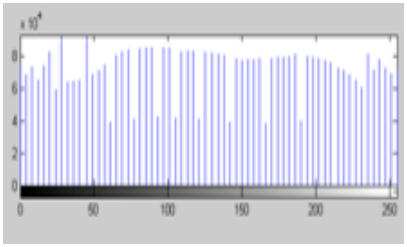


Fig 19(e) Green region histogram equalization image

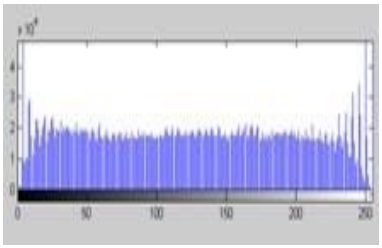


Fig 19(f) Green region Adaptive histogram image

Fig 20(a) Blue region optical texture got using histogram technique

Fig 20(b) Blue region optical texture for histogram equalization

Fig 20(c) Blue region optical texture for Adaptive histogram

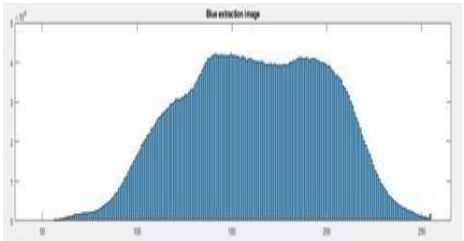


Fig 20(d) Blue region histogram image

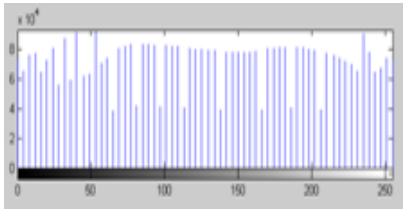


Fig 20(e) Blue region histogram equalization image

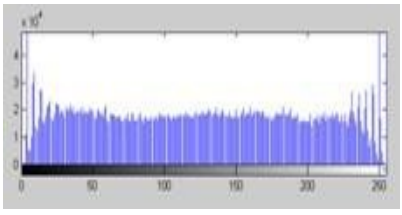


Fig 20(f) Blue region Adaptive histogram image

II. RESULT AND DISCUSSIONS

The POM is a ideal technique for preliminary characterization of Liquid crystalline phases. The optical texture is a picture of thin layer of liquid crystal obtained when observed by the microscope under linearly polarized light. the existence of mesophases and defects are identified based on textures. Usually the textural images obtained in POM are dark and low contrast. To enhance the images the original image is to be extracted in Red, Green and Blue regions separately thereby histogram equalization and adaptive histograms are to be done.

Figure 5(a) shows the optical texture of pure compound at Isotropic - Nematic transition obtained at temperature 103.4^{o}C. Figure 5(b) represents the true RGB colour histogram image of pure compound. 6(a) represents the converted image of true Red colour image. In which the dark nature of the image is expected because the histogram is biased towards the dark end of the gray scale. Hence the width of the histogram is narrow with respect to entire gray scale as shown in Figure 6(d). The image in fig. 6(b) is converted image of histogram equalization of fig. 6(a) and fig. 6(e) is an improvement in average intensity and contrast are observed. For further enhancement the adaptive histogram is carried out and there is an enhancement in the contrast image as shown in fig. 6(c). In this adaptive equalization there is increase in overall intensity, this is due to the fact that the average intensity levels in adaptive histogram is higher than equalized histogram.

By this technique it is learnt that if the contrast of the image is enhanced it is very easy to observe the defects in the textures. Even if some nano particles are dispersed into pure liquid crystals. Black coloured areas in texture represents the local mean intensity which is different from the total mean intensity of the image. The histogram equalization and adaptive histogram equalization are done at different liquid crystalline transitions and shown in the fig. 7(a), 7(b), 7(c), 7(d), 7(e) and fig. 7(f) to fig. 20(a), 20(b), 20(c), 20(d), 20(e) and fig. 20(f).

III. CONCLUSION

In this Maniscript the author mainly discussed about the histogram equalization and adaptive histogram equalization techniques for extracted Red, Green and Blue colours. By increasing the visual appearance of the low contrast image it is possible to identify the phases at transition temperature with naked eye. The high contrast image obtained covers a broad range of gray scale and further the distribution of the pixels is not too far from the uniform.

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