# CERVICAL CELL FOR THINPREP IMAGE ENHANCEMENT USING MORPHOLOGICAL SEGMENTATION

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## ABSTRACT:

This paper proposes a contrast enhancement technique, which is applied on the ThinPrep Cervical Cell. The proposed technique is divided into two stages. In the First Stage the cervical cells for the thin Prep Image will be Segmented using morphological Segmentation. Then, three algorithms of contrast enhancement technique are applied on the cervical cell to increase their contrast. The results show that the proposed technique has successfully increased the contrast of the thinPrep images. Hence, the resultant image would be more useful to the pathologists.

**Index Terms: -** Cervical Cancer, Segmentation, Enhancement.

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## 1. INTRODUCTION:

Cancer is a group of diseases in which cells in the body grow, change, and multiply out of control. Cervical cancer refers to the erratic growth of cells that originate in the tissues of a cervix. It is usually a slow-growing cancer that may not have symptoms but can be found with regular Pap tests.[1]

Cervical cancer is the most common malignancy in women of developing countries. [3].Cervical cancer is a preventable disease and unlike most other cancers, it can be easily detected by a routine screening test. Currently, cervical smear screening is the most popular method used to detect the presence of abnormal cells developing in the cervix [2].

It is mainly caused by Human Papillomavirus. Therefore, the mortality related to cervical cancer can be substantially reduced through early detection and treatment.

ThinPrep monolayer cytology was introduced to overcome the limitations of the conventional Pap smear [4]. However, the cytology image of ThinPrep captured from the ThinPrep slide using standard image analyzer usually has low contrast quality due to the magnification and overexposure to the light built in the system of the image analyzer. In some cases, the ThinPrep images are hazy and afflicted by unwanted noises [5]. These problems can hide and obscure the important cervical cells morphologies, hence increase false diagnosis rate.

Contrast is the factors that provide the accuracy of interpretation of diseases based on medical images by pathologists or radiologists. To date, contrast enhancement process plays an important role in enhancing the quality and contrast of medical images [6]. Several previous studies have proven that contrast enhancement techniques are capable of removing unwanted noises and enhance the brightness and contrast of medical images [7].

Most of researchers still focus on enhancing the contrast of conventional Pap smear images. Ghafar *et al.* (2003) has implemented bright and dark stretching method on the conventional Pap smear images [8]. The implementation results show that the contrast of the overall Pap smear images improved significantly. Mat- Isa *et al.* (2003) proposed contrast enhancement processing on the segmented conventional Pap smear images [6].

Therefore, the current study proposes a contrast enhancement method for ThinPrep images of the cervical cell.

## 2. MORPHOLOGICAL SEGMENTATION AND CONTRAST ENHANCEMENT METHO DOLOGY (MSCEM):

The proposed MSCEM methodology is illustrated by the flow chart in Figure 1. The proposed methodology needs two image processing techniques, which are morphological segmentation of cervical cell and apply the contrast enhancement algorithm on the segmented cervical cell.

During the screening process of a cervical precancerous cells, pathologists observe that the abnormalities of morphological features in cervical cells.

These characteristics include [9]:

(i) Abnormal size and shape of cells

(ii) Abnormal biological changes in nucleus and cytoplasm

Most of the contrast enhancement techniques are applied to the whole Pap smear images in the screening process. As compared to these studies, work involved in this paper focused on enhancing the contrast of the cervical cell of interest (nucleus and cytoplasm components). The proposed contrast enhancement technique will first, determine the cervical cell of interest. The cervical cell of interest in ThinPrep image will be segmented by using the proposed MSCEM Methodology. Then, the cervical cell of interest will be implemented with three contrast enhancement algorithms.

The three contrast enhancement algorithms that have been selected to increase the contrast of cervical cell of ThinPrep images are linear contrast, non-linear bright contrast and non-linear dark contrast.

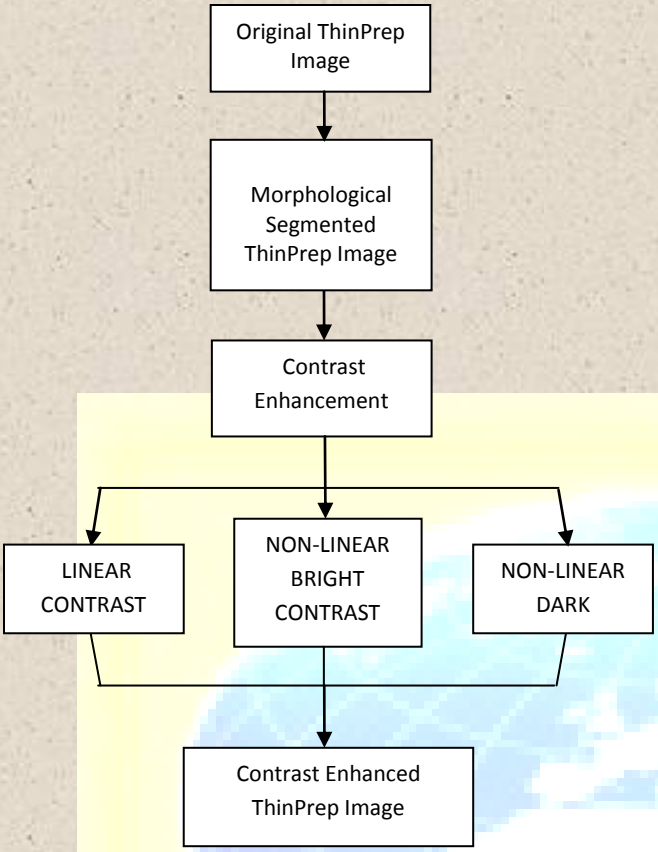



**Figure 1. The proposed MSCEM Methodology**

Before enhancement the thinprep cervical cell image was segmented with the more details of the nucleus than the original thin prep image using a series of automated fast morphological transforms with octagonal structuring elements[11].

Then through this proposed MSCEM Methodology the original Thin Prep colour Image is Converted into single Red,Green and Blue plane Image.

Then the Each R, G and B plane cell image was first globally thresholded, resulting in an incomplete segmentation of the nucleus. So Cytoplasmic were removed by performing a Morphological closing of the image using a structuring element smaller than the smallest nucleus, and nuclear inhomogeneity was corrected by an Morphological opening of similar size. The resulting segmented image for the respective R,G and B plane were used for identifying the nucleus with more details than the original thinprep image and it is given in eqn 1,2& 3.

$$SI_R = I_R + ((TI_R \bullet MC_R) \circ MO_R), \quad (1)$$

$$SI_G = I_G + ((TI_G \bullet MC_G) \circ MO_G), \quad (2)$$

$$SI_B = I_B + ((TI_B \bullet MC_B) \circ MO_B), \quad (3)$$

where $SI_R$, $SI_G$, $SI_B$ is the resulting segmented image for the respective R,G and B plane, $I_R$ , $I_G$ , $I_B$ is the original image for the respective R,G and B plane. $TI_R$, $TI_G$, $TI_B$ is the thresholded image for the respective R,G and B plane, $MC_R$, $MC_G$, $MC_B$, $MO_R$, $MO_G$, $MO_B$ are structuring elements for the respective R,G and B plane. The symbols ● and o denote morphological closing and opening, respectively.

Then by combining R, G and B Channel Segmented image $SI_R$, $SI_G$, $SI_B$ we get the segmented cervical cell image is eqn (6).

$$SI_{RGB} = I_{RGB} + ((TI_{RGB} \bullet MC_{RGB}) \circ MO_{RGB}) \quad (4)$$

where $SI_{RGB}$ is the resulting segmented image, $I_{RGB}$ is the original thinprep Image, $TI_{RGB}$ is the thresholded image, $MC_{RGB}$ and $MO_{RGB}$ are structuring elements. The symbols ● and o denote morphological closing and opening, respectively.

The method proved quite robust, however on some darkly stained cells the initial threshold required adjustment. It is felt that local thresholding may be more appropriate and this will be investigated at a future date, allowing the segmentation to be fully automated.

After Segmentation the thinprep image was enhanced by the three contrast enhancement algorithm and it proposed a linear contrast enhancement algorithm is given in Equation 5 [9]. By implementing this algorithm, the narrow range of data in an image will be stretched linearly to the whole of histogram so that its dynamic range is fulfilled.

$$LC_{RGB}(i,j) = 255 * \left[\frac{SI_{RGB}(i,j) - MIN_{RGB}}{MAX_{RGB} - MIN_{RGB}}\right] \quad (5)$$

Where

$LC_{RGB}(i,j)$ : The new RGB value of the pixel

$SI_{RGB}(i,j)$ : The segmented RGB value of the pixel

$MIN_{RGB}$ : Minimum RGB value

$MAX_{RGB}$ : Maximum RGB value

The two non-linear contrast algorithms are non-linear bright and non-linear dark. The non-linear bright contrast algorithm is given in Equation 6. By implementing this algorithm, the narrow range of data that lie in the right side of histogram will be stretched while the data that lie in the left side of histogram will be compressed.

$$NLBC_{RGB}(i,j) = 255 * \left[\frac{r^{SI_{RGB}(i,j) - MIN_{RGB}}}{r^{MAX_{RGB} - MIN_{RGB}}}\right] \quad (6)$$

Where

$NLBC_{RGB}(i,j)$: The new RGB value of the pixel

$SI_{RGB}(i,j)$ : The segmented RGB value of the pixel

$MIN_{RGB}$ : Minimum RGB value

$MAX_{RGB}$ : Maximum RGB value

$r$ : Typical constant value 1.02

The second non-linear contrast algorithm is known as non-linear dark. The non-linear dark contrast algorithm is given in Equation 7. This algorithm is able to expand the data that lie in the

left side of histogram and compress the data that lie in the right side of histogram. Thus, the contrast of the dark area will increase and the contrast of the bright area will decrease.

$$NLDC_{RGB}(i,j)=255*\left[\frac{r^{MAX_{RGB}-MIN_{RGB}}-r^{MIN_{RGB}-SI_{RGB}(i,j)}}{r^{MAX_{RGB}-MIN_{RGB}}}\right] \quad (7)$$

Where

$NLDC_{RGB}(i,j)$ : The new RGB value of the pixel

$SI_{RGB}(i,j)$ : The segmented RGB value of the pixel

$MIN_{RGB}$ : Minimum RGB value

$MAX_{RGB}$ : Maximum RGB value

$r$ : Typical constant value range between 1.02 and 1.03

## 3. EXPERIMENTAL RESULTS AND ANALYSIS:

The MSCEM Methodology is tested on two ThinPrep images namely ThinPrep 1 and ThinPrep 2. The results for ThinPrep 1 and ThinPrep 2 are shown in Figure 2 respectively. Figure 2(a) shows the original ThinPrep image, Figure 2(b) Segmented thinprep Image, 2(c), 2(d) and 2(e) represents the results after applying contrast enhancement algorithm; linear, nonlinear bright, non-linear dark contrast respectively.

Table 1 shows the optimum value for constant, *r* of ThinPrep 1 and ThinPrep 2 which have been implemented with non-linear bright and non-linear dark contrast algorithm. The values were obtained after some try and error analysis.

The implementation results of linear contrast algorithm on segmented ThinPrep images are shown in Figure 2(c).

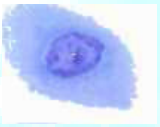
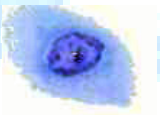
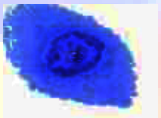
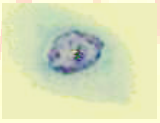
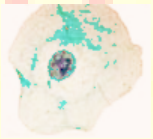
| Figure | Image | Thinprep 1 | Thinprep 2 |
|---|---|---|---|
| (a) | Original |  |  |
| (b) | Segmented Image |  |  |
| (c) | Linear Contrast |  |  |
| (d) | Non Linear Bright Contrast |  |  |
| (e) | Non Linear Dark Contrast |  |  |

**Figure 2. MSCEM Methodology Results of two Thinprep Images of ThinPrep 1 and ThinPrep 2**

**Table 1: The optimum value for constant, *r* of ThinPrep 1 and ThinPrep 2**

| Image | Non-Linear Contrast (r) | |
|---|---|---|
| | Bright | Dark |
| ThinPrep 1 | 1.02 | 1.03 |
| ThinPrep 2 | 1.02 | 1.02 |

The histogram of the Original Image is shown in figure 3(a). The linear contrast algorithm has spread the RGB value of pixel linearly so that they will cover the full range of RGB histogram (0 – 255) and it's shown in figure 3(b). Thus, the contrast of the nucleus and cytoplasm components in the ThinPrep image was successfully increased.

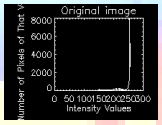
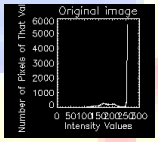
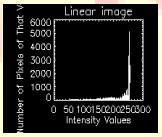
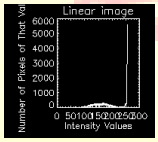
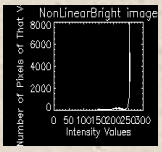
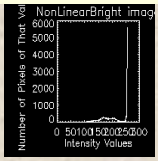
The second contrast enhancement algorithm is nonlinear bright contrast are shown in Figure 2(d). The optimum value of constants, *r* for ThinPrep 1 and ThinPrep 2 images are shown in Table 1. For ThinPrep slide images, most of pixels in cytoplasm region lying on the bright side of RGB histogram (on the right of histogram) while pixels in nucleus region lying on the dark side of the histogram (on the left of histogram) is shown in figure 3(c). Thus, when applying the MSCEM Methodology, only the RGB values of the cytoplasm pixels will be stretched while the RGB values of nucleus pixels will be compressed. As the result, the contrast of the cytoplasm area is increased higher than before the implementation of the algorithm. From this comparison we conclude that Non-Linear bright contrast method gives better contrast than other contrast methods.

Finally, the images of ThinPrep 1 and ThinPrep 2 have been implemented with non-linear dark contrast algorithm. The results in Figure 2(e) that used the optimum value of constants, *r* given in Table 1 show that the contrast of the nucleus area is higher than before the implementation of the non-linear dark contrast algorithm and the histogram is shown in figure 3(d). The MSCEM algorithm has been successfully implemented to stretch the RGB value of nucleus pixels in order to increase the contrast of the nucleus region. The RGB value of

cytoplasm pixel has been compressed and causes the decreased in contrast for cytoplasm region. Therefore, after applying this algorithm, the morphological changes in the nucleus can be easily seen.

## 4. CONCLUSION:

This work shows that the MSCEM Methodology Segmented thin prep image with more explained details of nucleas. After segmented thin prep image then apply contrast enhancement technique can be used to enhance the contrast of the Thin Prep image. Linear contrast algorithm can be used to improve the overall contrast of ThinPrep images. Contrast of specific area in an image can be increased by using the specific non-linear contrast enhancement algorithm. Morphological changes in cytoplasm and nucleus regions can be easily seen after implementation of non-linear bright and non-linear dark contrast algorithm respectively. The MSCEM enhancement

| Figure | Image | Thinprep 1 | Thinprep 2 |
|---|---|---|---|
| (a) | Histogram of Original Image |   |   |
| (b) | Histogram of Linear Contrast Image |   |   |
| (c) | Histogram of Non Linear Bright Contrast Image |   |   |

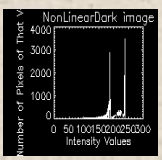
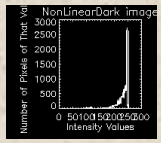
| | | | |
|---|---|---|---|
| (d) | Histogram of Non Linear Dark Contrast Image |   |   |

**Figure 3. MSCEM Methodology Histogram Results of two Thinprep Images of ThinPrep 1 and ThinPrep 2**

technique has successfully enhanced the cervical cells of interest and also improves the image quality so that the resultant images would be more useful for further analysis by pathologists.

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